GREEN CHINA

Chinese insights on environment and development

Edited by James Keeley and Zheng Yisheng

绿色中国

本土学者论中国的环境与发展

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For further information please contact:
International Institute for Environment and Development (IIED)
80-86 Grays Inn road
London WC1X 8NH
United Kingdom
newbooks@iied.org
www.iied.org/pubs

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CONTRIBUTORS

Cao Dong	Senior Research Fellow, Chinese Academy for Environmental Planning, Ministry of Environmental Protection
Chen Jie	Graduate Student, China University of Political Science and Law
Chen Shaojun	Professor, Chinese Institute of Water Resources and Hydropower
Dalintai	Senior Research Fellow, Churiya Research Centre for Rangeland Ecology, Inner Mongolia
Fu Tao	Editor-in-Chief, China Development Brief
Gao Minxue	Deputy Director, School of Statistics, Renmin University, Beijing
Guo Xiaomin	Senior Research Fellow, Ministry of Environmental Protection
Han Nianyong	Senior Research Fellow, Chinese National Committee for Man and the Biosphere
Jiang Hongqiang	Senior Research Fellow, Chinese Academy for Environmental Planning, Ministry of Environmental Protection
Jiang Xuemei	Doctoral student, Northeastern Forestry University
Li Shengzhi	Senior Research Fellow, Shan Shui Conservation Centre
Liang Fan	City University of New York, New York
Lu Feng	Department of Philosophy, Tsinghua University
Lu Zhi	Executive Director, Centre for Nature and Society, Peking University
Ma Zhong	Professor, Dean of School of Environment and Natural Resources, Renmin University
Piao Zhengji	Senior Engineer, Department of Zoology, Changbaishan Academy of Sciences, Jilin Province
Shen Keting	Associate professor, College of Economics, Zhejiang Gongshang University
Shen Xiaohui	Senior Engineer, State Forestry Administration
Shen Xiaoli	Centre of Conservation Biology, Peking University
Wang Jin	Professor, School of Law, Peking University
Wang Jinnan	Vice-President and Chief Engineer, Chinese Academy of Environmental Planning, Ministry of Environmental Protection
Wang Mingyuan	Professor, School of Law, Tsinghua University
Wu Jian	Associate Professor, School of Environment and Natural Resources, Renmin University, Beijing
Xu Jintao	Professor, College of Environmental Sciences, Peking University
Xu Songling	Senior Research Fellow, Centre for Environment and Development, Chinese Academy of Social Sciences
Yi Fujin	Doctoral student, University of California, Davis
Yu Fang	Senior Research Fellow, Chinese Academy of Environmental Planning, Ministry of Environmental Protection
Zhang Shiqiu	Professor and Deputy Dean, College of Environmental Sciences and Engineering, Peking University
Zhang Xiao	Senior Research Fellow, Centre for Environment and Development, Chinese Academy of Social Sciences
Zhao Hongmei	Associate Professor, China University of Political Science and Law
Zheng Yisheng	Senior Research Fellow, Deputy Director, Centre for Environment and Development, Chinese Academy of Social Sciences; and Professor, Institute of Quantitative and Technical Economics, Chinese Academy of Social Sciences.

CONTENTS

Foreword

IIED is delighted to partner with the China Academy of Social Sciences and the Ford Foundation-China on the translation and publication of *Green China: Chinese insights on environment and development* (published in Chinese as the China Environment and Development Review).
In a world in which China's environmental footprint is often portrayed in alarmist terms, the chapters presented here show a more nuanced and diverse range of experiences and problems faced, and focus on how they are being tackled. This foreword is written in a week dominated by the aftermath of Japan's huge earthquake, and the fall-out from the nuclear crisis, reactions to which include the Chinese government's decision to halt their nuclear power plant building programme. Given the scale on which demand for energy in China has been growing, such a decision will have wide-ranging consequences for the rest of the world. The global interconnections between energy, climate change, and land and water use mean that everyone has an interest in seeing China succeed in getting continued growth, but at lower environmental cost.

China's economy has generated an unprecedented level of growth, bringing large increases in income, and falling poverty for hundreds of millions of people. For example, per capita incomes have risen almost tenfold from 1985 to 2006, and levels of poverty have fallen from two-thirds in 1981 to 10% today. This hugely impressive performance is seen by many low income countries as offering a model for rapid economic transformation that they could also follow, in preference to western models of development. But the chapters presented here show clearly that China's model, while demonstrating remarkable performance has also brought high environmental costs within and across the country's borders. Internally, China's land and water has suffered from over-use of chemical fertiliser, heavy levels of air pollution, and extremely low levels of water quality with many lakes and rivers ranked as unfit to touch, let alone use for irrigation. Climate change impacts are of growing significance, especially in the north-west, where growing numbers of people face acute water shortages and depletion of aquifers. These environmental impacts are hitting both urban and rural areas, both poor and rich, through ill-health, rising levels of cancer, floods and falling productivity of water and soils. However, they are disproportionately affecting the poor, especially those in more marginal areas.

China is also having an environmental impact at international and global levels, having become the largest emitter of CO_2 and nitrous oxide (NOx) emissions from agriculture, as well as SO_2, and the source of a range of transboundary water problems. China's environmental footprint is also increasingly visible around the world, given its rapid growth in demand for resources from overseas, whether wood, oil and gas, metals or agricultural commodities, such as soya and oil palm. However, it should be remembered that a good measure of these impacts are due to China meeting consumer demand elsewhere in Europe and North America.

China's performance has excited both envy and alarm, because of the scale and speed of change. There has been a single-mindedness to the Chinese pursuit of economic growth, which has successfully re-positioned China on the global stage after two centuries of relative powerlessness. The leadership has recognised the importance of growth as essential to keep the nation together. China presents a puzzle for many outsiders, because it is assumed that central government can get things done. In practice, while there is a fair body of environmental law and regulation, implementation has been limited and central government has found itself less able to achieve its ends than many outsiders would believe. Civil society and media pressures while starting to establish themselves, remain relatively weak and with limited ability to get significant shifts in policy and practice.

China's leadership understands the need for a shift in practice, as is visible in official policy promoting an environmentally friendly and resource efficient society, and promotion of a circular economy. Ambitious targets have been set for the 12th Five Year Plan and its predecessor,

as regards energy intensity and the shift towards non-fossil fuels. Government has sought to innovate with testing out of green accounting and payments for ecosystem services. There have been huge campaigns, a legacy of the Maoist years, such as the Sloping Land Conversion programme or the South-North Water Diversion project. These tend to be very ambitious, target driven programmes on a massive scale that can generate as many problems as they seek to solve. China retains a strong respect and central role for technocrats, as seen in who holds the top jobs, and strong reliance on research institutes and academics for policy advice. A technology led process of innovation has allowed for the production at scale of many innovations for sustainability, such as solar panels, biogas plants and low carbon technologies. But it has meant that there has been less interest in more holistic approaches, involving citizen action, and re-design of legal and institutional mechanisms.

China's sustainability challenges are many and increasingly global in nature. As we advance into the 21st century, it has become ever more apparent how interconnected are our hopes for prosperity and well-being. No single country has all the resources they need, and each is faced by a different set of problems, interests and tools to work with. These chapters, written by China's leading thinkers on environment and development, show that we need a better understanding of how China is trying to address many of the same challenges faced elsewhere, with a tool kit not dissimilar to our own. We have much to learn from their insights, but also experience to offer as we come to terms with our mutual responsibility for our one and only earth.

Camilla Toulmin
Director, IIED.

Preface

It has been a decade since the first volume of the *China Environment and Development Review* was published in 2000 by the Centre for Environment and Development, Chinese Academy of Social Sciences. The second volume of the series came out in 2004, the third in 2007, and a fourth was published in 2011. Over the years, these Chinese language publications have generated considerable interest. It also became clear that there was considerable demand from researchers, policymakers, practitioners and others for these publications in English. It was therefore exciting for us when the Ford Foundation China agreed to support the International Institute for Environment (IIED) to produce *Green China: Chinese insights on environment and development*, an English version of the *China Environment and Development Review* bringing together twenty of the most significant articles from the 83 articles written for the Review to date. It is hoped that this book will contribute to improved understandings of the environmental challenges China faces, and what actions have been taken to address them. Most of the 20 chapters have been revised or updated by their author(s), in some cases extensively.

The book is divided into five parts. Part One offers an overview of some of the major environmental problems in China, including pollution (Ch. 2), declining forest quality (Ch. 3), grassland deterioration in Inner Mongolia (Ch.4), ecological reconstruction (Ch. 5), water scarcity (Ch. 6), and climate change (Ch. 7). Part Two contains case studies of conservation in protected areas (Ch. 8), human disturbances of old-growth forests (Ch. 9), and the relationship between the protection of cultural and biological diversity (Ch. 10). Part Three focuses on the role institution and policies have played in environmental management in China. These articles examine the rule of law in China from an environmental perspective (Ch. 11), investment policies (Ch. 12), national targets for environmental protection and the roles of public and private spending in meeting them (Ch. 13), and the state of research and practice in green GDP accounting (Ch. 14). In Part Four, we present five articles that discuss theoretical and methodological issues, including those relating to green economic accounting (Ch. 15), the economics and the ethics of consumerism (Ch. 16), equity in the distribution of natural capital (Ch. 17), China's water crisis and water footprints linked to international trade (Ch. 18), and a legal analysis of water rights (Ch. 19). The fifth and final part of the book highlights the importance of civil society and NGOs to China's environment and development, with a historical review of environmental NGOs in China (Ch. 20).

Dr. Liang Fan did the vast majority of the translation. She translated and/or polished earlier translations of 19 of the 20 chapters. In addition, she provided valuable editorial assistance throughout the process, and made many useful substantive suggestions on various aspects of the project. Thanks are also due to Dr. Annie Huang for her help with translation on some chapters.

It is no easy task to compile a collection of articles on the state of the environment and development in China that are at once empirically well-informed, theoretically sound, critically reflective, and fair to different points of view. The publication of each of the four volumes of *China Environment and Development Review* would not have been possible without the concerted efforts on the part of all the members of the Centre for Environment and Development at the Chinese Academy of Social Sciences.

There are many people to thank. In particular, Professor Zheng Yuxin, the director of the Centre, has been instrumental in putting together the series over the last ten years. His leadership and support helped make the project the success that it is. His wise insistence on deep probing of the economic drivers underlying the many environmental problem faced by China did as much as anything else to shape the general orientation of the series.

We are also grateful to Professor Wang Tongsan, Director of the Institute of Quantitative and Technical Economics at the Chinese Academy of Social Sciences. He has helped us in many ways with this endeavour since its earliest days. His encouragement has meant most to all of us who have worked on it over the years.

My colleague Dr. Wang Shiwen, Senior Research Fellow at the Centre (one of the two editors of Volume I) has made the series better than it would otherwise have been by imparting many helpful insights and suggestions. Another colleague, Qian Yihong, also Senior Research Fellow at the Centre, has, in addition to her rigorous research activities, spent many hours working on all of the first three volumes of the *China Environment and Development Review*.

Last, but not least, we owe a debt of gratitude to Dr. Irene Bain of the Ford Foundation. This book would have been nothing more than a very good concept without her belief in the project and commitment to excellence. Enormously generous with her time, Dr. Bain has provided unfailing support every step of the way.

Zheng Yisheng
Centre for Environment and Development, Chinese Academy of Social Sciences, Beijing.

IIED has welcomed this opportunity to join with Professor Zheng Yisheng and colleagues at the Centre for Environment and Development, Chinese Academy of Sciences in editing *Green China: Chinese insights on environment and development*. China's environmental and development challenges are important not just for China, but also worldwide. The chapters in this book illustrate this, but also set out some of the ways in which China has been experimenting with ways of promoting greater sustainability. The insights of these Chinese researchers and the experiences they describe offer lessons not only for China, but also for other countries, developed and developing alike.

We would particularly like to thank Khanh Tran-Thanh and Vanessa McLeod-Kourie for their work on the production and distribution process for this book. IIED would also like to thank the Ford Foundation China, and Irene Bain in particular for her support for this project.

James Keeley
IIED Research Associate, Addis Ababa, Ethiopia.

Part One
Environmental Issues

1
Introduction
China's environment and development challenge

Zheng Yisheng

总论

China's rapid economic growth means that Chinese environmental problems are also global problems. It would require several Earths to support the global population if every Chinese (not to mention the Indian population as well) consumed resources at, or even near, the level of the average citizen in wealthier, developed countries (Chinese Academy of Sciences, 2010)[1]. The deputy group leader of the China Energy Group at Lawrence Berkeley National Laboratory in California, David Fridley, has estimated that China's huge carbon emissions have serious potential to adversely affect the rest of the world (Warburton and Horn, 2007).

Nobody, however, is more troubled by this picture than those in China who work on sustainable development issues. After the 1972 United Nations Conference on the Human Environment, and especially after the 1992 United Nations Conference on Environment and Development (the Earth Summit), a loose-knit group of individuals from diverse backgrounds, but united in their commitment to the environmental cause, emerged in China. They included scientists, government officials (particularly those from agencies responsible for the environment and natural resources), people associated with environmental NGOs, social scientists, and individuals from the private sector. After years of trying to be heard and taken seriously, the group and its cause have both gained increasing recognition over time and begun to have some influence on public discourse and legislation. The magnitude of China's environmental problems and what these problems mean for the world as well as for China itself are urgent issues for them. This book will explore these challenges, and introduce the perspectives of leading Chinese thinkers working on cutting edge environment and development issues.

I. China's environmental challenges

Environmental conditions in China have changed considerably in the 25 or so years since environmental protection became a basic 'national policy' in China. Despite some localised improvements, overall environmental conditions in the country have worsened[2]. China's environmental problems are the outcome of a set of causes and circumstances particular to China, including complex relations between human resources, industrial development, and efforts to protect the environment.

This situation reflects the composite nature of Chinese environmental problems. Whereas countries that industrialized early have tended to experience different kinds of environmental damage during different stages of economic development, in China these stages and problems have been conflated. As a result, new problems are forming faster than existing ones are solved, if indeed they are solved at all, which they often are not. This situation also reflects a number of other problems. First, the scope of environmental pollution monitoring has remained rather limited since environmental protection measures were initiated over 20 years ago. Monitored pollutants include only common industrial discharges (such as sulphur dioxide, smoke dust, chemical oxygen demand (COD) and biochemical oxygen demand (BOD)), and monitoring has been largely confined to major cities, and key rivers and waterways. While there has been some decrease in these monitored forms of pollution over the years, groundwater pollution from nitrate and phosphorous compounds and air pollution from nitrous oxides have all been growing steadily.

Furthermore, pollution in China has become more toxic, posing greater health risks. This also reflects uneven levels of regional economic development in China. When the urban environment registers improvement, it is often because problems that seem to have been addressed in one place have actually gone elsewhere. Indeed, China's environmental problems are of a highly mobile nature, moving from bigger cities to smaller ones, from urban to rural areas, and from more to less developed regions. Soil and underground water pollution in rural areas have become so serious that they are a ticking time-bomb. Indeed, signs of this are already visible to those who know

where to look. And finally, these environmental problems increase overall ecological instability and vulnerability. The few remaining places untouched by human activities are rapidly disappearing. When many different environmental problems occur at the same time, individual effects of any one problem are compounded by interactions with other problems. This means that resolving any one problem is far more difficult than it would be if the problems occurred separately.

Indeed, Chinese environmental challenges have grown so serious and large that the Chinese economy may be on the verge of exceeding ecosystem carrying capacities, if it has not done so already. While there continue to be disputes among scholars in academia about what the notion of 'carrying capacity' means and how it should be measured, most are nonetheless willing to allow that in China the problem of reaching the limits of different carrying capacities is most acute. Despite China's small per capita ecological footprint compared with that of many other countries,[3] its enormous and growing population places it among the world's poorest countries with respect to per capita ecological space.

Just what these facts about China's environmental predicament entail for both China and the world as a whole still requires greater and more urgent attention. Debates about the environmental challenges facing China have often focused on the relation between energy supply and economic growth. This problem has engaged much, if not most, of the effort devoted to research on climate change and its responses. But for China, this is far from the only, or perhaps even the most pressing, environmental issue. In addition to the various problems directly associated with global warming and energy shortages, China faces a whole host of environmental stresses brought about by economic growth. Water quantity is one example. China's per capita fresh water supply is less than 2,000m^3, comparable to that for some tropical African countries (World Bank, 2011). And 61 per cent of the Chinese population, or 0.8 billion people, has a per capita water supply less than the world average. Moreover, many economically advanced regions and densely populated areas in China face a crisis of water quality. Yet, efforts to solve these water supply problems have often been undermined by the very hydropower projects that the country hopes can help it meet its international obligations to reduce carbon emissions through increasing use of renewable sources of energy. These hydro projects are often located in ecologically vulnerable areas, and pose risks for aquatic environments and ecosystems. Clearly, gains in one environmental area too often entail losses in others. These difficult choices may have been forgotten by developed countries, but they remain a reality in many developing countries, including China.

For a long time, many in China have not regarded the natural environment as something that needs maintenance and care. When the adverse effects of environmental problems on the population became manifest, initial responses were poorly coordinated. They were based on the assumption that the environment was no more than the sum of its parts and not an organic whole. In practice, this meant that different environmental problems, such as those with water, land, or vegetation, were addressed by different government departments who did not work in collaboration with one another. This compartmentalization is very clear in the case of water. Water-related management responsibilities are shared between four different government agencies. The Ministry of Water Resources is responsible for the development of surface water, the Ministry of Land and Resources for underground water, the State Oceanic Administration for sea water, and the Ministry of Environmental Protection for waste water treatment.

This bureaucratic compartmentalization and fragmentation manifest themselves in academia as well, in which departments are divided much like government agencies are, thereby rendering invisible the problems of the ecosystem as a whole. This necessarily means that it is difficult for them to come up with useful solutions. While the notion of 'inter-disciplinary studies' does exist, for the most part it is just an idea. Disciplinary boundaries dictate which problems should be studied, instead of real world problems dictating the form and content of research. These tendencies help explain the widespread dismissal of the precautionary principle that has now been fully

incorporated into environmental laws in the European Union. Indeed, environmental activists are not immune to these tendencies, and this has also compromised their own effectiveness.

However, reigning in environmentally destructive economic forces remains the toughest challenge. This is perhaps historically inevitable, as since its formation, the Chinese environmental movement has been caught in a vortex formed by two powerful currents: rapidly dwindling per capita ecological space on the one hand and rapidly growing per capita material wealth on the other.

II. Environmental mainstreaming: The influence of the environmental movement on economic development

There is no denying that China's efforts to slow ecological deterioration have yielded some success. However, the forces of economic development continue to be so powerful that environmental policies remain marginalized (Zhang, 2004). Neither the formulation nor the implementation of these policies has been fully integrated into economic planning and the legislative process. They have tended to be used to fight fires rather than prevent crises appearing in the first place.

Addressing this situation, and elevating the general status of environmental protection and ecological preservation relative to other national objectives, has been a strategic goal for concerned individuals over many years. These scholar-activists have worked in four different but related areas: developing a system of green economic accounting; linking environmental well-being with social justice; reforming the role of the government; and, promoting more environmentally-friendly developmental models.

1. Green economic accounting

In 1984, key government leaders came across a report about the cost of environmental pollution to the national economy. At that time it was about RMB 40 billion (US$ 6 billion) annually. They were so shocked by this figure that they decided to make environmental protection a national policy. Since then, economists have repeatedly performed similar calculations in an ongoing effort to change the traditional official attitude of dismissal and neglect towards environmental protection. These efforts culminated in 2004-2005, when the State Environmental Protection Administration (now the Ministry of Environmental Protection) and the National Bureau of Statistics cooperated to calculate China's green GDP (see Chapters 14 and 15). In this period, environmentally-aware economists used the new national policy for 'economic development in accordance with sound science' to mount an unprecedented critique on the dominance of GDP in economic thinking at every level. These economists argued that when the late Chinese leader Deng Xiaoping, broke with the past and proclaimed economic development to be the national imperative of a modern China, he did not mean that indefinite increase in GDP was the overarching national objective, but rather something more akin to sustainable development. Around this time, many anticipated that the environment would become a factor to be included in the criteria for evaluating the performance of governmental officials. But that hope was soon dashed and such proposals were widely dismissed, especially by agencies and departments responsible for economic development. Nor did technical difficulties in green GDP calculation help matters. In the end, nothing came of green GDP. By 2008, the global financial crisis, and the need to keep the country's economy afloat by maintaining a high rate of growth had pushed this issue further down the priority list.

However, those who are concerned about the environment in China remain hopeful that the greening of the national accounting system will come to pass. In the interim, understandings of the issues continues to deepen, and many who have thought long and hard about the subject are fully aware that a green national accounting system is no panacea for the country's environmental ills,

which will continue so long as the environmentally destructive mode of economic and material production remains intact. Until officials in every level of government answer to the people and society, and not just to their superiors, green economic indicators will be little more than a numbers-game. Secondly, historical, international, and cross-cultural experience has shown that environmental protection ultimately does not depend on abstract concepts, and still less on empty slogans, but rather on ordinary people's genuine concern for their own well-being and that of their fellow creatures, including their descendants. And finally, as long as the market is the sole measure of value, then many things will be under- or disvalued, even in a green accounting system.

2. Linking environmental protection with social justice

From the time environmental protection was first proposed as a subject of national importance in China, its proponents were accused of elitism or neglecting the on-going problem of poverty in China. This may have been because many of those who first became interested or actively involved were from the cities or from overseas, and particularly from developed countries. However, the proponents' own lack of understanding of the social implications of environmentalism and environmental activism was probably also partly responsible. Famously, growth-obsessed government officials and developers attacked environmentalists by proclaiming that China's poor 'would rather die from inhaling pollutants than from starvation'.

Yet, the choice between environmental protection and poverty reduction is often a false one. Unfortunately, the real choice is between satisfying the wants of a few and meeting the needs of many. For example, there has been a pervasive phenomenon where officials in local government (which can be referred to as A), particularly in poor areas, and corporate interests (referred to as B) try to profit from natural resources by exploiting local residents (which are denoted by C) and the natural environment (D). A and B often receive huge profits at the expense of C and D. The phenomenon can be encapsulated in the formula: A & B > C & D. Indeed, the well-being of the environment in effect represents that of future generations, whose well-being will depend in part on the condition of the environment bequeathed to them. Recent initiatives to grab or enclose land, water or scenic landscapes illustrate this phenomena. In fact, these actions reveal something that many have long suspected - that there is considerable overlap between environmental issues and the interests of socially-disenfranchised groups. Where farmers' interests are discounted, the environment is usually damaged as well. Environmentalists and cultural anthropologists have increasingly recognized the pernicious effects that simplistic use of the notion of 'modernity' can have on understandings and attitudes toward traditional, 'pre-scientific', forms of knowledge and indigenous cultures. The trivialization and dismissal of genuine sources of knowledge and understanding have contributed to the wanton destruction of the environment (see Chapter 10).

Economically poorer regions that have functioned as raw materials supplier to the national the economy will, sooner or later, become ecologically overspent. In the final years of the 20th century, three environmental disasters of catastrophic proportions shook China. In 1997, the Yellow River ran dry for a record 226 days; in 1998, historic floods in the Yangtze River basin threatened much of southeast China; and in 2000, sand and dust storms of unprecedented frequency and magnitude nearly paralyzed vast areas of northern China, including metropolitan Beijing. These events helped alert many Chinese to ecological degradation and deepened thinking about environmental issues. The trans-regional ecological repercussions of these events also raised awareness that the economy is necessarily a part of, and dependent upon, the natural environment. It was this profound, albeit belated, realization that finally brought the issues of intra-territorial and intra-national ecological debt and compensation to national attention.

Largely in response to this, around the turn of this century, a number of large scale eco-compensation projects were launched, including programmes to restore forests, lakes, and grasslands through reductions or prohibitions of cropping, logging and grazing activities.

These programmes have achieved some measure of success in China in mediating the conflicts – sometimes real and sometimes apparent– between poverty reduction and environmental protection. But they were often a vehicle for wealthier regions to aid poorer regions in economic development. They also represented a new and holistic approach to national development that integrated economic and social development objectives with environmental protection and ecological preservation. Until then, these goals had typically been considered incompatible. People's thinking has changed, and efforts are being made to achieve these goals jointly.

Despite some positive results of these programmes so far, only time will tell if they can successfully rehabilitate ravaged ecosystems (see Chapters 3, 5 and 9). Moreover, even the limited progress that has materialized under these programmes is always in danger of being reversed given pervasive ecological illiteracy and ineffective or absent environmental monitoring. Adding to these problems, the programmes themselves are at constant risk of being co-opted by special interests.

3. Adjusting the role of government

Most environmental activists in China agree that there are already plenty of environmental laws and regulations on paper. The problem lies in enforcement. Environmentalists are painfully aware that too many businesses and corporations are shielded from the legal consequences of their environmental misconduct by local governments that are often in their pay.

The symptoms of this problem appear at the local level, but the root cause lies in the country's tax and resource management systems. Local governments have strong incentives to turn a blind eye to corporate environmental misconduct because they often depend on tax revenue from these same businesses to fulfil their service provision role. Moreover, local governments often exceed their designated powers over commercial development of natural resources. Businesses pay taxes on their revenues, factory operations, and for license registration. These function as a significant source of tax revenue for local governments. And local governments can be unscrupulous in approving business operations. Charged with the twin tasks of providing public services within their geographic jurisdiction and sustaining it economically, many local governments understandably succumb to the temptation to sell the rights to extract natural resources to private developers for short-term profit.

Secondly, because government funding tends to make up only a small proportion of the operating budget of institutions that provide education, public health, resource conservation and environmental protection services, these entities are often pressured into addressing the shortfall by initiating market reforms and behaving much like businesses. Natural resource management agencies, for example, often end up exploiting the very resources they are supposed to be managing in the public interest. They do so by creating policies that involve regular collection of various fees, initiating large projects with big budgets, and implementing 'market reforms' that allow them to lease resource use rights.

People who are involved with resource conservation work have found themselves fighting an uphill battle because, in addition to whatever other substantive advantages they have enjoyed, the forces of environmental destruction have gained a rhetorical upper-hand by co-opting terms that carry positive connotations in contemporary Chinese society, such as 'development' and 'market reform'. The narrow focus on GDP growth and the market only began to subside after the central government officially adopted the 'scientific outlook on development', a move that was largely a response to the SARS outbreak in 2003.

Today, the question of what kind of policies are needed for sustainable development has given rise to whole series of further questions. These include the question of what kind of government is best suited for this task. In recent years, calls for reform of the public sector have emphasised the need to strengthen governmental regulations to improve public management and administrative

efficiency, and to streamline organizational structures. In particular, all reform measures must be consistent with the principle of sustainable development. Specifically, these reforms would entail:

1 Reform of processes for major decisions about the responsibilities, obligations and entitlements of the government. For example, decisions about the establishment and elimination of government agencies should be made in accordance with the long-term interests of Chinese citizens and through transparent processes in the National People's Congress, and not through haggling or deals between existing departments, ministries, and agencies.
2 The establishment of independent research organizations to analyze factors which determine the long-term interests of the people.
3 Conduct of business and discharge of institutional obligations at all levels of government in accordance with the law.
4 Decision-making processes which are open and inclusive of all stakeholders (and not just a few powerful stakeholders).
5 The government and its operations must be subject to supervision from, and evaluation by, the public.
6 The status of environmental resource regulations and agencies charged with environmental management must be elevated.

Chinese environmental NGOs have played an especially important and positive role by bringing their vitality and innovation to bear on this last challenge.

4. Shifting towards ecologically-friendly development models

Chinese environmentalists are keenly aware that sticking plaster solutions will not address the problem of 'some localized improvement amidst overall environmental deterioration'. If the environment is not to be polluted faster than pollution can be cleaned up, it is necessary to find a root-and-branch solution. The existing model of economic development must be replaced with a new one that is less ecologically-destructive. If Chinese environmentalists are to exert effective influence on this issue, timing is of critical importance.

In 1994, the Chinese government adopted 'China's Agenda 21 White Paper on China's Population, Environment, and Development in the 21st Century' as part of its effort to respond to the Rio UN Conference on Environmental and Development. This historic document was notable for its foresight in emphasizing that: 'China is still applying a model of economic development that is resource intensive, energy intensive, and highly polluting. Adherence to this model is not only environmentally devastating but also economically unsustainable' (State Council, 1994). Around the same time, at the fifth annual meeting of the 14th National People's Congress, the government made 'the transformation of the model of economic growth…[a] fundamental shift of national significance', and demanded all levels of government take this new national economic imperative seriously. Specifically, this change meant that measures would be taken in the areas of economic structuring, productive technology, human resources, natural resources, job performance evaluation, and business development to allow the national economy to grow not just quantitatively, but also qualitatively (Zeng, 1995).

Since 2000, the Chinese government has issued a series of similar strategic statements, promoting a number of national objectives. These included statements on ecological modernization (2002), on the scientific outlook on development (2003), on resource and energy conservation (2004), on innovation (2006), and ecologically-based civilization (2007). While each of these statements had been issued in response to a specific event, they are all part of the Chinese government's efforts to shift the economy onto a sustainable path. Matching policies have been formulated and announced to realize these strategic objectives.

The 2008-9 global financial crisis taught China a painful lesson about the long-term economic, social, and security implications of export dependency. The climate change summit in Copenhagen in 2009 left little doubt that the world had entered a new era of crisis where climate change was the defining reality. In late 2009, the Chinese government reiterated, but this time with unprecedented focus and intensity, the importance of building a new and greener economy. Indeed, this shift has been presented as nothing less than the 'third great transformation', following the founding of the new republic in 1949 and the commencement of economic reforms in 1978. According to Ren: 'Changing the model of economic development is a profound and profoundly-wise choice the Chinese people and their leaders have made that will leave an indelible mark on the country's future and determine the eventual outcome of its modernizing efforts' (Ren, 2010). All this has given a strong boost to existing measures to cut greenhouse gas emissions and other activities aimed at 'greening' the economy.

Since the 1994 publication of the 'White Paper', the strategic goal of transforming China's model of economic development has been given repeated emphasis. During this time, rapid industrialization and urbanization have been accompanied by equally rapid environmental degradation. But even as the limits to growth imposed by natural systems are being reached, pressures of international competition are adding to the stress on the Chinese economy. Chinese entrepreneurs have realized that their businesses will soon be placed in a competitive disadvantage in the global market if they do not adopt clean productive technologies the way many in developed countries have done.

Chinese people now better understand the environmental problems they face and what it will take to address them than they did a few decades ago. However, the country is still relying mostly on technical fixes to address these problems. This dependency on technological improvements been used as an excuse for the government to drag its feet on overhauling the economy at the structural and institutional levels. An incentive structure that encourages wasteful, GDP-boosting spending at the expense of environmental sustainability has been the key institutional constraint impeding economic restructuring for over a decade, yet it remains basically intact. Furthermore, the unrelenting and growing pressure for government to generate employment for newly-unemployed millions and to maintain social stability is only reinforcing the status quo.

There are also significant disagreements among scholars on key economic issues with important ecological implications. For example, many economists have insisted that the country must wean itself from an unsustainable dependency on exports by boosting domestic consumption. They warn that the economy could otherwise lose momentum, with disastrous social consequences. They also caution that there are still too many Chinese who consume too little, and who cannot turn to public services to meet their basic living needs. Policies to encourage domestic consumption have already taken effect.

Others question the wisdom of this approach. Where would China find, some ask, the resources to fuel domestic economic demand if all, or even a large portion, of Chinese became heavy consumers? For example, the rapid increase in private automobile ownership is in effect pushing global oil prices upwards. It is all but certain that China will end up with a large number of car owners who cannot afford to drive. Heavy dependency on both foreign currency (US$) and foreign resources (crude oil) means that any tightening in the supply of either would greatly raise of the risk of serious inflation (Zhang, 2009). These critics contend that the most important economic challenge at present is not boosting domestic consumption but ensuring the nation's financial security and resource sustainability.

This debate and others on similar topics illustrate the difficult situation China faces and the challenges that exist if the economic, social, and even cultural transformations discussed here are to be realised. China is only at the beginning of a long and difficult journey towards sustainability.

III. Global interconnectedness

Neoclassical environmental economics has been the primary theoretical guide for China in its efforts to address environmental problems. Neoclassical environmental economics teaches that most environmental problems can be corrected by 'getting the price right', that is by making sure that the market prices of economic activities and products properly reflect their full environmental costs. This will no doubt require not only government involvement, but more important, transparent government involvement. Until this happens prospects for an ecologically sustainable, green economy will remains elusive.

Of course, even if problems are solved, success in reversing worsening trends in environmental conditions in China and the wider world cannot be guaranteed. The solution to these problems is a necessary but insufficient condition for genuine transformation of the prevailing, ecologically destructive model of economic development. A change which, as discussed, is necessary if ecological deterioration at local, regional and global scales is to be arrested. Added to this, even if China were to achieve this transformation, it would still not be enough if the rest of the world were not able to achieve a similar feat. On the whole, there are good reasons to be skeptical that change either in China or worldwide will come quickly enough.

1. Not the factory of the world?

As the proverbial 'factory of the world', China has gained global prominence, borne the brunt of environmental costs, and taken the resulting blame. Reliable calculations indicate that export-oriented production accounts for 20 per cent of the nation's total industrial energy consumption (Zhang, 2009). It should also be noted that most of these global consumers live in countries where the per capita ecological space is much more generous than is the case in China. Reducing export-dependency would therefore have huge structural implications for China's economy.

However, where export policies are concerned, the economic growth imperative continues to trump any ecological preservation imperative. As soon as a drop in exports threatens to slow down growth, even if only in the short-term (especially given the vast number of workers employed by export industries), policies aimed at arresting that drop are put in place. And considerations of environmental and resource sustainability are simply too weak to tilt the policy calculation in the other direction. The Chinese government and environmental scholars and activists understand well that this is indeed a terrible dilemma for China: the country has to choose between economically unsustainable export-dependency and a socially-destabilizing surge in unemployment that would certainly result from a sudden 'emancipation' from that dependency. This is the price that has to be paid for integration into the world economy. Indeed, under economic globalization, it is becoming increasingly difficult for any country to make economic adjustments of its own choosing. Increased global interdependency means a decrease in economic autonomy.

2. Advocacy for a new consumption pattern?

Environmental scholars and activists in China – particularly those associated with NGOs – have long been advocating for the adoption of new, more ecologically-appropriate consumption patterns by the Chinese people (FON, 2010; see Chapter 20). This is a tall order because most of their audience are members of China's young consumer generations, who are also shaped by powerful forces of consumerism and materialism fuelled by capital, particularly globally mobile capital (see Chapter 16). While these behaviours may seem to be voluntary choices by individual Chinese consumers, in fact, they are to a large degree the product of corporate manipulation and are as such powerful proof of how successful foreign capital interests have been in prying open and penetrating the markets of developing countries.

Many economists have noted the enormous impact that multinational corporations have been able to exert on importing countries. The British economist A. P. Thirlwall has pointed out how these

corporations undermine social cohesion by feeding the wants of the rich and fostering the desires of the poor. The global popularity of Coca Cola offers one example, which has taken place despite the fact that regular consumption of the ubiquitous beverage, arguably hurts the consumers more than it benefits them (Thirlwall, 1999). This is precisely what has happened in China. In fact, China has, thanks in part to these forces, become the world's second largest market for luxury goods.

Yet even if all of the world's voices advocating for an ecologically-appropriate consumption pattern and lifestyle were to unite, they would be no match for the powerful forces of consumerism and materialism. As a Chinese environmental philosopher observed: 'Developed countries are the dominating forces within today's economic world order. If they do not set a good example by transforming their own growth model, then developing countries acting alone cannot solve the world's environmental problems. For not only do the latter have to address domestic issues such as poverty, they must do so while standing at an international competitive disadvantage relative to developed countries' (Zhang and Lu, 2006). However, it does not seem realistic to expect developed countries to set such a positive example, as they are still going in the wrong direction. As such, it would be a considerable achievement if they could slow down.

3. Home-grown, environmentally-friendly technologies?

Some Chinese scholars have powerfully and convincingly argued that technological advances are the key to greening the economy, and should be the very centrepiece of ecological modernization (Wang, 2010).

However, increases in resource efficiency are not the same as, and do not necessarily translate into, increases in overall economic efficiency. While the former certainly *may* lead to the latter in a competitive market, whether they actually do so depends on their short-term profit return, which in turn is contingent on various factors. While the clean, or at least cleaner, technologies developed in developing countries can often claim certain second-generation advantages, and do quite well in the local markets (as is the case with many Chinese home-grown green technologies), they tend to perform poorly internationally. This is attributable to a combination of two factors: the invisible hand of the global market and the visible hand of intellectual property laws, which systematically favour developed countries, home to many of the world's patent-holding, financially powerful and politically connected corporations.

These corporations and their home countries tend to be unwilling, citing intellectual property concerns, to make green technologies inexpensively available to developing countries, many of which cannot develop them on their own. Yet, when developing countries develop their own clean technologies, or even break into foreign markets, developed countries and their corporations do all they can to prevent these technologies from becoming commercially successful. One tactic is to flood the market with their own products. For example, high quality agricultural products produced in ecologically-appropriate ways in developing countries have often been out-priced and out-gunned by cheaper ones created in more resource-intensive and less sustainable ways in developed countries. The experience of the Chinese soybean market offers an illustration of this cruel logic. While some may argue that this is only the law of comparative advantage at work, the fact is that what counts as advantages and what counts as disadvantages are not only a matter of debate, but in practice vulnerable to manipulation.

Therefore, in addition to domestic institutional, economic, and cultural hurdles, obstruction by global capital is also a hindrance to China's efforts to develop its own commercially viable clean technologies. China is encouraged to 'buy green' from developed countries instead. The feasibility of this option is, however, highly questionable; for a country and an economy the size of China, is total dependency on imported technologies for its ecological modernization either realistic or desirable?

4. Conclusions: Why China cannot easily transform its economic growth model

In her efforts to shift towards a less ecologically destructive model of economic growth and to stop the degeneration of the global environmental commons, China already has the full support of environmentally-committed citizens the world over. However, China faces obstacles from the forces of economic globalization. While the globalization process can yield some environmental benefits, all things considered, the environmental costs of that process are far greater.

The synergy between the growth of the Chinese economy and economic globalization is the result of a complex set of circumstances, the most important of which being the state of social- and economic- preparedness the country happened to be in as it began to integrate with the rest of the world economically. The combination of China's status as a sovereign country, a modern nation-state, its domestic social stability, the existence of a fairly well-established industrial structure and of a government committed to social and economic development made for a propitious condition for a relatively smooth integration with the global economy (Zhao, 2009). These conditions allowed China's market, labour force and natural resources (including its ecological space) to be made easily accessible to whoever who can make profitable use of them. However, as has been illustrated, global capital has not hesitated to undermine efforts by developing countries to achieve ecological modernization of their industrial systems through home-grown technologies. Indeed, more often than not, forces of globalization do not support national efforts to become economically and technologically self-sufficient.

As significantly beneficial as integration into the global economy has been for China, it has also created many serious problems. To solve them, continuing or intensifying the integration process cannot be the right strategy. As Einstein said: 'We can't solve problems by using the same kind of thinking we used when we created them'. Unfortunately, many people in China do not fully appreciate this yet; a fact which may prove to be one of the greater challenges that need overcoming if a thorough and sustained greening of the Chinese economy is to be achieved.

IV. China's responsibilities

1. Preserving the global environmental commons through global environment justice

No country should be expected to accomplish a global transformation of modes of economic production and models of economic growth all by itself. Moreover, it is only commonsense that no country can justifiably accuse others of failing to solve problems of which it is a main cause. The global ecological crisis that humanity now faces is an outcome of complex historical processes. However, to address this crisis, approaches such as technical fixes, cost-benefit analysis and litigation do little more than relieve symptoms. Those who argue otherwise are guilty not only of ideological stubbornness but perhaps also of superficiality and even bad faith. To cure the global ecological crisis nothing less than a transformation of the model of economic development and material culture is necessary. This is bound to be more painful in the short-term, but it is only way to be responsible to future generations.

Presently, the world is being held hostage by those whose vast power and boundless greed have become the sources of global instability. This has created the impression that a more ecologically stressed world would also be more economically unequal and geopolitically volatile. But in fact, this is not inevitable. The future may unfold in either one of two very different ways, depending on what choices are taken in the coming years. In one scenario, international and inter-regional economic inequalities increase to the point where world peace becomes jeopardized; in another scenario, these inequalities begin to reduce as groups work together to address, among other things, the threat of global climate change and its ecological risks. It would be difficult to deny that the second scenario is by far the most preferable one from the point of view of both environmental

sustainability and global social justice. Environmental sustainability cannot be separated from, or independent of, economic and social sustainability; in other words, a clean environment and a harmonious and just society are mutually reinforcing.

This is why efforts to reduce differences in social capacity and economic prosperity, either within or between countries, are also likely to help slow the worsening of global environmental conditions. This obviously calls for a new kind of relationship between developed and developing countries, in which the latter not only receive aid from the former, but eventually become economically independent. As the principle of 'common but differentiated responsibilities' is now being tested in the global response to climate change, it may be that the first collective steps are being taken towards a more just world.

2. The need for a new philosophy

Some Chinese commentators and members of the general public are of the opinion that many of the environmental problems the country is suffering from today are temporary, and will naturally pass as China moves into the next stage of economic development. These people believe that the environmental Kuznets curve applies in China, so that once per capita income reaches a certain level, many forms of environmental pollution will begin to level off and environmental conditions will improve. On this view, the worst thing that can happen to China now would be for Chinese efforts to catch up with the developed economies to falter. This sentiment has helped fuel the conspiracy theory that many developed countries are trying to obstruct China's growth and development. These commentators may have different views on the market and the role of the government in economic development, but they agree that economic growth must continue lest the economy would collapse. They are fully in favour of all Chinese people achieving their consumption desires, and dismiss suggestions that the virtue of thrift be reinstated.

A very different and more sombre view is that the ecological foundation for economic progress may crumble beneath us. People who are sympathetic to this view are skeptical that unlimited expansion of material wealth is either ecologically feasible or necessary to achieve social and cultural progress. In particular, they question whether China can ever grow over the hump of Kuznets' inverted U-curve as some developed countries have allegedly done. The world is not as resource abundant or ecologically robust today, they point out, as it was when developed countries began their industrializing process. It is not possible for China to grab what natural resources it needs in any expeditious way it sees fit from anywhere in the world without dangerous geopolitical consequences. These same people also object to China's emulating the profligate consumption patterns of wealthy countries.

Both the optimists and the pessimists have identified some key points, and both may have missed others. Indeed, each has chosen to emphasize different aspects of the situation. The authors in this book have aimed to go beyond the apparent impasse, to stand higher, look further, and probe more deeply. These issues are complicated, and it would be naive to expect to find simple solutions. Hard though it may be, emotion should not cloud the capacity for sound judgment:

> "The environmental challenge is a highly elastic and stubborn one. China is being asked to keep up with the rest of the world in cultural values while guarding its own interests from being trumped in ruthless international competition. What could seem more paradoxical than trying to industrialize while at the same time criticizing the modern industrial economy, or trying to shift towards a market economy while at the same time reflecting critically on the very way that material production is organized? We must avoid drawing large and premature conclusions about these complicated topics. Extant theoretical frameworks may, or may not, suit our purposes and our needs. Yet, these are the very kinds of difficulties that propel us forward. Where there is not yet road, we are free to find a new one."
> (Zheng and Qian, 1998: 2)

This passage seems even more poignant now than when it was written. A more realistic sustainable development model is needed. Its exact nature is still unclear. Many are closely watching unfolding development processes in China and India precisely for this reason. Meticulous design may play but a small role in this experiment, which will be an arduous process of trial and error. China is well placed to make a significant contribution to this enterprise of creating a new form of sustainable development. It will be important for government, business and citizens to be open-minded, and dare to take responsibility for the future, and to be committed to serving the many and not just a few. Global justice and a pluralistic and innovative approach to putting theory into practice will clearly be needed if success in this endeavour is to be achieved.

1 Between 1978 and 2008, Chinese GDP increased fifteen-fold. By the end of that period, China consumed four times as much energy, 21 times as much iron and steel, 22 times as much cement, and produced 10 times as many goods as it did in 1978. China is now the world's largest consumer of coal, hydroelectric power, metals, cement, fertilizer and it also claims the largest fish catch. In 2007, the Chinese economy comprised 6.2 per cent of the world economy, but its consumption of energy from non-renewable sources, and its steel, cement, and non-ferrous metal consumption were 17 per cent, 34 per cent, 48 per cent and 31 per cent respectively of global consumption. Moreover, China is also the world's biggest producer of organic waste water, sulphur dioxide, and ozone-damaging pollutants. And China accounts for 21 per cent of global carbon dioxide emissions, and this proportion continues to increase (Chinese Academy of Sciences, 2010).

2 Since the beginning of the 21st century, the increasing resource and ecological stresses caused by China's rapid economic growth have become more apparent. Ecological degradation has been steadily growing in scale and severity, with worsening social consequences. For instance, in the 1970s, an average 1,560 km^2 of land became desertified annually, but this rate grew to 2,100 km^2/year during the 1980s, to 2,460 km^2/year in the early 1990s, and to 3,436 km^2/year by the end of the decade. Major rivers and smaller streams ran dry, not just in arid and semi-arid regions of north and west China, but also in areas of abundant rainfall in southern China. Lakes and wetlands have also dried or are disappearing at alarming rates. Water tables in many places continue to drop rapidly. In the 1970s, underground water was being extracted at the rate of 57.2 billion m^3/year, but by 1999, it had increased to 111.6 billion m^3. In many areas, underground water table decline, agricultural water shortages, rises in agricultural production costs, and intensification of soil erosion have created a vicious spiral of environmental degradation. Marine ecosystem degeneration is another serious problem. Before the 1960s, red tides were a relatively rare phenomenon in China, occurring once every five to six years. But by the 1970s, they occurred on average once every two years. In the 1980s, the frequency was four times per year on average. Twelve occurrences were recorded in 1989, 34 in 1990, 38 in 1991, over 50 in 1992, and more frequently thereafter. Soil erosion now destroys about five billion tons of soil each year (Sustainable Development Strategy Study Group, Chinese Academy of Sciences, 2010).

3 'Ecological footprint' is the measure of human demand on the environment in terms of the area of biologically productive land and sea areas necessary to maintain a given consumption pattern (Wackernagel, 1996).

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2
Understanding Environmental Pollution in China

Guo Xiaomin

中国环境污染态势的特点分析

China has achieved remarkable success in recent years in its efforts to protect the environment in the face of huge environmental pressures. However, the country continues to face serious challenges, and many environmental problems have yet to be addressed. This chapter analyses key aspects of environmental pollution in China, particularly as they have emerged during the last decade. The chapter argues that: (1) there has been moderate success in slowing down the rate of increase in aggregate emissions for major pollutants, but emissions reductions remains an enormous task; (2) there is a need to focus pollution reduction efforts on heavy industry within for the foreseeable future; (3)municipal waste water treatment is emerging as a serious and long-term problem, particularly as urbanisation rates increase; (4) urban air quality is variable and there are serious health consequences linked to air pollution; (5) rural areas are facing serious environmental pollution problems, which currently receive insufficient attention; (6) the cumulative effects of pollution are becoming increasingly evident, with soil pollution now constituting a serious threat to food safety; (7) serious underground water pollution is emerging as an insidious threat to public health; and, (8) there has been an increase in occurrences of environmentally-related accidents.

As the largest developing country in the world, China is currently experiencing rapid growth of its heavy industries as well as rapid urbanization. Its political and economic systems are also changing. Effective management of the Chinese economy in the face of such rapid and wide-ranging change is a major challenge. Key issues that trouble policymakers include: uneven geographical distribution of environmental problems reflecting regional differences in China's economic development, as well as social stratification; problems associated with particular stages in an economic development process (which in the past were faced by developed countries); and, global environmental problems which today's developed countries did not face in the past.

For many years now, the Chinese government has made environmental protection and the pursuit of sustainable development a core public policy commitment. As China has followed a path of industrial modernization, a series of measures have been implemented to strengthen environmental protection, alongside promotion of economic development. Current thinking on the environment is also informed by President Hu Jintao's concept of a 'Scientific Outlook on Development'. The government has prioritized prevention of problems, used a variety of methods, and focused on specific environmental threats, as well as designing a comprehensive development strategy. The government has also been institutionally innovative, and prioritised application of science and technology for sustainable development; it has strengthened environmental laws and tried to take advantage of the expertise and the resources of different social groups in addressing environmental challenges.

Some of this effort has paid off. Ecological degradation and environmental pollution have got worse in China, but they have not worsened as quickly as might be expected given levels of increase in resource use and waste discharge. On the plus side, some waterway clean-up projects have begun to show positive results; environmental quality indicators for some cities and regions shows some improvement; small gains have been achieved in industrial efficiency; and public awareness of environmental issues is greater than ever.

Nevertheless, as Premier Wen Jiabao pointed out at the Sixth National Convention on Environmental Protection, China still faces serious environmental problems, which need to be clearly understood. What is more, new problems continue to emerge even while old and chronic ones remain unsolved. Environmental pollution levels and processes of ecological deterioration are extremely serious in some places, and emissions of major pollutants have exceeded environmental sink capacities, causing increasingly serious pollution of water, air, and soil. Pollution from solid waste, exhaust emissions and persistent organic pollutants are all on the rise. Pollution affects most waterways, including important sections of rivers that run through cities. Serious air pollution exists in one-fifth of Chinese cities, and acid rain affects one-third of Chinese territory.

Ecological destruction has cost the Chinese economy dearly, and it has also affected the well-being of the Chinese people. However, there have been remarkable achievements in environmental protection in China despite ongoing serious problems. More effective prevention of future environmental problems, and better responses to current challenges, requires macro-level intelligence on how to pursue a sustainable development path, as well as deep understandings of specific problems. This chapter examines the nature of environmental pollution in China. The aim of the analysis is to provide a clear baseline to guide policy thinking.

I. Emissions of major pollutants: Slower increase, but major problems remain

Emissions of major pollutants in China have far exceeded the sink capacities of natural systems. The result has been serious environmental pollution. The Chinese government began to respond to this in a major way during the Ninth Five Year Plan period (1996-2000), when it began to control aggregate emissions of major pollutants, and set itself the goal of continuing economic growth while also reducing total emissions for major pollutants.

Since 1995, Chinese GDP increase has followed the shape of a horseshoe (see Figure 1). During the Ninth Five Year Plan, annual GDP increases slowed somewhat, dropping from 10.9 per cent in 1997 to 7.6 per cent in 1999. This was mainly due to the Asian financial crisis and adjustments to the national economy (Table 1 and Figure 1). Total emissions also decreased in the same period. During the Tenth Five Year Plan (2001-2005), the Chinese economy surged forward again, finishing off the period with a 10 per cent annual GDP increase. The trend continued into the Eleventh Five Year Plan (2006-2010). For 2007, GDP growth reached 11.9 per cent, and for 2008 the rate fell to 9 per cent, reflecting the impact of the global financial crisis. During the Tenth Five Year Plan period outputs of major pollutants went out of control, as a result of high growth rates, escalating demand for resources, and a quickening pace of urbanization. Total discharges of certain major pollutants rose each year (see Tables 1 & 2 and Figure 2).

Unlike most of the economic targets set by the Tenth Five Year Plan, which were actually surpassed, two targets for environmental protection were unmet: namely, the target of a 10% reduction in emissions of sulphur dioxide (SO_2) and chemical oxygen demand (COD). In 2005, total SO_2 emissions were actually 28 per cent higher than the 2000 level and, over the same period, COD emissions dropped by only 2 per cent. Moreover, total discharge of waste water, smoke dust and industrial particulates, which had already exceeded the sink capacities of corresponding environmental resources, continued to increase between 2000 and 2005, at the rates of 27 per cent, 2 per cent and 28 per cent, respectively, exacerbating an already dire situation. All things

Figure 1 Chinese GDP Growth Rates (1995-2008)
(y = GDP Growth %)

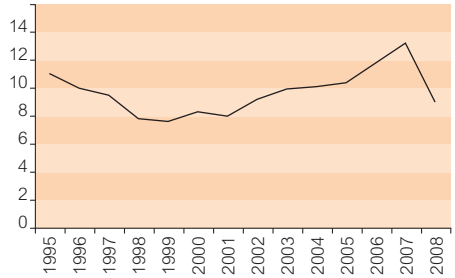


Figure 2 SO_2 and COD Emissions (1998-2008)
(y = Emission 10,000 tons)

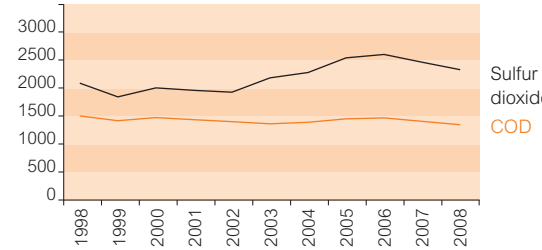


Table 1 Waste water discharge and emissions of major pollutants (1998-2008)

Year	Waste Water Discharge (10^8 t)			COD Emission (10^4 t)			Ammonia Nitrogen Emission (10^4 t)		
	Total	Industrial	Residential	Total	Industrial	Residential	Total	Industrial	Residential
1998	395	200	195	1496	801	695	–	–	–
1999	401	197	204	1389	692	697	–	–	–
2000	415	194	221	1445	705	740	–	–	–
2001	433	203	230	1405	608	797	–	–	–
2002	440	207	232	1367	584	783	129	42	87
2003	460	212	248	1334	512	822	130	41	89
2004	482	221	261	1339	510	830	133	42	91
2005	525	243	281	1414	555	859	150	53	97
2006	537	240	297	1429	542	887	142	43	99
2007	557	247	310	1382	511	871	132	34	98
2008	572	242	330	1321	458	863	127	30	97
2008/ 1998	1.45	1.21	1.69	0.88	0.57	1.24	0.98	0.71	1.11
2008 compared with 2005 (%)	-8.95	0.41	-17.44	6.58	17.48	-0.47	15.33	94.29	60.08

Source: China Environmental Statistics Bulletin.

Table 2 Emissions of major air pollutants (1998-2008), Unit:10,000 tons

Year	SO_2			Smoke dust			Industrial Particle
	Total	Industrial	Residential	Total	Industrial	Residential	
1998	2091	1594	497	1455	1178	277	1321
1999	1858	1460	398	1159	953	206	1175
2000	1995	1613	383	1165	953	212	1995
2001	1948	1567	381	1070	852	218	1948
2002	1927	1562	365	1013	804	209	1927
2003	2159	1791	367	1049	846	203	2159
2004	2255	1891	364	1095	887	209	2255
2005	2549	2168	381	1183	949	234	2549
2006	2589	2235	354	1089	865	224	808
2007	2468	2140	328	987	771	216	699
2008	2321	1991	330	902	671	231	585
2008/ 1998	1.11	1.25	0.66	0.62	0.57	0.83	0.44
2008 compared with 2005 (%?)	8.94	8.16	13.39	23.75	29.29	1.28	77.05

Source: China Environmental Statistics Bulletin.

considered, therefore, the problem of environmental pollution in China got considerably worse over the Tenth Five Year Plan period.

During the period 2000-2005, serious tensions were evident between the pursuit of rapid economic growth and efforts to reign in pollution. The upward trajectory for total pollution indicates that in terms of both the quality of its economic development and its pollution control capacity, China still fell short of what was needed to achieve its economic and environmental objectives simultaneously, that is, to reduce environmental pollution without slowing economic growth. In other words, rapid economic growth came at the expense of the environment.

The Eleventh Five Year Plan again included reduction targets for SO_2 and COD emissions of 10 per cent by the end of the plan period. Moreover, the plan called for pollution control through improvement in resource use efficiency as an integral part of economic restructuring and transition towards a new model of development. As a result of a combination of structural abatement (such as restricting the growth of energy-intensive, highly polluting and resource-consuming industries), increased investment in environmental protection and improved waste management (such as building waste water treatment plants in key cities and installing desulphurization equipment in power plants), pollution levels have been considerably reduced. Emission levels for SO_2 and COD were 9 per cent and 7 per cent lower, respectively, in 2008 than they were in 2005. And according to reliable sources, by 2009, SO_2 and COD emission had reduced by 13 per cent and 10 per cent respectively from 2005 figures. In fact, the target for SO_2 emission reduction was met one year ahead of schedule.

In absolute terms, of course, total emissions for both these pollutants remains high, and in excess of the sink capacity of the environment. And because environmental pollution in China is of a composite nature (i.e. it has multiple sources), reducing SO_2 and COD emissions alone will by no means fully address the problem. There are as yet no effective ways of controlling nitrogen oxide and ammonia nitrogen emissions from fuel combustion and automobiles. Extreme levels of ammonia nitrogen emissions have actually caused acid rain in China to turn from pure sulphuric acid into a hybrid of sulphuric acid and nitric acid. Levels of nitrogen oxide emissions have caused eutrophication in many lakes. Indeed, the problems of acid rain and eutrophication have taken a turn for the worse over the last decade or so. A clear example of this is the 2007 blue algal bloom on Lake Tai which threatened the water supply to Wuxi city, in Jiangsu province. Furthermore, heavy metal contamination of water remains a significant public health hazard. All told, pollution control in China continues to be an uphill battle.

II. Heavy industry: The focus on pollution control in a structurally-imbalanced economy

China's recent period of rapid economic growth has been driven by a rapid expansion of heavy industry. This has led to a structural imbalance in the Chinese economy. The percentage of aggregate industrial output accounted for by heavy industry rose from 60 per cent in 2000 to 70 per cent in 2007 (see Table 3 and Figure 3). Total output for many heavy industrial products has increased by many orders of magnitude. In 2008, output levels for coal, electricity, steel and cement were 2, 3, 4 and 2.5 times, respectively, what they were in 1998 (Table 4). Heavy industries are both resource- and pollution-intensive. In 2006, the combined contribution of coal-fired power plants, ferrous metal smelting and steel-rolling, and non-metallic mineral industries towards the nation's total SO_2, smoke dust and airborne particulates discharge from industrial sources were 75 per cent and 70 per cent respectively (Table 5). Non-metallic mineral industries and ferrous metal smelting and steel-rolling industries together accounted for 86% of all industrially-generated airborne particulate emissions. In the same year, the percentages of COD discharged in waste water

Table 3 Structural shifts in Chinese industry (2000 - 2007), Unit: %

Year	2000	2002	2004	2007
Light industry as a percentage of overall industry	39.8	39.1	33.5	29.5
Heavy industry as a percentage of overall industry	60.2	60.9	66.5	70.5
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Chinese Statistics Bulletin

Table 4 Output for major industrial products (1998-2008)

Year	Coal 10^8 t	Electricity 10^8 Kilo-watt hours	Steel 10^4 t	Cement 10^4 t
1998	12.5	11670	11559	53600
1999	10.45	12393	12426	57300
2000	9.98	13556	12850	59700
2001	11.61	14808	15163	66104
2002	13.8	16540	18237	72500
2003	16.67	19106	22234	86208
2004	19.56	21870	26800	97000
2005	21.9	24747	34936	105000
2006	23.8	28344	42266	124000
2007	25.4	32777	48966	136000
2008	27.9	34668	50092	140000
2008/ 1998	223	297	433	261

Source: Chinese Statistics Bulletin.

Table 5 Air pollutant discharge by economic sector as a percentage of total industrial air pollutant discharge (2006)

Sector	SO^2	Smoke Dust	Particulates
Coal-fired power plants	59.0	44.7	–
Non-metalic mineral products	9.1	15.8	70.2
Ferrous metal smelting and steel-rolling	7.3	9.4	15.7
Total	75.4	**69.9**	**85.9**

Source: 2006 China Environmental Statistics Bulletin

attributable to paper, agricultural, and food processing, chemical and textile industries were 34 per cent, 1 per cent, 12 per cent and 7 per cent, respectively – or a combined 65 per cent – of the total from all industries (Table 6). The amount of heavy metals released by nonferrous metal smelting and steel-rolling, nonferrous metal mining, chemical, and ferrous metal smelting and steel-rolling industries through waste water discharge was 32 per cent, 31 per cent, 16 per cent, and 7 per cent respectively – or a combined 86 per cent – of the national total from industrial sources.

There is ample evidence that different economic sectors contribute differently to China's pollution problems. Demand for heavy industrial products is high, and still far from peaking. Take, for example, the iron and steel industry, which has received much attention in this respect. Even though China already leads the world in iron and steel production, domestic consumption has only very recently begun to escalate. Currently, per capita annual consumption in China stands at 94 kg, compared with 450 kg for other developing countries such as Malaysia. The rapid growth of heavy industries has caused environmental pollution and ecological destruction, and placed enormous pressure on the world's remaining stocks of coal, crude oil, and mineral resources. So long as structural imbalances in the Chinese economy persist, heavy industries will for the foreseeable future inevitably continue to be the main focus of pollution control efforts.

Figure 3 Ratio of light to heavy industry in Chinese industrial structure (1995-2007)

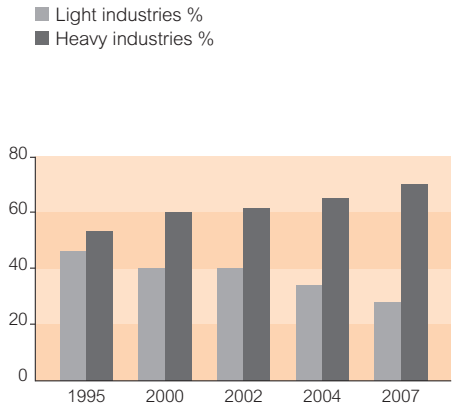
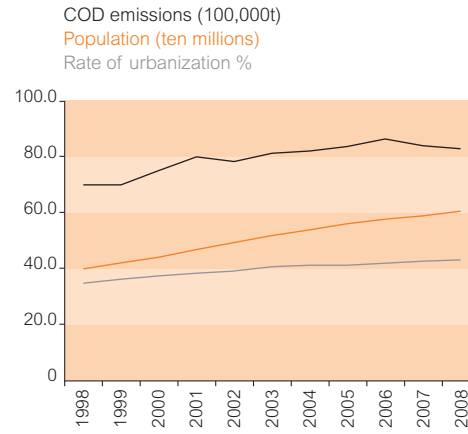


Figure 4 Chinese urban population and COD emission



III. Municipal waste water treatment: A large and growing problem

Urbanisation rates in China have increased dramatically in recent years. The urban population increased from 416 million in 1998 to 607 million in 2008, at an annual rate of 3.9 per cent. The urban share of the total population increased from 33 per cent to nearly 46 per cent over the same period. Assuming the urban population continues to grow at an annual rate of 1.2 per cent, by 2020, 60 per cent of the Chinese pollution will live in urban areas (Table 8 and Figure 4).

As urban populations have increased, there has also been a corresponding increase in the number of waste water treatment facilities that service urban areas. Their combined capacity went from 12 million m^3/day in 1998 to 83 million m^3/day in 2008, and the treatment rate for waste water went from 16 per cent to 70 per cent during the same period. Within the last decade, waste water treatment capacity grew by an average 22 per cent each year, faster than the growth of the urban population.

While the growth in the number of waste water treatment plants is to be welcomed, it is also the case that many treatment plants are badly run. According to a 2004 study by the Ministry of Construction, waste water treatment plants in urban areas were operating at an average of 65 per cent capacity, with some of them failing to provide adequate waste water treatment services. By the end of June 2005, waste water treatment plants in 38 of the total of 364 cities that had any such facilities at all were operating at less than 30 per cent of capacity (in 17 of the 38 cities plants had been completed but were never used). In addition, State Environmental Protection Administration (now the Ministry for Environmental Protection) statistics and a case study by the Panel on the Monitoring of Law Enforcement of the Standing Committee of the National People's Congress indicated that, by the end of 2004, only one third of the 709 waste water treatment plants that had been built in 600 cities were operating properly. One third were operating below full capacity and the remaining third were operating sporadically or not at all.

Table 6 COD emission through wastewater discharge by economic sector as a percentage of total COD industrial emission through wastewater discharge (2006)

Sector	COD
Paper and paper products	33.6
Agriculture and Food Industry	12.8
Chemical Industry	11.7
Textile	6.8
Total	**64.9**

Source: 2006 China Environmental Statistics Bulletin

Table 7 Heavy metal content in wastewater discharge by economic sector as a percentage of total industrial heavy metal discharge (2006)

Industrial Sector	Heavy Metal Discharge through Wastewater
Non-ferrous metal smelting and steel-rolling	31.9
Non-ferrous metal extraction	30.7
Chemical Industry	16.4
Ferrous metal smelting and steel-rolling	6.8
Total	**85.8**

Source: 2006 China Environmental Statistics Bulletin

Table 8 Changes in urban population and COD emissions (1998-2008)

Year	Urban population 10,000	As percentage of total population (%)	COD Emission 10,000 t
1998	41608	33.35	695
1999	43748	34.78	697
2000	45906	36.22	740
2001	48064	37.66	797
2002	50212	39.09	783
2003	52376	40.53	822
2004	54283	41.76	830
2005	56212	43.0	859
2006	57706	43.9	887
2007	59379	44.9	871
2008	60667	45.7	863
Average Annual growth rate	**3.80%**	**1.2%**	**2.19%**

Source: China Urban Statistics Bulletin; China Environmental Statistics Bulletin.

Many factors explain the poor performance of these plants, chief among these is the absence of a fee-based system, which renders many plants financial unviable. In addition, many plants simply have no waste to treat because supporting networks of water pipes to collect the municipal waste water have not been constructed. The level of COD emissions from urban residential sources increased at an average annual rate of 3 per cent from 7 million tons in 1998 to 9 million tons in 2008. Since the Eleventh Five Year Plan, the central government has stepped up its efforts to reduce pollution, and has made great progress in constructing and running municipal waste water treatment facilities. As a result, urban COD emissions began to decline in 2007. The 2007 and 2008 levels were 8.7 million tons and 8.6 million tons respectively. But at 1.2 times the 1998 level, the 2008 level was of course still high in absolute terms. In short, the problem of municipal waste water will continue to grow for the foreseeable future.

IV. The adverse health effects of urban air pollution

Progress in recent years on urban air quality has been mixed. According to China's official reports on environmental quality, particulate matter continues to be the chief airborne pollutant in Chinese cities (Tables 9 and 10). Air quality in urban areas changed little between 2000 and 2004, and improved appreciably after 2005 (Table 9). In 2008, the percentage of Chinese cities that achieved Grade II quality level was 77 per cent, compared with a 37 per cent figure in 2000, and the number of cities that only made Grade III had markedly decreased[1]. Urban air quality in China has improved in some respects, despite the country's high rate of economic growth and the increasing pace of urbanization. This attests to the effectiveness of some pollution abatement measures. However, it would be premature to be too optimistic, as much still remains to be done.

1. Smog has become the number one air pollution problem for affected areas

In recent years, sharp increases in automobile ownership, growing fossil fuel consumption, and escalating industrial discharge of airborne pollutants have turned smog into the number one air pollution problem in many highly populated parts of the country. These areas include: the Pearl River delta, the Yangtze River delta, the Sichuan basin, the Beijing-Tianjin metropolitan area, and

Table 9 Urban air quality in China

Year	No. of Cities Monitored	Grade II and below	Above Grade II
2000	338	36.5	63.5
2004	342	38.6	61.4
2005	522	60.3*	39.7
2008	519	76.8**	23.2

Note: * 4.2% achieved Grade I, ** 4.0% achieved Grade I
Source: China Environmental Statistics Bulletin.

Table 10 Urban air quality according to PM_{10} density ranking

Year	Grade II ≦100 mmg/m^3	Grade III 100-150 mmg/m^3	Above Grade III ≥150 mmg/m^3
2005	59.5	35.0	5.5
2008	81.5	7.9	0.6

Source: China Environmental Statistics Bulletin.

Hebei Province. Statistical analyses show that prior to the 1960s-1970s, smog was extremely rare in Guangzhou, occurring for only one to two days a year on average, and then largely for natural reasons. After the 1980s, however, the situation worsened precipitously. It has remained poor ever since. Now, smog occurs on between 100-200 days, and sometimes for as much as two thirds of the year. According to an analysis of daily smog records between 1961 and 2005, Nanjing experienced smog only a few days each year during the 1960s. But by 1991, over 100 days were affected by smog, and in 1994, 158 days had smog. Even though enhanced pollution control measures subsequently reduced this number, it has begun to rise again in recent years as automobile use in the city has skyrocketed.

Smog is made up of ultra-fine particles with diameters of less than 2.5 micrometres[2]. These host many forms of toxic and harmful substances, which are able to enter air pockets inside the lungs and even the circulatory system. This can lead to cardiac and pulmonary problems and reduced lung capacity. Smog, therefore, poses a serious threat to human health, and is a prevailing cause of lung cancer and other diseases of the respiratory system. Zhong Nanshan, a Fellow of the Chinese Institute of Engineering and President of the Chinese Medical Association, notes that lung cancer has now become a common illness in Guangzhou, where incidences of the disease are higher than in neighbouring cities such as Nanhai, Zhuhai, Hong Kong and Macau. In the 1990s, there were on average 27.5 cases of lung cancer for every 1 million Guangzhou residents. This figure has now doubled. The same trend holds for the country as a whole. Lung cancer now accounts for 33 per cent of all cases of malignant lung tumours, and has overtaken liver cancer to become the number one cause of death from malignant tumours. Related studies show that despite a continuous decline in the number of smokers, the incidence of lung cancer has nonetheless increased by 46.5 per cent during the last 30 years. Air pollution has much to do with this.

2. As composite pollution replaces smoke pollution in urban areas, control becomes an even greater challenge

There are now only a very small number of Chinese cities with a particulate matter (PM_{10}) concentration greater than 150 micrometres/m^3. In 2008, only 0.6 per cent of the Chinese cities monitored for PM_{10} concentration were in this category. Air pollution caused by exhaust emissions has now become an acute problem in China; this is a consequence of course of the rapid expansion of car ownership in the country. Composite pollution has either already overtaken or is replacing smoke pollution as the key air pollution issue in many urban areas. $PM_{2.5}$, NOX, O_3 and composite photochemical particles – which are far harder to control than much larger smoke and dust particles – have overtaken TSP (Total Suspended Particulates) and SO_2 to become the dominant urban air pollutants.

3. A pollution control 'blind spot'

According to official reports on China's environmental conditions, there has been a significant improvement in the country's urban air quality. This claim appears dubious, however, in the light of current knowledge about smog pollution. The reason for this discrepancy is that China still uses air quality monitoring standards that were set in 1996, and which are no longer best-suited for current monitoring needs. Fine particles with diameters of less than 2.5 micrometres fall entirely outside the scope of these standards, yet it is precisely these particles, which include sulphates, nitrates, and organic carbon, that are the causes of smog. According to the international system of air quality monitoring (API), the items for which air is monitored include sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, particulate matter (PM_{10}), ultrafine particles ($PM_{2.5}$, PM_1) and visibility. But China only tests air for sulphur dioxide, nitrogen dioxide, and particulate matter. Therefore, conventional monitoring does not accurately reflect the extent of air pollution, especially with respect to smog, which has thus become a 'blind spot' in air quality monitoring.

In addition to this 'blind spot' in air quality monitoring, the existence of a geographical 'blind spot' in pollution control has also become increasingly evident. In the last decade or so, the main focus of air pollution control has been densely-populated cities, and the typical approach involves moving the most polluting businesses and industries to their outskirts, in some cases into industrial parks that have been built especially for this purpose. In the meantime, cleaner businesses in the service industry have been growing in many of these cities. In a reference to the conventional numerical designation for different economic sectors, this practice has been dubbed 'pushing out secondary and pulling in tertiary industry'. This strategy has indeed helped improve urban air quality in some areas. However, in this process of replacing secondary with tertiary industry, some cities have failed to implement industrial upgrading or technological innovations. As a result, the aggregate level of pollution is often not reduced, and there is only a shuffling of relative pollution burdens for different areas. Pollution often moves from downtown areas to suburbs and beyond, following the relocation of polluting industries. Improved air quality in cities, therefore, has been achieved at the high price of worsening air quality outside them. Indeed, the high concentration of seriously-polluting businesses and industries in relatively small geographical areas has given rise to the new and serious problem of regional pollution. Furthermore, because the distribution and locations of air quality monitoring stations have yet to keep up with the demands of these new trends in the urban economy, the result has been another 'blind spot' in environmental monitoring, and another area of uncontrolled environmental pollution.

4. Grade II as a low standard for urban air quality

In urban air quality assessment, Grade II is usually viewed as a minimum standard. Meeting the Grade II standard is usually a basic objective for urban air quality improvement. However, the Chinese definition of Grade II is considerably less demanding than the international definition. According to international studies from recent years, there are no safe levels of PM_{10} (particulate matter of diameters smaller than 10 micrometres), meaning that such particles pose health risks even at very low concentrations. In the 2005 global update of its air quality guidelines, the World Health Organization (WHO) determined the safe level for PM_{10} to be 20 microgram's per cubic metre ($\mu g/m^3$) annual mean. By contrast, the safe level according to the Chinese criteria is 100 $\mu g/m^3$ annual mean, five-times the WTO standard. This means that if the Chinese standard is used, Grade II air quality is still harmful to human health. Achieving Grade II air quality by reference to criteria based on PM concentration is a short-term, and only an initial goal, for urban air pollution control. By Chinese criteria, Grade I is defined by a PM_{10} concentration of less than 40 $\mu g/m^3$ annual mean, which is still twice the WHO-recommended safety level. In 2008, only 4 per cent of all cities in China made Grade I. This means that it is imperative that the current criteria for air quality assessment be revised to provide sound guidance for cities seeking to address their air pollution problems.

V. Environmental protection in rural areas

For a long time now, the main foci of pollution control in China have been cities and industry. Pollution problems in rural areas and the countryside have not been taken as seriously. The main symptoms of this neglect include: the fact that there is no government agency with a special remit to manage and protect the rural environment; the practical non-existence of environmental monitoring; unconstrained pollution by factories and businesses; severe underdevelopment of the basic infrastructure for environmental protection; and, a dearth of financial investment.

This neglect has important consequences as rural China has been struggling under enormous environmental pressures. Two main sources of environmental stress are identifiable: pollution generated *in situ*, that is, by agriculture and related industrial operations located inside rural areas;

and, pollution generated exogenously in cities and urban areas, for which rural areas have for a long time served as a waste sinks.

1. Pollution by modern agriculture

China is the world's largest consumer of chemical fertilizers and pesticides. Annual consumption of chemical fertilizers stands at 46 million tons, which translates into 40 tons/km^2 of arable land. This is much higher than the 22.5 tons/ km^2 maximum that developed countries abide by to protect the soil and human beings from the adverse effects of chemical fertilizer. Inefficiency entails high runoff rates, which have been a cause of soil erosion, water pollution by organic chemicals, eutrophication, and even air pollution. There are now already places in eastern China where non-point source pollution accounts for a larger share of total pollution than industrial pollution.

Annual consumption of pesticides in China now stands at 1.3 million tons. A large part of this enters the water system and soils or is left as residue on agricultural products. All of the country's 93,000 km^2 of farmland have been affected, albeit to varying degrees, by these problems, as has public health. According to the results of tests done in 2002 at wholesale markets in 16 provincial capitals, traces of pesticide were found in between 20 - 60 per cent of the produce tested and the amount found was in excess of safe levels in 20 - 45 per cent of this produce. These numbers place China far behind developed countries with respect to pesticide pollution of crops. The situation has improved slightly since 2002, but the situation remains serious.

2. Infrastructure construction and the underdevelopment of environmental protection measures turn residential waste discharge into a serious source of pollution in towns and rural residential areas

Over the last decade, rural towns have been going through rapid economic growth. Due to a combination of lagging pollution abatement and environmental protection measures, and a lack of rules and regulations, residential waste generated in these areas has typically been released directly into the surrounding environment. The result has been landscapes best described as filthy, messy, and vile. 120 million tons of rural residential waste is produced each year. It is almost entirely un-treated and is dumped in the open, where it is left. Nearly all residential waste water produced each year in these areas, some 25 million tons of it, is also discharged into the environment untreated. All of this has caused serious environmental pollution for these residential areas and those around them. Access to safe drinking water remains a problem on a colossal scale for rural China. Currently, there are still 300 million rural residents with no access to safe drinking water, and 60 per cent of these are the victims of water shortages due to source pollution from non-natural causes. The situation has begun to attract the attention of the government, which is now promoting the 'New Socialist Countryside', a campaign which includes support for environmental management. However, given the magnitude of the problems China currently faces, there is still a long way to go.

3. Pollution by businesses and factories in rural towns and municipalities

Businesses and factories in rural towns and municipalities have been instrumental in alleviating poverty within China's rural population. However, this rural industrialisation model, led by town and village enterprises has relied on mainly crude technologies and has been poorly coordinated. The decentralized nature of the process, in which each rural household industrializes its own family operation, has cost the environment dearly. This has posed great challenges for pollution abatement and control, and because of close proximity to where people live, these businesses and factories have tended to cause particularly serious and direct harm to human health and wellbeing. In recent years, as a result of the strengthening of pollution abatement and environmental control measures in cities and the reconfiguration of the urban economy in accordance with the 'pushing out secondary and pulling in tertiary industry' strategy (see IV, 3 above), many industrial polluters

have relocated from cities to the countryside, in the process compounding the latter's industrial pollution problems. This pattern reflects the geographic unevenness of China's economic development. The westward migration of large industrial polluters is a clear trend. Having gradually been phased out and pushed out of more developed areas in eastern China, many polluting enterprises have relocated to rural areas of western China, adding to their already serious problems with industrial pollution.

4. Pollution from factory farming

In recent years there has been a proliferation of factory farms in densely populated and industrially developed regions. These developments have brought with them serious problems of environmental pollution. According to the first national survey of pollution sources in 2007, waste water discharged by factory farming operations accounted for 42 per cent, 22 per cent an 38 per cent of the nation's total output of COD, nitrogen, and phosphorous, respectively (ZGHJBHB *et al.*, 2010). These operations tend to be located in areas with inadequate sink capacity for the animal waste they generate and where close proximity with human populations means that they sometimes share the same local water supply system. Moreover, lack of planning means these operations are often either too close to residential areas or in ecologically-sensitive or strategic locations. This has caused serious problems of environmental pollution from animal waste, including the pollution of surface water by organic chemicals, eutrophication, ozone depletion, and even groundwater pollution. Added to this, pathogens in animal waste are a significant health hazard.

5. Pollution in rural areas caused by municipal waste discharge from cities and urban areas

Rural areas can be considered part of a wider urban ecosystem, functioning as sinks for industrial and residential wastes generated in cities. Irrigation with untreated waste water, dumping of solid waste, and the shift of industrial pollution into rural areas has all resulted in serious soil pollution by heavy metals. The problem has extended itself to food products. In 1982, the national total of farmland irrigated with untreated waste water was 1.4 million hectares, by 2003, this had increased to 4 million hectares, or 10 per cent of all irrigated farmland in China. Nationally, 1.3 million hectares of farmland have been occupied or otherwise destroyed because of dumping of solid waste.

Because the institutions for implementing pollution abatement and control in rural areas have yet to be established, 'micro pollution' has not only turned into 'large pollution' but also into a 'burden', compounding the social, economic, and political disadvantages from which farmers and farming already suffer. There are 300 million rural residents without access to safe drinking water, and according to China's *Health Statistical Yearbook* for 2005, the death rate for sufferers of malignant tumours directly attributable to water pollution was 0.8 for every one hundred thousand people in the countryside, or 1.5 times the urban rate of 0.6 deaths for for every one hundred thousand people (ZGWSB, 2006). According to WHO investigations and studies, indoor air pollution from the burning of coal, straw, and dung for heating and cooking is extremely serious in rural China (Table 11), and has led to very high death rates from respiratory diseases. Again, according to the *Health Statistical Yearbook*, in 2004 the death rate for people suffering from chronic diseases of the lower respiratory tract was nearly 1.2 for every 100 people, over two and a half times the rate for urban areas, which was 0.5 for every 100 people (ZGWSB, 2006). The exclusion of these pollution-related diseases from coverage under the current healthcare system has only added to the burdens of China's rural population. Chinese farmers are badly in need of help, and the environment in rural China is badly in need of wise management and protection.

Table 11 Indoor air quality in rural China

Pollutant	Fuel Type	Rural Household (mmg/m^3)
Total Suspended Particulate (TSP)	Coal	10 - 20000
	Biomass	170 - 2600
PM_{10}	Coal	120 - 26000
	Biomass	830 - 22000
Carbon Monoxide	Coal	700 - 87000
	Biomass	500 - 16000
Sulfur Dioxide	Coal	10 - 23000
	Biomass	10 - 9100
Nitrogen Oxide	Coal	10 - 1700
	Biomass	10 - 320

Note: These results are based on data reported in articles published in academic journals on the average quality of indoor air samples collected within set time periods from individual rural households that use different types of fuel sources for cooking and heating.
Source: See reference no. 6.

VI. Soil pollution: Creating new food safety problems

Currently, soil quality is not yet subject to regular environmental monitoring in China. This is partly because there has never been any comprehensive and systematic reporting on the state of soil pollution in the country. Pollution need not be an insurmountable problem. As long as its sources and extent are known, it is possible to try to control it and to limit its adverse impacts on society. What is extremely serious, however, is ignorance about a particular form of pollution, including its insidious effects on human health, so that it is not possible to respond to them. Soil pollution is one such case. Two decades of rapid economic growth have left a legacy of badly polluted soil across the country. What, then, is the situation with respect to soil pollution in China? This has been a source of concern for many over the years. Recently, surveys on soil pollution have been conducted in many places, and the results are deeply alarming.

1 In February 2006, *Guangzhou Daily* reported on studies of the soil of the Pearl River delta, Shantou (eastern Guangdong), and Zhanjiang (western Guangdong) conducted by a team of researchers working on soil pollution from the Guangdong Institute of Ecological Environment and Soil. The findings were that 40 per cent of the soil in the Pearl River delta is contaminated with heavy metals; and 10 per cent seriously so. The problem is even worse west of the river, where 60-70 per cent of the soil is polluted by heavy metals (Guangzhou Daily, 2006).
2 Lin Yusuo, Director of the Centre for Rural Environmental Studies, at the Nanjing Institute of Environmental Sciences, leads a Ministry of Environmental Protection project called 'Investigation of the state of soil and environmental pollution in representative regions'. Liu told *First Financial Daily* that: 'Soil pollution in the Yangtze River delta is essentially of a composite nature. There may be anywhere between one and over ten different pollutants involved, which would include not just heavy metals but also organic chemicals. Worse still, soil pollution in the Yangtze River delta is regional in scope, which is the result of the spread of what was initially a local problem that only affected a relatively small area (Zhang, 2005).' Soil pollution is therefore spreading.
3 Sun Tieheng, a Fellow of the Institute of Ecology in the Chinese Academy of Sciences, told reporters that the amount of farmland polluted by cadmium, arsenic, chromium and lead in China is nearly 20 million hectares, or approximately one fifth of all farmland. Of the affected areas, 10 million hectares are polluted by water, solid, and airborne waste discharged by industry, and the area irrigated with untreated waste water has reached 3.3 million hectares (Liu, 2005).

4 A study by the Nanjing Soil Research Institute of the Chinese Academy of Sciences of Taihu Lake area using a composite pollution index for representative regions indicates that only half of the soil in rice fields is considered safe, one third is on pollution alert status, and 17 per cent is affected by light pollution. For soil in vegetable fields, these numbers are 29 - 39 per cent, 21– 23 per cent, and 36 - 39 per cent respectively. In some places intermediary pollution and heavy pollution each affect approximately 10 per cent of the soil. Heavy metals are the dominant source of soil pollution. If measured by national 'Green Food' criteria, which involves higher standards for soil quality, these soils would of course score even lower grades (Wang and Liu, 2005).

5 Researchers from the Nanjing Soil Institute of the Chinese Academy of Sciences recently collected 32 soil samples from agricultural fields near to an iron and steel plant, and its coking factory, iron ore sintering plant, the main plant transportation lines, and artificial greenery at the plant and tested them for concentrations of organic chemicals. The results showed that on average the concentration levels for 15 different kind of polycyclic aromatic hydrocarbons in soil for agricultural use was 4.3 mg/kg, which is comparable to levels in irrigated croplands in Shenyang and Tianjin, which have been polluted by untreated waste water. Moreover, in the soil samples used in this study, more than 85 per cent of the polycyclic aromatic hydrocarbons were tetra-cyclic or beyond, and therefore highly carcinogenic. Only 6 per cent of the sample soil couldbe considered safe (Wang and Liu, 2005).

6 The city of Taizhou, in Zhejiang province, is home to a booming industry in the collection, dismantling, and recycling of used electronics. For many years, crude methods were used to dismantle electronics and reclaim the heavy metals. Despite some recent modest improvement, soil pollution is already very serious in the region. According to the national 973 basic research project, 'Soil and Air Quality in the Yangtze River delta and the Pearl River delta: Patterns of Change and Management and Protection Fundamentals', managed by the Nanjing Soil Institute of the Chinese Academy of Sciences, dioxins and dibenzofurans were found to be present in agricultural soil used in and around Fengjiang Road, in Taizhou. These substances are persistent organic pollutants, and their releases should be reduced, and ultimately eliminated, as demanded by the Stockholm Convention on Persistent Organic Pollutants. The size of the area affected is estimated to be many tens of km^2 (Jiang *et al.*, 2005).

7 During the 2006 International Workshop on Lessons on the Abatement and Prevention of Soil Pollution, an attendee from the Ministry for Environmental Protection (then SEPA) noted four main areas of concern with respect to soil pollution in China. These are that: (1) the worsening of regional soil pollution puts the environmental quality of food-growing regions in jeopardy; (2) land used for commercial development, construction and waste disposal faces increasingly serious soil pollution problems; (3) soil pollution is becoming increasingly heterogeneous and composite; and, (4) the impact of pollution on soil ecology is becoming ever more harmful.

All of the above studies or communications show that China's soil pollution problem has reached a critical point, with action urgently needed. The topic of food safety has now become a source of anxiety for ordinary citizens. Because human health is so intimately linked with food safety, which depends on soil quality, soil quality should be given much more attention. Moreover, soil pollution is far more difficult to tackle than air and water pollution problems. For example, the soil at the old Shenyang Smelter site has been heavily polluted by heavy metals. The most seriously polluted portions have had to be literally dug up and disposed of as hazardous waste material, which involves being taken to special locations where hazardous wastes are buried in accordance with safety guidelines. Less seriously polluted portions have been covered with a hard surface, planted with vegetation, or otherwise decontaminated by having the heavy metals in them extracted using a variety of soil-cleaning technologies and techniques. The old factory grounds occupy an area of 300 km^2, and can be eligible for municipal zoning only after contaminated soil has been thoroughly treated or removed. The total costs associated with these measures have been estimated to be RMB 50 million (US$ 7.6 m). At this rate, the cost to the national economy of treating all the metal-contaminated soil in the country will be astronomical. Therefore, it is absolutely paramount that greater attention is paid to soil pollution prevention. The government has already initiated a nationwide soil survey, which, when completed, will offer a first comprehensive evaluation and assessment of the state of soil pollution in China.

VII. Underground water pollution: The threat to public health

Underground water is a significant source of water supply in China. Historically, one third of all water came from underground water. Because of its superior quality, it has been the main source of drinking water. Its national and economic importance can hardly be exaggerated. Unlike surface water pollution, which is relatively easy to detect and monitor, pollution of underground water, especially of deep underground water, is particularly difficult to detect before it is too late. While greater fluidity allows surface water to effect a certain degree of self-cleansing, the same is not true for underground water, especially at the deepest levels. Underground water pollution is very difficult, and sometimes impossible, to reverse. Therefore, prevention, early detection, and early treatment are absolutely essential for addressing this problem. Regrettably, there has never been a national survey or study of the subject in China. Consequently, for such a critical and highly sensitive issue, there is no comprehensive data to support discussion and analysis. Nevertheless, experts and agencies that have done some limited monitoring suggest that the situation in China with respect to underground water pollution is extremely grave.

1. Results from the second round of underground water quality assessment conducted between 2000 and 2002 by the Ministry of Land and Resources using a regional evaluation based on criteria specified in 'Standards for Underground Water Quality', showed that 63 per cent of groundwater in China is potable, 17 per cent requires some treatment, 12 per cent is unfit for drinking but can be used in industrial and agricultural production, while the remaining 8 per cent is unusable for any purposes without special treatment. The groundwater quality in two thirds of Chinese cities has deteriorated, and in about half of all cities, underground water pollution is fairly serious and continuing to worsen. Moreover, pollutants have become more varied and complex in composition, and are finding their way deeper and deeper underground. Meantime, cases of local diseases attributable to drinking water pollution have been diagnosed in many provinces, regions, and cities. Nationwide, about 70 million people regularly consume groundwater that does meet safe drinking water standards (Qi, 2003).
2. Results from the Chinese national geological survey (Zhao, 2005) show that 25 per cent of all 253 underground water extraction sites distributed across 185 cities, showed worsening trends for underground water pollution.
3. In 2002, the Chinese Academy of Environmental Sciences did an analysis of monitoring results for underground water in 118 medium-sized and large cities, and found varying degrees of pollution in almost all of them. The situation is serious for 64 per cent of the 118 cities and mild for 33 per cent. In some places, underground water is extremely polluted and becoming more so all the time. The situation tends to be worse for cities in northern China, where a larger number of pollutants are involved, and the concentration levels are higher. For example, among the main cities in the Huabei region, those of the Haihe River valley alone account for aquifers with about 70,000 km^2 of the surface area that fail to meet the Grade I standards. Underground water in the region that includes metropolitan Beijing, Tianjin, and Tangshan contains up to 133 organic chemicals. Unsustainable abstraction has led to large areas of ground subsidence, which causes shallow underground water to flow downward, thereby contaminating deeper underground water. The area affected by ground subsidence in the Haihe River valley and the region that includes metropolitan Beijing, Tianjin and Tangshan has increased to 35,000 km^2. Most of the underground water in Beijing is polluted, either seriously or extremely seriously in areas of considerable size. Many places in Beijing no longer have any drinkable groundwater (Ma, 2006).

To summarize, the overall situation with respect to underground water pollution in China is best characterized as extremely alarming. In 2006, the Ministry of Land and Resources, the Ministry of Environmental Protection (then SEPA) and other government agencies set in motion a national campaign to study and evaluate groundwater quality. The campaign should help to reveal just how serious this problem is in China, and lead to action to address it.

VIII. Environment-related accidents and disasters: More frequent and serious

Another notable feature of the current situation in China with respect to environmental pollution is the increasing frequency and risks of environmentally-related accidents and disasters. The Tuojiang River pollution incident that took place between February and April of 2004 had serious industrial, agricultural, and residential water supply consequences for downstream cities, including Chengdu, Ziyang and three other cities. The explosion that took place at the Jilin Chemical Corporation in 2005 led to serious pollution of the Songhuajiang River valley, and even halted operations at the Harbin municipal water utilities company. There were many environmental accidents in 2009, notably in Fengxiang, Shaanxi province, and Shuangfeng and Liuyang in Hunan province, both involving heavy metal pollution. In the same year, there was a serious water pollution accident in Jiangdong, Guangdong province, an oil well spill in Kaixian, in Chongqing, and a liquid chlorine spill in Huai'an, Jiangsu province. These are only some of the better known environmental accidents and disasters. According to some reports, environmentally-related accidents have been occurring at the frequency of one every two days. These incidents have not only wreaked havoc on the environment and threatened people's lives and health; they have also undermined sustainable development and jeopardized national security and social stability. They have also, in cases where other countries have been affected, hurt China's international reputation. Still, it is no coincidence that these types of disasters have been occurring at such alarmingly high rates in recent years. This development has been more or less inevitable.

1 With the rapid expansion of the national economy, and the growth of heavy industries (especially the petroleum and chemical industries), the production, storage, and transportation of hazardous materials has increased precipitously. This greatly increases the risk of accidents.
2 The uneven geographical concentration of industries has increased the risks of environmental accidents on the regional scale. A generally low level of awareness about risk factors for environmental accidents partly explains why many high-risk businesses and industries have been built near major waterways such as large and mid-sized rivers, in ecologically sensitive areas, and upstream from locations that supply drinking water. This tendency has greatly increased the probability of environmentally-related accidents and disasters that are regional in scale and geographically-clustered, as well as of those that are international in scope. According to a 2006 study by the Ministry of Environmental Protection of 7,555 businesses in the chemical and petroleum industries, 81 per cent were located in ecologically sensitive locations such as river valleys and densely populated areas. 45 percent of these businesses were considered major safety hazards (Guo and Li, 2010).
3 Temporary storage of large volumes of waste material constitutes a significant risk factor for environmental accidents. Many businesses do not have measures in place for safe disposal of waste discharges. Instead, they simply leave their solid and water waste in temporary storage facilities, which tend to be shoddily constructed makeshift structures vulnerable to destruction by violent weather events, including heavy rain. The resultant spillage of waste material can cause serious environmental pollution. During the annual low water season in the Huaihe River valley sluggish water flow causes a concentration of pollutants in the reservoir. During high water and rainy seasons, this body of highly polluted water is suddenly released through the dam sluice-gates. This practice has led to frequent pollution-related accidents downstream from dams.
4 The lack of awareness about risk factors for environmental accidents by businesses in high risk industries and indeed society as a whole means there is inadequate institutional preparedness for handling accidents and their consequences. This can, in turn, augment damage. The pollution accident that took place in the Songhuajiang River valley has helped expose the degree of great ignorance about the issue and raised general awareness. If the response to the explosion at Jihua diphenyl plant had been faster and more effective, it would have prevented devastation and the massive pollution accident on a regional scale that resulted.

IX. The environmental costs of economic growth

The transformation of the Chinese economy has been characterised by spectacular GDP growth as well as acute problems of environmental pollution. Both should be acknowledged. This means that environmental accounting is a critical undertaking, even though a theoretically sound and well-tested system for such a practice has yet to be established.

The Ministry for Environmental Protection and the National Bureau of Statistics have jointly conducted research on environmental accounting in China, and have generated valuable insights. The results are documented in the '2004 Report on the Study of Green Accounting in China' (Wang and Yu, 2009). Calculations that factor in the economic cost of environmental degradation indicate that environmental pollution amounted to a loss of over RMB 511.8 billion (US$ 77.7 billion) to the national economy in 2004, or over 3 per cent of GDP (see Table 12). Water pollution accounted for a loss of over RMB 286.28 billion (US$ 42.5 billion), or 56 per cent of the total economic cost of environmental degradation. More specifically, the economic cost of the adverse health impacts of water pollution on rural populations was RMB 17.86 billion (US$ 2.7 billion), the cost of pollution-induced water shortages was RMB 147.83 billion (US$ 23.0 billion), the extra cost of pollution clean-up for industrial water use RMB 46.26 billion (US$ 7.0 billion), economic losses due to the adverse impacts of water pollution on agricultural production was RMB 46.84 billion (US$7.1 billion), and the combined clean-up and maintenance costs for water for urban residential use was RMB 27.49 billion (US$ 4.0 billion).

Air pollution represented RMB 219.8. billion (US$ 33.0 billion) worth of economic losses or 43 per cent of the total economic cost of environmental degradation. Of this amount, the adverse health effects of air pollution on urban populations cost the economy RMB 152.7 billion (US$ 23.0 billion), while the costs associated with a pollution-related drop in agricultural productivity was over RMB 53.78 billion (US$ 7.5 billion), and the loss of construction material was RMB 13.28 billion (US$ 2 billion). The environmental degradation costs of solid waste disposal were RMB0. 65 billion (US$ 100 million) and accounted for 0.1 per cent of the total due to environmental pollution. Of this amount, the opportunity cost associated with land losses due to the dumping of industrial solid waste was RMB 130 million (US$ 19.1 million), and that associated with land losses due to the dumping of residential waste discharge from cities and rural areas was RMB 520 million (US$ 75 million). The cost of pollution-related environmental accidents and disasters was RMB 5.06 billion (US$ 0.75 billion), accounting for 1.1 per cent of the total cost of environmental pollution to the national economy. Of this amount, RMB 330 million (US$ 50 million) was directly associated with incidents involving pollution, while the costs associated with losses to the aquaculture industry was RMB 1.08 billion (US$ 160 million), and that associated with resource depletion to the fishing industry was RMB 3.65 billion (US$ 550 million).

It must be noted, however, that these numbers do not capture the whole situation in all its detail, and are only as reliable as current computational methodology and available data would allow. Therefore, 3.05% of total GDP was, at best, a low estimate for the cost of environmental pollution to the national economy for 2004. First, health risks from environmental pollution were estimated on the basis of risk of death, which is in turn calculated in human capital terms. This practice tends to underestimate health risks. The alternative method of contingent valuation, on the basis of willingness-to-pay, would have likely yielded a higher estimate by orders of magnitude. Secondly, handicapped by the lack of necessary data from environmental monitoring, the estimate for the costs of adverse health impacts from environmental pollution is likely to be much higher than the current value of RMB 17.86 billion (US$ 2.7 billion). Thirdly, the estimate for the economic losses due to air pollution did not take into account, largely due to a lack of data, the cost of reduced agricultural productivity as a result of ozone depletion or traffic-related costs due to smog-induced decreases in visibility, or the cost of reduction in the scenic value of landscapes.

On the basis of the foregoing analyses, we can decisively conclude that the situation in China with respect to environmental pollution is complex, dire, and acute, and it presents an enormous challenge to the country. Moreover, China does not have the luxury of 'polluting first, cleaning up later', as developed countries have done. Instead, China has no other choice but to commit itself to science-based development. The approach to national economic development should change, with greater attention paid to the quality of growth, as well as quantity. At the same time, effective measures are needed in the areas of law, administration, economic planning, financial investment, scientific research, technological development, and public participation that will facilitate the strengthening of environmental pollution abatement and control. Only if economic growth is integrated with environmental protection can China experience rapid, balanced, and sustainable development.

Table 12 Economic losses from environmental pollution 2004

Water pollution	Human health	RMB 17.86 billion (US$ 2.7 billion)
	Pollution-induced water scarcity	147.83 billion (US$ 23.0 billion)
	Cleanup of industrial wastewater	FRMB 46.26 billion (US$ 7.0 billion)
	Agricultural production	RMB 46.84 billion (US$7.1 billion),
	Cleanup and treatment of municipal/ residential wastewater	RMB 27.49 billion (US$ 4.0 billion
	Sub-total	**RMB 286.28 billion (US$ 42.5 billion)**
Air Pollution	Health of urban residents	RMB 152.74 billion (US$ 23.0 billion)
	Reduced agricultural yields	RMB 53.78 billion (US$ 7.5 billion)
	Materials loss	RMB 13.28 billion (US$ 2.0 billion)
	Sub-total	**RMB 219.8. billion (US$ 33.0 billion)**
Solid Waste Pollution	Opportunity cost of land used for dumping solid industrial waste	RMB 0.13 billion (US$ 19.1 million)
	Opportunity cost of land used for dumping solid municipal waste	RMB 0.52 billion (US$ 75 million)
	Sub-total	**RMB0. 65 billion (US$ 0.1 billion)**
Pollution Accidents	Direct economic cost	RMB 0.33 billion (US$ 50 million)
	Fishery related costs	RMB 1.08 billion (US$ 0.16 billion)
	Costs to natural fishery	RMB 3.65 billion (US$ 0.55 billion)
	Sub-total	**RMB 5.06 billion (US$ 0.75 billion)**
	Total	**RMB 511.8 billion (US$ 77.7 billion)**

1 According to the grading system, the cities with higher grades are more polluted.

2 1 micrometre = 0.001 millimetres

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3
Forests in China: A problem of quality

Shen Xiaohui

中国森林质量与森林可持续经营

China has historically been a poor performer both in terms of forest management, and also the quality of ecological, economic and social services provided by its forests. This situation is unlikely to improve, until mistakes in traditional thinking about forests and forestry are identified and corrected. It is necessary to understand and apply the most rigorous theories on the subject currently available.

There has long been an influential school of thought which argues that forest cover over 20 per cent yields significant ecological benefits, and cover over 30 per cent can set off a virtuous ecological cycle. Misguided application of this doctrine of 'forest cover determinism' in China, over many years, has resulted in a single-minded preoccupation with forest expansion in Chinese forestry policies. This has found expression in the promotion of 'prolific logging and prolific building' (*dakan dazao*) policies. This has resulted in heavy logging of natural and primary forests and enthusiastic establishment of plantation forests. Because it is relatively quick and easy, planting trees in locations where there had historically been few or none has been the method of choice to increase forest cover. Wave after wave of national tree-planting campaigns over the last six decades mean that China has the largest area of planted forests on earth. While this feat has been a source of great pride for most forestry professionals in China, it is a decidedly problematic achievement. Has there been any decrease in the occurrence of droughts, floods, dust and sandstorms, landslides, and mudslides? The answer is no. And has this increase slowed the loss of biodiversity and arrested the trend of species extinction in China? The answer is also no. But if it is not forest cover that matters most or at all to the ecological quality of the land or that offers ecological security to a nation, then what does? The answer is the overall *quality* of the forest, which in turn depends on its ecological, social, and economic functionality. Lamentably, this topic has yet to receive the attention it deserves. Indeed, in China there has scarcely been any open discussion of this issue.

In December 2000, the World Resources Institute (WRI) launched the first independent online network for monitoring forests called Global Forest Watch. WRI then published its seminal *World Forest Report*. The report attempted to give the first comprehensive assessment of the state of the world's forests in terms of the range and quality of products and services they provide. The report made it clear that the quality of forests is just as important as their size.

This report correctly identifies the problem facing the world's forests: that rhetorical talk about protecting biodiversity is frivolous unless it entails protection of old-growth, primary and other kinds of natural forests. Conventional criteria for measuring the job performance of professional foresters, including changes in forest size, cover, and timber reserves do not accurately reflect the state of forest ecosystems, or forest quality. Such benchmarks may be fundamentally misleading. A particularly poignant illustration of this problem is enthusiastic tree planting to balance loss of natural forests. Such 'greening' campaigns produce only superficially verdant landscapes that are little more than a façade, covering over deep ecological crises.

Deterioration in quality is a problem that faces forests throughout the world, and it is particularly acute in China. Forest management in China has gone through three stages in the recent past: deforestation, (natural) reforestation, and silvicultural afforestation. It was not until the beginning of this century that forestry practices were re-oriented towards protecting natural forests and promoting sustainability. China's forests cannot be sustained until those responsible for them abandon the idea that planting more trees should always be the first aim of forest management. The focus needs to shift to overall quality. It is only when this ideological shift is complete, that national ecological security will improve.

I. The Present Quality of China's Forests

Historically, forest management has primarily served the needs of timber production and arbour species have been in the greatest demand. But as people began to understand the benefits of forest ecosystem services, forestry also gradually evolved into a type of ecological and social service industry. It has now begun to address the issue of optimizing the value of forests as providers of a wide range of social services, including as an energy source, climate stabilizer, support system and provider of other amenities, including as a location for cultural and recreational activities.

1. What is meant by 'forest quality'?

Forests have traditionally been evaluated in terms of their absolute size and cover within a certain land area. However, this only refers to the quantity of forest, and says nothing about its substantive quality, which is highly dependant on other factors.

The notion of quality refers to whether something satisfies a certain standard as measured by a given set of criteria. Since social needs and expectations are constantly changing, so too are ideas of what constitutes 'good' quality. Societies make many and varied demands on forests; so forest quality encompasses different dimensions including ecological, economic, spiritual, cultural, intrinsic value. These different functions and values can be defined as follows:

Ecological functions. These include the ability of the forest to protect biodiversity and to provide a protective shield for society, to facilitate energy flow within forest ecosystems and recycling of materials.

Economic functions. The economic value of forests is bound up with issues such as net primary productivity (NPP), the size and annual rate of increase of timber reserves, and the variety and quantity of commercial plants, animals and microbial species (excluding rare and endangered ones).

Spiritual and cultural significance. Diverse types of forest landscape reflect both a variety of forest ecosystems and forest communities and also the potential for different forest components (such as rivers, waterfalls, lakes, grasslands, tundra, rock, glaciers, peaks, and valleys) to be valued in such diverse areas as scientific research, education, tourism, social well-being and cultural industries.

Inherent value. Forests have an inherent value independent of human interests and desires. The inherent value of forests depends on their structural complexity and robustness, their productivity as a life-supporting system, and their biodiversity. It is generally believed that primary forests rank highest in terms of these measures, especially when they are considered as a whole, and as such they define the standard by which the inherent value of restored and planted forests in comparable climate zones and elevations is assessed.

2. A qualitative assessment of China's forests today

Primary forests are forests of natural origin, untouched by human activities. They tend to be highly diverse in terms of animal and plant species, structurally sound, effective as a natural shield, ecologically stable, and resilient, that is capable of self-regeneration and self-rehabilitation. The capacity of primary forests to perform a wide range of ecological, economic and social services and functions exceeds that of even the most successful and best managed planted forests, although these may be comparable in terms of timber reserves and annual growth rates. Primary forests may surpass managed forests in terms of the output of certain high-value forest products.

It is estimated that four to five thousand years ago, about 600 million hectares or 60 per cent of the Chinese land area was covered by primary forests. Over many dynasties and generations, felling and fires have reduced this area to 14 million hectares. Primary forests are found mostly in nature reserves and deep and remote mountains. They are in a fragmented and isolated state, and are continuing to deteriorate.

Many primary forests are over-logged, due to excessive selective logging. The shelter function of this type of forest may remain relatively strong despite its structural defects. Properly managed, they stand a reasonable chance of full recovery. However, repeated or serious assaults on primary forests often result in open forests or even bare land denuded of vegetation. Vegetation does not recover easily on these sites, and little of the ecological function of the original forests remains. There are two possible scenarios for natural succession in these open forests. In one, natural recovery fails, even after long periods, due to the severity of destruction or unfavourable topographical features such as high elevations. For example, the forested uplands of the Yunnan-Guizhou Plateau could not recover after intense selective cutting (both natural and artificial). Instead, the Plateau has degenerated into alpine grassland or rocky desert. Conversely, relatively favourable topographical conditions allow open forest to become natural secondary forest. Secondary forests are typically made up of pioneer tree species. However, without unique links between primary forests and the natural environment, secondary natural forests tend to be inferior to primary ones in terms of ecological stability and ecological function. Still, if left undisturbed, the prospects for their structural recovery are relatively good.

Currently, secondary forests cover about 93 million hectares of the Chinese land mass, and 70 per cent is dominated by young and immature growth. China has lost almost all of its original vast stock of primary forests and naturally generated secondary forests now dominate. They play a critical role in timber production, in fuelwood supply, in sustaining the livelihoods of local residents, and they harbour enormous potential for commercial and other kinds of development. Yet this type of forest has been taken for granted and neglected for years. Some forests of this kind have been converted for agricultural use, some have been allowed to deteriorate, and still others have been replaced with tree plantations. This situation began to change in 1989, however, when major initiatives to protect the country's primary and secondary forests were launched.

II. Impacts of planted and managed forests on overall forest quality

Silviculture has a long history in China. Legend has it that the arbour in the Temple of the Yellow Emperor on Qiao Mountain in Huangling county, Shaanxi province was planted by the Yellow Emperor himself. However, such tree plantations (which served a variety of purposes, including supply of wood products, shelter, and aesthetic value) have tended to be rather limited in scale. Few of them have survived to the present day. With the rapid disappearance of primary forests in the 1950s, tree planting became a matter of great urgency. Massive campaigns were undertaken to tackle deforestation. Measured by their own internal criteria, many of these activities were extremely successful. China now claims to have a total of 53 million hectares of planted trees, more than any other country in the world. The value of these forests for carbon storage, climate change mitigation, improvements in microclimates and local ecological conditions, facilitation of industrial and agricultural activities and supply of tree products is not in dispute. However, the prolific growth of planted and managed forests has given rise to a series of problems, with negative consequences for the quality of China's forests as a whole.

1. The preponderance of young and immature growth reduces timber density in planted forests

Trees in planted and managed stands tend to be disproportionately immature. Although they comprise 33 per cent of all forests in China by area, planted forests account for only 8 per cent of aggregate commercial timber volume, or a meagre 28 m^3 per hectare, less than one third of that coming from primary forests. Of all the planted forests in the country, 7 million hectares have very low timber yields and some just produce so-called 'old-man trees' that remain short after many

years. In some provinces, the 'transformation of low-yielding forests' has led to further investments to tackle the extremely poor quality of trees that had previously been planted to convert so-called 'wasteland' (*huangdi*) and meet greening quotas. These low-yielding, cost-inefficient plantations are enormously wasteful of Chinese resources.

2. The prevalence of monoculture forest plantations threatens biodiversity

Pure conifer forests comprise two-thirds of all planted forests in China, and they tend to be highly concentrated. The percentage can be as high as 95 per cent in some provinces. 80 per cent of trees in pure conifer plantations come from four conifer species (Chinese fir, Mason pine, larch, and Chinese pine). In total, seventeen conifer species are used for planting.

China is one of the three most biologically diverse countries in the world. However, four to five thousand species of higher plants are now endangered. There are many endangered animal species, including 94 large mammals, 17 reptiles, and 7 amphibians. China is home to one quarter of the 640 species from around the world that are listed as endangered in the Convention on *International Trade in Endangered Species of Wild Fauna and Flora* (CITES). Today, 15-20 per cent of the animal and plant species found in China are endangered, compared with the world average of 10-15 per cent. There are many reasons for this, including deterioration and deliberate destruction of natural habitats and illegal removal of plants and animals. The ratio of planted to natural forests also contributes to these alarming statistics.

3. The growing problem of pest infestations

86 million hectares of China's forests have been affected by some kind of pest infestation in recent years. Insects and rats kill more than 400 million trees annually, reducing the volume of commercial timber by more than 17 million m^3 and costing the economy RMB 88 billion (US$ 13 m). Such 'smokeless forest fires' can be more damaging than real infernos. As the area of planted forests in China continues to expand, so has the reach of pest infestations. In the 1950s, pests would affect an average of 8.5 million hectares of forests each year, this figure was 3.65 million hectares in the 1970s. By 2004, the number was about 9.5 million hectares, a massive eleven-fold increase over the level half a century earlier.

4. Declining contribution to soil and water conservation

Forest undergrowth plays a critical role in forest capacity to protect water sources and conserve soil. However, planted forests, especially pure conifers, are not conducive to supporting such growth. In 1958, Yunnan pines were aerially-sown in the Daliang mountain region. However, the trees were too close to one another and 40 years later many were still no bigger in size than a rice bowl. Moreover, the absence of undergrowth exposed the soil between the trees. Another example is in Gucheng County, Hubei Province, which was famous for 'achieving the quota to develop wasteland'. Forty-six percent of the county, however, suffers from serious soil erosion, of comparable severity to erosion in the Yellow River watershed. In the past, the favoured approach to 'developing wasteland' in many parts of China was to prepare the ground for afforestation by burning-off the original vegetation. This practice led to surface erosion and severe nutrient loss in the top soil. Burning before large-scale afforestation can result in soil erosion four to six times more severe than would occur in small-scale afforestation without burning. Many tons of soil per hectare may be eroded through this type of misguided afforestation.

5. Pure conifer plantations are extremely fire-prone, and aggravate decreases in soil fertility

The area under planted stands tends to be dry and combustible, particularly in pure conifer plantations. Yunnan pine forests are a good example. The pine needles from Yunnan pine decompose inefficiently, which means that soils in these pine plantations become blanketed by

needles, deficient in soil organic matter and lacking in water. Pine resin is a fire hazard in its own right because it is highly inflammable. The problem is further exacerbated because pure conifer plantations are inhospitable to animal species, including some of the invertebrates that play a key role in nutrient recycling and soil maintenance. As the soils in these forests degrade over time, tree quality also diminishes.

6. Ecological risks associated with genetic modification

Potential species contamination through genetic modification (GM) is a new risk factor in planted forests that has yet to receive adequate attention. Trees can be genetically-modified to grow fast and mature quickly. Plantations of genetically-modified trees are a cost-effective and highly profitable approach to commercial timber production. However, GM tree pollen can travel hundreds of miles. This can result in natural species becoming contaminated by pollen from genetically modified trees growing great distances away. In the worst case scenario, this could lead to massive disruption or even wholesale collapse of an entire forest ecosystem. The ecological implications of the genetic engineering of tree species are still poorly understood. In the United States, genetically-modified tree species may only be grown experimentally under close surveillance in test locations that are rarely larger than two acres. Moreover, these trees are never allowed to live past pollination age. By contrast, in China, more than one million GM poplars have already been planted in at least seven provinces and regions. Very little research has been undertaken on the impacts of GM tree species. Whereas the adverse consequences of pollution are often amenable to mitigation and even elimination, the same is not true of genetic contamination. Once genetically-engineered material enters the gene pool, the effects could be harmful and irreversible, with unimaginable consequences for society.

Forests are an important component of the earth's land ecosystems. They are irreplaceable as a provider of many crucial ecological, economic, and social services. This much is not in dispute. However, China's rapid progress in increasing forest cover during the second half of the twentieth century has stood in sharp contrast to lagging improvements in the overall ecological conditions of the country. A paradoxical phenomenon of 'macro deterioration amid micro improvements' is observable. This phenomenon results from many factors, but is closely linked to a general decline in the quality of China's forests. The disappearance of high quality primary and natural forests through over-logging, the subsequent abuse and neglect of the natural secondary forests that replaced them, the rise of single species plantations, and the shortage and uneven geographical distribution of forests compared to the demand for forest products, have all contributed to the creation of forests that do nothing to stem the loss of ecosystem services and vulnerability to natural disasters.

III. Reasons for the Poor Quality of China's Forests

1. Lack of progress in forestry research

In the second half of the twentieth century, mainstream Chinese forestry scholars mostly subscribed to research methods and perspectives coming from the Soviet Union. However, Germany had historically played a pioneering role in forest management, particularly in relation to sustainability issues. But in the early years of the People's Republic of China, the government chose to follow the Soviet Union and rejected the German idea of sustainable forest management as 'bourgeois'. The Soviet 'exploitation model' of the time essentially involved treating forests as though they were mineral deposits to be mined. The idea was that for every forest, could the country could, and should, determine the timber reserve, the productive lifespan, and the economic prospects of the forest. No consideration was given to the issues of forest sustainability, or stewardship and maintenance of the forest's ecological and social values.

After the country officially broke relations with the Soviet Union in the 1960s, forestry studies in China was left without a sound theoretical foundation. Attempts were made to made to address this but with limited success. It was not until the 1992 United Nations Conference on Environment and Development that China officially adopted the philosophy of sustainable development and sought to apply it to forestry management.

2. Policy level challenges

In China, the process of industrialization started late, and from a lower starting point than for many other countries. It has been characterized as involving a trade-off between environmental protection and resource conservation, and rapid economic growth. Add to this the enormous pressure of rapid population growth, and the result has been an exacerbation of the plundering of forest resources.

Between the 1950s and the 1970s, timber production was the sole concern of the forestry industry and reflected the dominance of wood as the raw material of choice in economic production. In the 'mass campaign' model of that period, hundreds of thousands of people across the country were mobilized to set up 135 state-owned forestry enterprises in the northeast, Inner Mongolia, and the southwest. As a result, the forestry industry surged ahead and quickly became one of the top contributors to GDP growth. Political movements and the institutional straightjacket of the command-and-control economic system ensured that the country's commitment to 'a pluralist and holistic approach to forest management that prudently integrates use and cultivation, felling and planting, and that is based on the principle of sustainability' remained little more than a slogan. Instead, as more trees were cut and planted, the quality of China's forests worsened and the rationale for sustaining them diminished.

Wave upon wave of political movements and campaigns had serious impacts on China's forests. The Great Leap Forward and the Backyard Iron and Steel Furnace campaign of the 1950s, the movements to Take Grain Production as the Key Link, and to Learn from Dazhai (a model village for agricultural production) in the 1960s and 1970s, and the deregulation of the forestry industry in the early 1980s all contributed to the depletion of China's stock of primary forests. Some current reports also indicate that a good deal of what remains of China's dwindling reserve of primary forests is still displaced by planted forests despite, or perhaps because of, changing regulations concerning rights to forestry resources.

From the late 1970s until the 1990s, cultivation and utilization gradually became more equally balanced as concerns for China's forest industry. During this period, timber output remained high. Between 1978 and 1988, domestic demand and consumption continued to rise despite a one third reduction in timber volumes in mature and over-mature commercial forests. This resulted in a forest resource deficit of 170 million m^3. By the late 1980s, most timber companies were facing the dire prospect of stock depletion and the forestry sector of the national economy seemed to be on the brink of collapse. Moreover, frequent floods and intensified desertification across the nation plunged the country into an unprecedented ecological crisis. However, the early 1980s also saw the beginnings of a massive national greening campaign and a rise in voluntary tree-planting. Key activities included the 'Three Norths' Shelterbelt programme in the northeast, northwest and central northern regions, and the Mountain Wastelands Development project. The express goal of all these campaigns was to increase forest area. Manual tree planting, aerial-sowing, and mountain closure for tree cultivation contributed 4.2 million hectares, 60,000 hectares, and 4 million hectares to annual increases in forest cover respectively. Indeed, the Fourth National Forest Inventory was able to deliver the good news that China had achieved a 'dual gain', with increases in both forest size and forest cover. However, the moderate and localized ecological benefits of planted forests could not fully compensate for the ecological and economic costs associated with a loss of primary forests overall. Even today, China's forests are continuing to decline.

3. Forest management and production: the role of administration and technology

The basic model of forestry management is one of systems management. It is not reducible to pure technicalities, but is also concerned with the comprehensive utilization of forests for multiple values, including ecological, economic, social, scientific, technological, legal and cultural values. Since forestry management in China was poorly practiced and even a free-for-all for many years, the question of whether it met a certain set of standards never really arose. Some of the symptoms of this problem include the following:

Seedling production. Seedling quality determines whether afforestation succeeds, by how much, and whether the planted forests are able to provide an adequate level of ecological and social services.

In developed countries, prime seeds of superior quality typically account for over 80 per cent of all seeds used in tree planting. In China in 2002, this figure was 28 per cent. This means that many planted forests in China are congenitally deficient.

Uniform standards for the production and sale of seedlings are lacking and irregularity is pervasive. Clear lines separating regulatory agencies from businesses and corporations are lacking in many places. Conflicts of interests and corruption are commonplace. The seedling market is full of counterfeit and inferior products.

Seed orchards or seed tree collection sites do not yet exist for many popular species used in plantations. Many important indigenous tree species have yet to be utilized. Local agencies in charge of plantation development and management and business interests favour so-called 'short-rotation' species that grow fast over 'long-rotation' species that tend to be more valuable in terms of their long-term ecological and economic benefits.

Making seedlings widely commercially available, transporting them over great distances, and using them across ecologically heterogeneous regions creates a number of problems. The first is a pervasive mismatch between species of seedlings and the environment in which they are planted. Secondly, eight fast-growing species (including eucalyptus, Mason pine, China fir, exotic pine, poplar, paulownia, and larch), account for the vast majority of planted trees. This low level of species diversity renders forests more susceptible to soil degradation and disease outbreaks, and less ecologically stable.

Six large forestry programmes have commenced in China in recent years. Together, they have added nearly 7 million hectares of planted forests to the national total. But they have also increased the demand for seedlings. This upward pressure promises to exacerbate the nationwide problem of poor seedling quality, and it does not bode well for the future of China's forests.

Timber production. If the concept of sustainable development and modern forest ecology theory is used to reflect on the havoc caused to China's forests, it must be accepted that a complex and intricate life-sustaining system has been treated with mechanistic brute force. For example, clear-cutting involves uprooting all the trees in a forest stand, it ravages the forest environment, reduces forest biodiversity, greatly compromises the capacity of the forest for self-regeneration and self-renewal, and causes serious soil erosion. Clear-cut logging in select and small areas of the Changbaishan mountain region was commonly-practiced for many years. However, the number of these clear-felled areas eventually increased and reached a tipping point, resulting in serious environmental damage.

In another example, in the Xiao Xing'an Ling Korean pine forests, culling and selective cutting has been a popular logging method. According to official guidelines, the use of this method requires maintaining a canopy density above 0.4. However, because Korean pines have shallow roots and are vulnerable to strong winds, the canopy density of culled and selective cut forests can easily result in a canopy density of only 0.1 to 0.2 after just 1-2 years, creating open forests. It is

precisely this kind of extractive economic logging regimen that is to blame for the precipitous decrease in forest resources in the Xiao Xing'an Ling mountains, long called the 'Home of Korean pines'.

The forests of the Greater Xing'an Ling mountain region are primarily made up of larch. The use of a staggered and incremental logging method called 'secondary shelter-wood cutting' results in a good natural rate of replacement. Before a tree was cut, its replacement had already grown. However, cutting and use of tractors for logging eliminated many saplings. The forest environment was seriously damaged, and the barren top soil was washed out and eroded by rain. This made artificial reforestation very difficult. This is the reason why a great number of barren mountain ranges have emerged in the Greater Xing'an Ling mountain region.

The forests in southwest China have long served as conservation forests for the headwaters of many great rivers. They are also the habitat and gene bank for countless valuable and rare plant and animal species. However, in the 1960 and 1970s, they became a timber production hub. The result of 20-30 years of concentrated and excessive cutting is now ravaged mountains and destroyed rivers.

Illegal logging and quota violations. One of the most influential legal documents for forest management has been ministerial legislation for a felling quota or allowable annual cut (AAC). The document was a product of a number of different influences. It reflects the government's recognition that China faces forest resource scarcity, and incorporates lessons the government has learned from past mistakes in forestry management together with international experiences in this area. It is designed to protect and develop the nation's forest resources. The measure was mandated by the *Forest Law*, and ratified by the State Council, and has been operational since 1987. Its implementation has, however, left much to be desired. The *Fifth National Forest Inventory* revealed that each year, quota violation resulted in over 86 million m3 of timber being obtained through over-quota or illegal logging. In addition, each year on average 500,000 cases are reported of forest abuse or destruction. Recent results in the *Sixth National Forest Resources Survey* showed that quota violation accounted for the production of 76 million m^3 of timber each year. This is a staggering figure, even if it is slightly below that in the previous survey. This provides ample evidence of problems in forest resources management and loopholes in law enforcement. Illegal logging and quota violations surpass legitimate timber production in terms of destructiveness. The widespread nature of these twin problems is an important reason for continuing declines in forest quality in China.

Forest cover data inflated due to lowered standards. Another piece of indirect evidence for the poor overall quality of China's forests relates to illicit downward adjustments of official standards. Some technical standards used in compiling forest data have been lowered since the *Fifth National Forest Inventory.* As a result, large areas of open forest and shrubs that should not have counted as national forest cover were included in the official figure.

For example, the technical standards included in the revised edition of the *Fifth National Forest Inventory Data* (1994-1998) were quite different, and much lower than those found in the results of the *Fourth Forest Inventory.* One example is the standard for minimum forest canopy density. It was 0.3 (exclusive) in the *Fourth Inventory* but 0.2 (inclusive) in the revised edition of the *Fifth Inventory*. Canopy density is a key indicator for calculating forest cover, as it determines whether a stand can be counted as forest. When the minimum forest canopy density standard is reduced from 0.3 to 0.2, it means is that over 250 million hectares of open forest can be counted as forests. This calculation radically increased the reported aggregate forest size and cover in China, but also reduced its biomass density and growth rate. The national average canopy density fell from the 0.6 reported in the *Fourth National Forest Inventory* to 0.5, and the biomass density per hectare of forest stand fell by $0.4m^3$.

These technical manipulations of course do not alter the real state of China's forests in any way, but they are deceptive and contribute to a false sense of security about the state of China's forests. Just as important, the resulting incompatibility in results from different surveys makes it much more difficult to determine general trends relating to the status of forestry resources.

IV. Modern Forestry Development Theory and Practice

The succession, degeneration, and recovery of forests follow similar patterns the world over: primary forests give way to deforestation, which then gives way to planted and managed forests, which are then (re)naturalized. A fundamental paradigm shift in the philosophy of forest management, from sustaining timber production to sustaining the forest itself, underpins evolution from an exploitation model to a plantation and cultivation model, and eventually to a naturalization model.

Many countries are engaging with a transition from a single-value, single-function approach to forestry to a multi-value, multi-function approach, on a trial-and-error basis. While there have been some successes, the overall picture is mixed at best. The philosophy of sustainable development has still to be applied at the policy level in many developing countries and so the trend of overall deterioration of the world's forests continues. It is paramount that lessons are learned from developed countries that have made significant progress in raising their forest quality. This would help clarify thinking and replace obsolete notions with scientifically-sound approaches. Adjustments to national forestry strategy would be possible in order to repeating the mistakes of other nations.

Human understandings of forests remain woefully imperfect. Fierce debates over strategies for forest management in developed countries in Europe and North America in the 1980s were a key part of the development of the modern environmental movement.

Modern theories of forest management reflect changing social values. These include the quasi-naturalist model adopted by Germany, the new systematic ecological management model adopted by the US, and the sustainable development model that the world endorsed at the 1992 UN Conference on Environment and Development. Their rise is a mark of genuine progress in the underlying philosophy of forest management, which seeks to achieve both economic production and environmental protection.

How then can forest quality be improved? In short, the best approach will depend on the specific type of forest being considered with and concrete objectives. The basic principle should be to protect and preserve primary forests, rehabilitate deteriorating forest ecosystems, and construct quasi-natural forest ecosystems, in accordance with ecological principles.

1. Protecting primary forests is essential

The World Resources Institute has referred to primary forests that have retained their original ecological features as 'frontier forests' (a phrase that conveys a sense of urgency and crisis). According to their studies, about 8,000 years ago, primary forests covered over 6 billion hectares of the earth's land surface. The total is now only 1.35 billion. This downward trend is continuing with the loss of about 10 million hectares annually. Forest plantations can be 'made to order', but once primary forests are lost, they can never be recovered. For this very reason, some scholars have proposed clearly designating a no-go boundary between frontier forests and everything else for the sake of other species and future generations.

WRI data indicates that China lost 98 per cent of its primary forests during its recorded history. The two per cent that remains is fragmented and isolated. Most is located within national parks and nature reserves, and areas covered by primary forest protection projects. Shockingly, some is

still being used for timber production. Nothing is more important than making sure that what remains of China's original stock of primary forests is protected and preserved. One way of doing this is to extend the boundaries of nature reserves to include these areas. This can be done using the map of protected areas released by the World Resources Institute's Global Forest Watch (GFW-WRI). This would allow decision makers to mandate protective status by law, and to ensure protection from further exploitation.

Protecting and preserving primary forests is a prerequisite for overall efforts to improve forest quality across China. Of course, these are costly propositions. However, protection and preservation are infinitely more cost-effective than possibly irreversible losses from a policy of 'destroy first and repair later'. By definition, 'ecological health' is not something that can be built or constructed by human effort. It is something that can only be protected, preserved, restored, or sometimes improved upon. As Premier Wen Jiabao noted: 'what ecological and environmental strengthening essentially involves is not building something anew but protecting, preserving, restoring and improving upon what nature has already given us'.

2. Vigorously restoring natural secondary forests

Closing off mountains to facilitate afforestation is a policy of 'action through inaction' (*wei wu wei*). This method is particularly suitable for promoting public service forests. Sometimes doing nothing can be wiser than acting in hastily or without due reflection. This is especially true in areas where nature is so much more competent than human beings. Under these circumstances, it is completely unnecessary to try and recreate nature and natural beauty, or to clone biodiversity, ecosystems and food webs.

Primary forests are the product of billions of years of natural evolution. These marvellous homeostatic systems are characterised by spectacular vitality, and an ability to regulate, repair, regenerate, and renew themselves in the face of natural disturbances. These intricate and resilient systems are made up of numerous plant, animal, and microbial species that co-exist as an integrated whole. No planted forests can ever come close to natural forests in these respects.

If this logic is accepted, then it is clear that closing off hillsides or river valleys, to facilitate afforestation should be the first choice when constructing public service forests, as these methods make maximum use of nature's own self-regenerating mechanisms. These methods essentially involve choosing a topographically-suitable site in terms of sunlight, temperature, water availability, soil conditions, inclination, and elevation, and then preventing unsustainable levels of activities as felling, hunting, and herding to allow the original vegetation to regenerate naturally, until the climax vegetation at the site is restored. However, natural regeneration may be impossible in sites that are too high, cold, dry, infertile or otherwise heavily desertified. Where trees have never grown, in addition to sealing the area off, planting must be dictated by the principle of maximizing the fit between choice of tree and grass species and the site. One-size fits all is exactly the wrong approach.

Since the 1950s, heavy machinery has increasingly been used in timber harvesting, and the adverse impact on forest ecosystems has created widespread concern. A key lesson is that protecting forest quality and sustainable management of forest resources requires that destruction of ground surfaces, wildlife habitat, remaining trees, and other native vegetation is reduced by reducing the intensity of road construction, felling, and harvesting. Experiences have shown that lessening dependence on heavy machinery and advanced technology and substituting light machinery, labour, and draft animals is actually progressive. It is a particularly effective way of protecting forest ecosystems. A very successful experiment to test this approach was undertaken by the Great Sea Forest Bureau in Heilongjiang province.

Reducing logging intensity and re-integrating a traditional common-property model into the practice of modern forest management is a feasible approach for protecting timber production forests.

3. Active construction of quasi-natural forest plantations

China is already home to more than 53 million hectares of planted forests, and that number is projected to grow by 67 million hectares within the next 10 years. If the principles of ecology in the planning and conduct of forest planting and growth are not applied, further deterioration in forest quality will result in the coming decade, and the forests of China will be less diverse and less natural as a consequence.

When China's forest industry was still in its infancy it faced huge problems of low forest coverage, forest resource scarcity, and inadequate capital investment. The responsible agencies could ill-afford to focus on quality control as the actual internal demands at that stage of development dictated that there were no alternative options to 'covering the country with green first' without regard to quality, difficult as the choice must have been. But this choice, however much 'greener' it has made the national landscape, has done nothing to improve the livelihoods of tree planters. The greener the mountains have become, the poorer their residents have become.

Today, many state-owned tree farms have had to resort to borrowing heavily from banks to finance their Wasteland Development operations. They are barely surviving under large and growing debt burdens. With trees that strongly resemble chopsticks, the planted forests in these tree farms have become progressively more worthless. The low level of tree species diversity has meant that problems such as decreasing biodiversity and pest infestations have worsened even as others, such as soil erosion, have been somewhat mitigated. Still others, such as forest fires have the potential to become worse in the future. In short, the country is being harmed by massive planting of forests of inferior ecological quality. This constitutes a monumental waste of forest resources and forest productivity.

V. The quality of planted forests

Forest area and cover only refer to the quantity of a forest. Improving its quality entails optimizing forest ecological functions. Criteria such as 'first year survival rate' and 'three-year preservation rate' focus exclusively on technical issues relating to quantitative expansion, and are only peripheral to plantation quality. It is necessary to establish a criteria system for evaluating and monitoring forest quality. These criteria should be concerned with seedling quality, species composition, vertical integration among trees, shrubs and grass, the level of biodiversity, the aesthetic value of the forest landscape, its biological productivity, impact on soil erosion and seasonal rain runoff rates, and on dry season flow rates and biomass, and impact on the frequency and intensity of forest fires and pest infestations.

Diversification and (re)naturalization are two key topics in international forestry research. They also define the general direction of applied forestry. After 300 years of experience with planting forests and managing planted forests, and with a relatively successful timber industry, Germany has become one of the first countries in Europe to rethink how forests should be used and managed. Many European countries have followed suit.

Quasi-natural forests are neither primary forests nor planted forests in the traditional sense. They are a kind of forest system that has been artificially reconstructed using the species composition and stand structure of the original forest community. It has become increasingly popular to mix conifer, broad-leaved and many other species together in forest plantations to yield a kind of planted forest that comes quite close to what would have arisen under natural conditions. This method, therefore, is a giant step forward in the history of silviculture. It is particularly suited for those areas (such as in central China) where the primary forests have long been destroyed but where reforestation through mountain closure would take too long.

To improve biodiversity in planted forests, the Forest Service of the United States has selectively cultivated trees, shrubs and grass species in accordance with the specific foraging, habitat and reproductive needs of different animal species. This targeted approach is particularly effective for its intended purposes, and can help build the ecological corridors that are instrumental for the interchange of genetic material among different species and among groups of the same species. It promises to be especially valuable for the protection of primary forests and for restoring farmlands.

American forestry expert, David Kaimowitz, has noted that forestry is 'the greatest art and science'. In this new century, forest management professionals and practitioners in China must wean themselves off the notion that their job is simply to support the timber industry and to plant trees and commit themselves to the new goal of sustainable and multi-functional forest management. Preoccupation with size must be replaced with a comprehensive concern for both size and quality of forest integral ecosystem functions. It is only when the latter improves that increases in the former will be genuinely meaningful.

None of this is terribly complicated, nor are the basic ideas behind the theory esoteric. However, the power of vested interests means that there is still a long way to go before the transformation of Chinese forest management to a modern model is finally complete.

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4

The Ecological Impact of Institutions and Policies on the Mongolian-Manchurian Grassland Ecosystem: Past and present

Dalintai

制度与政策的历史演变对内蒙古草原生态环境的影响

This chapter is a study of the role that institutions and policies have historically played in the anthropogenic degradation of the Mongolian-Manchurian grassland. Over the last fifty years, the Mongolian-Manchurian grassland ecosystem has experienced serious deterioration as a result of dynamic interactions between economic activities and harsh environmental conditions. Inadequate understandings of the impact of human activities on grassland ecosystems have made it difficult to make long-term management and development plans for the grasslands. Indeed some of the grassland development and ecological restoration programmes that have already been implemented have themselves created ecological and social problems.

Introduction

The temperate grasslands of northern China, dominated by those of Inner Mongolia, function as a powerful ecological shield for the northern part of the country and as a cradle for the nomadic civilizations and grassland cultures of its peoples. It was once the most complete steppe ecosystem in the world. A nomadic mode of production facilitated the self-renewal of its grasslands, supporting a natural process of ecological diversification, ensuring the relative stability and security of valuable genetic resources, and providing stable feed resources for its livestock. But this is now in the past. The grasslands of Inner Mongolia have both shrunk in size and declined in grazing productivity, and the area experiences frequent natural disasters, and is ecologically dysfunctional. Severe desertification has turned Inner Mongolia into a threat to the country and its ecological environment. In 2000, the government launched a whole package of ecological compensation programmes that paid farmers and herders to stop farming or herding. These included grazing bans to allow the regeneration of grasslands. While these programmes have yielded moderate success, they have also generated serious problems.

This chapter will explore this, using historical analysis to trace the role institutions and policies have played in the anthropogenic degradation of the Inner Mongolian grassland.

I. The ecological evolution of the northern steppe

Around four thousand years ago, inhabitants of the area that is now northern China and those from its Central Plain learned how to cast bronze. However, the former learned how to cast iron before the latter. The introduction of metal tools greatly increased productivity, setting the stage for the first social division of northern China, in which herding and cropping became separate pursuits. Many Altai language family speaking communities from the northern steppe came to specialize in animal husbandry as their main form of production. As a result, livestock numbers greatly increased, and created the need for ever larger grasslands to cope with drought. Nomadic pastoralism was often the only response strategy to these fluctuations in precipitation. Accordingly, primitive forms of settled farming practice were replaced by mobile animal husbandry.

That such a primal form of mixed economy should have evolved into a pure nomadic economy was, for the inhabitants of northern China, a historical inevitability. A long history of interaction with the natural environment allowed people of the grasslands to develop a unique lifestyle, centred on a set of production methods. Their intimate understandings of the dynamics of grassland ecosystems shaped their natural resource consumption pattern.

The southern parts of the northern steppe are particularly suited to agriculture and have supported both crop cultivation and animal husbandry. In this region, the nomadic populations of the north and the dynastic powers that ruled over the Central Plain further south both mixed with and influenced each other. For example, after the Qin and Han dynasties, the Yellow River was

diverted through large scale water diversion projects to support irrigation in western Mongolia. Partly as a result of this, farmland subsequently expanded to take over the grasslands on the southern slope of the Yinshan Mountains. Later, thanks largely to frequent moves by the ethnic groups in the north, a patchwork of agro-pastoralism took shape in the region, in which some areas were more distinctly agro-silvo-pastoral[1]. For an extended period after the Yuan dynasty, pastoralism prevailed. Throughout the dynastic era, the ethnic Han people in the Central Plain and other northern communities were for the most part only able to manage short-lived and small scale farming operations. This is also why a considerable portion of the grasslands in this region remained largely ecologically intact.

This situation began to change in the early 20th century. In 1902, the Qing court initiated a policy of extensive land cultivation, bringing large numbers of ethnic Han people from the hinterlands to the north to take up farming. This was then followed by similar, but more violent, efforts by warlords from northern China. Between 1902 and 1937, the Han population in what is today's Inner Mongolia Autonomous Region increased from 1 million to 3.18 million. The expansion of cultivated areas proceeded northwards and westwards, drastically reducing the size of grasslands and pastoralist dominated areas. On top of this, rapid economic development accelerated grassland degradation and desertification, and the region experienced frequent natural disasters. Gradually, the southern parts of Inner Mongolia became semi-agricultural and semi-pastoralist[2]. In this process, many herders lost access to grasslands and fell into poverty, causing the human population of Inner Mongolia to drop to 0.83 million from 1.02 million, and the livestock population to fewer than 10 million in 1948 from 70 million in the 1920s. These developments created acute social and ethnic conflicts.

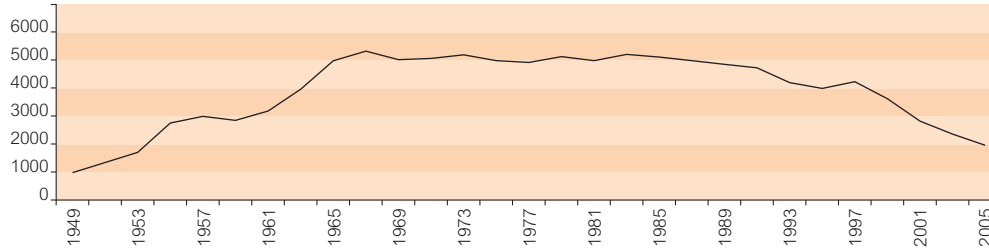
II. The ecological impact of institutions and policies on the grasslands since the founding of the People's Republic

In the past five decades or so, different levels of government have enacted a host of ecological management policies in a range of areas including land use rights, economic development, taxation, population management, and grassland restoration and protection. These policies have had enormous impacts on the steppe ecosystem.

1. Land use rights and policies

When it was established in 1948, the Inner Mongolia Autonomous Region was the first ethnic minority autonomous region to be set up by the Chinese government. During the reform process, official policies stated that 'all the land in Inner Mongolia is owned collectively by the people of Inner Mongolia', and that 'all are free to graze their animals on the grasslands', and that 'people and animals are to flourish together'. During the socialist reforms that followed, state policies stated that grasslands were a common property resource and were to be managed collectively. A restructuring of property rights in relation to the grasslands and farms then followed as communes were established. During this time, herders and livestock owners were registered as permanent residents for administrative purposes, and the common ownership of grassland allowed for flexible allocations of grassland resources to address the constant risk of drought. Flexibility meant that herders could decide how best to improve the fit between supply and demand, but not completely independent of the government, which played a role in adjudicating possible conflicts. Essentially, herders were able to practice nomadic pastoralism, within a sizable region. This not only allowed them to cope with spatial and temporal uncertainties and contingencies in grassland conditions, but it also helped to preserve the steppe ecosystem, which remained intact throughout the period. Indeed, animal husbandry was fairly efficient and productive at that time. During a second peak in the twentieth century, the total number of range livestock in Inner Mongolia reached 53,011,200 in the 1960s (Figure 1).

Figure 1 Change in livestock populations on natural rangelands in Inner Mongolia (10,000)



Note: Data reflect livestock numbers as calculated in terms of sheep-equivalent livestock units
Figure 1 is constructed on the basis of information compiled by the Inner Mongolia Grassland Management Bureau and collected from field studies. It includes information for the 24 herding banners and nine agro-pastoral banners (a banner is an administrative unit equivalent to a Chinese county). The livestock population used here does not included animals raised on farms inside the Autonomous Region.

In 1949, the number of livestock in Inner Mongolia, based on a standard calculation for sheep-equivalent livestock units, was 10.09 million. The number grew to 53.01 million in 1968, a historic high after 1949[3]. Between 1965 and 1989, the livestock sector was in a steady state, with the total number of livestock hovering around 50 million. But after 1990, the number began to decline. By 2005, the carrying capacity of the natural grasslands in Inner Mongolia was so reduced that it could support no more than 20 million head of livestock.

This raises another question relating to the tenure system, and specifically the separation of the two kinds of rights – ownership and user rights – that was put in place after de-collectivisation. Under this new post-commune system, grassland ownership, which was previously held by the commune, was transferred to the herding village collective or gacha (formerly the production team). Herding households were allocated user rights on a group or individual household basis in accordance with pasture availability and population conditions in the area. The same process applied to the collectively owned livestock. The establishment of these operating systems – one for grassland and the other for livestock – marked the end of the commune period. This copying of lessons learned from tenure reform through the Household Contract Responsibility System in the cropping areas onto the pastoralist context has greatly restricted the mobility across large distances which herders previously relied upon as a coping mechanism for climatic uncertainty. Moreover, other problems were created. Herders no longer worked jointly, but as individual units. This meant that, for example, given the cyclical nature of livestock production and the regularity with which female stock gave birth, many herders now had to resort to using birth control measures for female animals and buying hay that has been produced outside the pastoralist system to protect themselves against the threat of natural disasters. In the past the government had also been pro-active in dealing with natural disasters, now it has become entirely reactive, spending large amounts of money on constructing disaster prevention systems and on developing unclaimed land resources; processes that are reliant on exogenous sources of energy.

This user-rights system also gave rise to a smallholder-based herding system. Unlike the rise of the small farmer economy, the preconditions for the rise of a smallholder-based herding system were never fulfilled because under feudalism, herders were not allowed to own their own grassland and could at most have a small number of livestock. After 1949, the collective system replaced the small farmer household economy but otherwise had little discernible impact on herder households. While strictly speaking, for cropping areas, the user rights system meant the return of the family farm, the allocation of household pastures and household herding enterprises represented something new in the history of nomadic pastoralism in these locations. As the commune system replaced the league and banner system, and the user rights system replaced the

commune system, herding households became more and more sedentary, in a process that eventually lead to the emergence of an economy based on smallholder herding. Correspondingly, the traditional approach to natural resource utilization was gradually displaced by a new approach more suited to small-scale herding livelihoods and culture. The dissolution of the harmonious human-nature relationship that had been sustained by nomadic pastoralism and the disintegration of close-knit herding communities helped intensify the exploitation of the grasslands and to exacerbate their ecological degeneration.

Tenure reform, and particularly the creation of the user rights system, brought the Inner Mongolia grasslands into the market system. During this process, the grasslands underwent many changes. On the one hand, division into segments reduced the productivity of the pasture, which meant increasing operating costs and decreasing returns. On the other hand, the provision of what used to be social services, such as healthcare and basic education, became increasingly dependent on the market: both of these factors led to overuse of grassland resources.

Table 1 shows numbers of soil samples taken from each of the four strips of land which enclose the pasture owned by the Wu family, of Wang Banner[4]. The pasture is in the shape of a parallelogram.

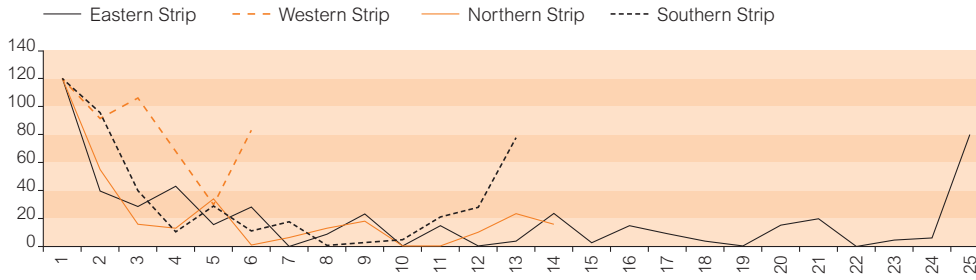
Table 1 Soil samples taken from each sample transect

Eastern Strip	Western Strip	Northern Strip	Southern Strip
26	6	14	13

Each soil sample was 1 square metre in size and was taken every 50 metres across a transect. To reduce disruption to a minimum, only the amount of *Peganum harmala* (hereafter harmel) found inside each sample quadrant was recorded, as this tough species is an indicator of severe grassland degeneration. The numbering of the samples started with those closest to the homestead and proceeded outwards[5]. The entire pasture area in this case was fenced in.

Figure 2 shows both the degree and the pattern of degeneration of the area under investigation. Seriously degraded on the whole, the areas immediately adjacent to the homestead and near to the fence were still more degraded. This is largely explained by the fact that these areas are the most heavily trampled by the livestock.

Figure 2 Number of harmel plants in each sample transect
(y = Number of degraded plants)



From Figure 1 and Figure 2 it is not difficult to see that when the user rights system for both grassland and livestock was established on natural grasslands, local degradation was initially confined to where each herding household's livestock grazed most heavily. This eventually escalated into regional degradation. Consequently, both the productivity of the grassland and its carrying capacity has progressively decreased.

These developments have also stymied income increases in Inner Mongolia. While herder incomes did increase over the 30-year period from 1978 to 2007, they did so only very slowly. After adjusting for inflation, the margin of increase was never above RMB 1,000 (US$ 146). Nominal income in Inner Mongolia was RMB 1,761 (US$ 267) per capita in 2002, only 71 per cent of the national figure for farmer and herder per capita income (RMB 2,451 (US$ 372)). Our own investigation of 1,000 herding households in representative locations in Inner Mongolia indicated that the average income was only RMB 627 (US$ 95), at subsistence level.

The data illustrate the impact on the pastoral economy and the grassland ecosystem of the two waves of rangeland user rights reform after 1949. The system of collective grassland user rights was relatively ecologically benign and also proved more productive than the pre-1949 feudal system. By contrast, because the household user rights system is unsuited to pastoralist modes of production and management systems, it has created many problems in the pastoral economy and for the grassland ecosystem over the past 20 years. Under this system, herders have been unable to maintain their traditional nomadic ways, despite their fitness with the geographic and climatic conditions of the Mongolian plateau.

2. Other economic policies

2.1 Implications of the overall national development strategy on the environment

Frequent changes in economic development plans have had a significant ecological impact on the steppe. Post-1949 government policies for Inner Mongolia distinguished between the agriculturally dominant area and the pastorally dominant area. The strategic emphasis on 'stability, durability, and flexibility' led to policies that not only facilitated the rebuilding of the pastoral economy but also ameliorated ethnic conflicts. However, in the late 1950s, the government introduced a new policy that called for 'integration of pastoralism with agriculture and elimination of the wealth gap between Inner Mongolia and other parts of China'. Even though economic policies shifted frequently during the Cultural Revolution (1966-1976), they had relatively limited impact on the pastoral economy. This meant they also had limited impact on the grassland ecosystem. Again in contrast with agricultural production, forestry operations in the area had also left relatively small ecological footprints. Because they had relied largely on human labour and were only minimally mechanized, this necessarily limited the adverse impact they could have on the ecosystem.

In the mid 1980s, new grassland and livestock user rights systems were unveiled. At around the same time, the Inner Mongolian government also began to look for an unconventional economic development strategy that would enable the region to catch up with and even overtake other regions in the country by leapfrogging. However, as a border region that is also dominated by pastoralism, the role of Inner Mongolia in the national economy is one of raw materials supplier. Had the prices of livestock grown as rapidly as has demand, it would have hugely benefited the region economically. However, at that time (until early 1990s) the prices of livestock and related products were not determined by the market, but set by the government through macro-economic policies, and these policies tended to favour manufacturers in the coastal provinces. Trade patterns as a result of these policies had the effect of transferring wealth from Inner Mongolia to the industrialising seaboard provinces. Inner Mongolia gave all it could in natural resource terms in support of urbanization and industrialization in other parts of the country[6].

2.2 Environmental implications of agricultural and pastoral development policies

Since 1949, Inner Mongolia experienced a total of six major land cultivation campaigns. The first lasted from 1958 to 1962. The aim of this campaign was to turn grassland into cropland, and production and processing centres for agricultural products. The campaign was, therefore, an integral part of the nationwide call to 'Take Grain Production as the Key Link'.

The second campaign was from 1966 to 1976 and focused on the slogan that 'no self-respecting herder would eat grain grown by others'. These first two waves of land opening and cultivation had two major consequences for the grassland: they ravaged the ecosystem in *areas that were opened up for development,* and caused a surge of immigrant farmers who subsequently came to dominate forage production. Today, visitors to the grassland are greeted by farmers who have now lived in the area for several generations and are growing crops and grazing livestock in cramped conditions around their residential settlements. This high grazing pressure has progressively degraded the grasslands. It continues to sprawl outwards onto the grazing areas. As a result of this rapid grassland deterioration, sand dunes tend to form on the outskirts of settlements. Each spring, menacing gusts sweep through the region and blow dust and sand into downwind areas. Increases in farming populations and crop-based agriculture as opposed to animal husbandry have continued to impact negatively on ecosystems.

The third land cultivation campaign lasted from 1986 to 1991. Within a few years of the establishment of the rangeland and livestock user rights system, local grassland deterioration that had previously been confined to the farming settlements and their immediate surroundings began to spread in different directions. Increased livestock numbers also contributed to a new wave of conflicts between farmers and herders. The government also intensified livestock feed production in the region in its third land cultivation campaign. The campaign itself was more moderate than the first two, but its philosophy of profit maximization under ecological and socio-economic constraints and promotion of modern mechanized farming equipment created deep impacts on the steppe. One victim was the riparian zones along inland rivers in the desert region. These zones had relatively thick top soil, reasonable vegetation cover and little past land use. After the third land cultivation campaign however, many of these rivers and some lakes dried-up. The vegetation of entire areas within the riparian zones began to die out. These river-dependent steppe ecosystems were on the brink of collapse.

The fourth land cultivation campaign was in 1992. The government encouraged herding households to build livestock feed production plants as part of the 'Five Fits Programme'. The plant would include a storage area, shelter-belts, water wells, pumping equipment and fences. Almost half of the herding households complied with government requirements. Although individually these plants seemed to be ecologically-benign, unlike crop-growing, their aggregate impact can be considerably harmful. In fact, many of the plants built under this programme, especially the smaller ones, could not be sustained. This was attributable to a combination of the lack of effective implementation of shelter-belts, herder inexperience in growing feed, and time conflicts (planting seasons tend to overlap with the season for shearing, fibre processing and other livestock-raising related work). As an unintended consequence, the programme weakened the ecological defence capacity of this northern border region, a fact that was brought to the nation's attention in the spring of 1993, when the largest sandstorm of the last century occurred.

Unfortunately, even such a catastrophic weather event could not effectively alert people to the unfolding problems. Soon afterwards, some locals began to experiment with planted pasture modelled on foreign examples and experiences. This lead to the fifth wave of land cultivation: the aim of which was to promote commercial production on rangelands along the lines of a US or Australian model. This increased grassland productivity, but was also water-, labour- and resource- intensive. It not only wrecked havoc on the original vegetation, moreover, outside the peak growing season, the grassland invariably degraded and became desertified. Nor did it bring

economic benefits for the herders, most of whom had only limited capital and for whom this proved to be a prohibitively expensive undertaking.

The sixth and last major phase of land cultivation was caused by ecological migration and the growth of the dairy industry. The accumulated effect of these six waves of land cultivation was a devastated grassland ecosystem (Table 2).

Table 2 Land Cultivation in Inner Mongolia

Period	Cultivated Grassland	Planted pasture	Five-part family feed production unit	Other systems
1949-1985	138 million mu (9.2 million ha)			
1985-2000	95 million mu (6.3 million ha)	12.7 million mu (851, 333 ha)	8.4 million mu (560, 000 ha)	20.4 million mu (1.37 million ha)
2000-2005		84 million mu (5.6 million ha)		

Source: Data from the Inner Mongolian Land Survey Institute and field studies.

2.3 Fiscal and taxation policies

In the 1950's, the grasslands of Inner Mongolia enjoyed a tax break. This generous policy had a significant and positive impact on the pastoral economy and on herder livelihoods. But after economic reform and opening-up in the early 1980s, many new fiscal and tax policies created profound and long-term impacts on the steppe ecosystem. This will be illustrated using tax policy as an example[7].

From the early 1980s until relatively recently, taxes were based on the number of livestock that households owned. For those people used the grasslands for grazing despite having no legal right to do so, this was a powerful incentive to increase the number of animals they owned. This may seem counterintuitive, for it might be thought that taxation would discourage ownership. However, the opposite is true for two reasons. First, for each additional animal, tax payment was almost always smaller than the marginal return. Secondly, tax payment somehow conferred a kind of informal legitimacy on livestock ownership. This lead to a positive feedback loop, in which owning more livestock went along with greater taxation but also higher incomes[8]. Moreover, when animals grazed on natural pasture, the operating cost was minimal. The combination of low operating cost and low tax rates makes livestock-raising a highly profitable undertaking. It was small wonder then that it made economic sense to own as many animals as possible. This quickly became obvious to the entrepreneurially-minded.

Under this tax system, county government turned a blind-eye towards animals illegally owned by pasture renters, so long as taxes were paid for them. Owners of these animals tend to have migrated from outside Inner Mongolia. They include farmers that work on livestock feed production sites. Although they are officially registered as herders, they do not hold pasture user rights. So they graze their animals on unfenced grasslands. Others are salaried government staff, laid-off workers, and even livestock owning corporations and former craft-workers. Many of these people are not even local residents. The animals owned by these groups account for about 30 per cent of all of the animals in the Inner Mongolia herding region, representing a significant burden on the grasslands.

Another feature of this tax system was the way in which the revenue was shared among different levels of governmen[9]. In some banners, 40 per cent of the tax returns went to the league or prefecture and 60 per cent to the county. Moreover, since the county had some discretion over certain tax items (such as felt and skins), it could demand an extra livestock value-added tax on top of the livestock tax for higher levels of government. Households that were unable to pay cash had the

option of paying in kind, that is, with livestock. All these gaps in the tax system had the effect of encouraging livestock ownership, because they were profitable and also a source of pride for the owner and the local government.

The national *Grassland Law* does contain rules for protecting grassland through measures that curtail the number of livestock. However, the stipulations are too general, abstract and inoperable, and so they were an inadequate safeguard to prevent grassland exploitation and abuse.

The exact mechanisms by which this new tax system contributed to grassland overuse and degeneration was complex, but their chief impact was a phenomenon where multiple factors – including ambiguous demarcation of user rights, lax and ineffective laws, individual self-interest of the many involved parties, and the pressure of population growth in the region – converged to ensure that people pursued short-term gains at the expense of long-term losses. Excessive and inappropriate land cultivation, aggressive water abstraction and other forms of unscrupulous resource use made severe grassland desertification and deterioration all but inevitable.

2.4 Population policies

In 1949, the population of Inner Mongolia totalled 263,000. By 2000, it had ballooned to 1,929,200, of which 385,000 were crop-farmers and 349,000 were herders. While the national population increased from 0.54 billion to 1.26 billion, or by 132.3 per cent, during this period, the increase in Inner Mongolia was over sixfold. The main factor behind this extraordinary population surge was in-migration.

Several different factors explain in-migration trends. Land cultivation policies resulted in large inland populations moving to Inner Mongolia en masse to help construct state-owned farms and pastures. From the early 1960s until the Cultural Revolution (1966-76), many farmers and other impoverished people fled to remote grassland regions to take up farming or become agro-pastoralists. Another wave of immigration originated from the campaign to send urban educated youth to the countryside to learn from farmers. The development of heavy industries, such as mining in grassland areas, also attracted a large number of people from elsewhere.

All these immigrants shared a common characteristic when they first arrived in Inner Mongolia; this was that their lives had little formal relationship with the local landscape. Some of them did engage in mixed animal husbandry as a way of supplementing their income. Workers laid-off from mining operations that concluded for one reason or another or underwent structural adjustment, also turned to the grasslands to sustain themselves. Worse still, some expropriated pastures and made a profit from cropping them. The Ewenki Autonomous Banner of Inner Mongolia is an example. Its population increased 21.2-fold between 1949 and 2000. In 1960 alone, a year marked by natural disasters and economic hardship across the nation, people migrated into the region in droves, and increased its population by nearly 60 per cent. In 1970, the construction of Dayan Coal Mine also attracted large numbers of workers from outside. Within that one year, the local population grew by 6,851 or the equivalent of an annual increase of 269 per cent. In 1976, the Yimin coal-firing plant was established. The local population was only 82 households (374 people) in that year, but subsequently increased to 4,156 households by 1990 (E'erdunbuhe, 2002). These numbers amply illustrate the negative demographic impact of industrialization and urbanization on the grassland regions.

III. The impact of grassland management on the steppe ecosystem and herding livelihoods

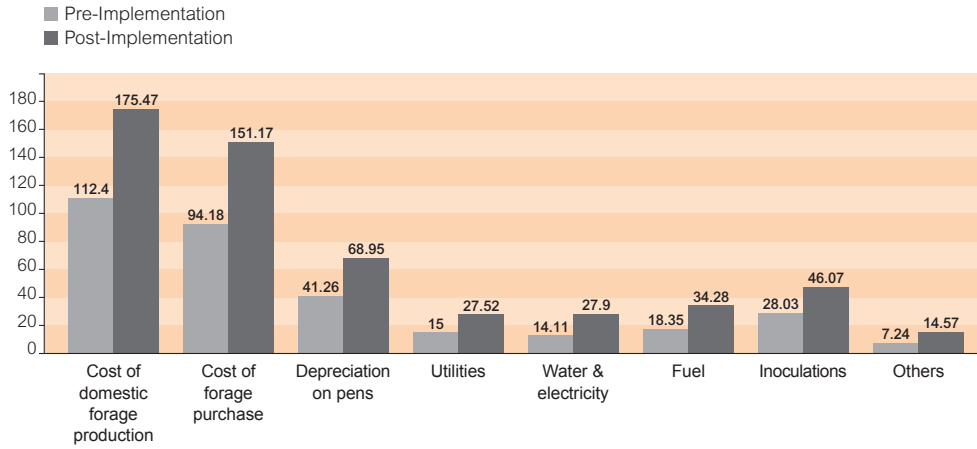
At the turn of the millennium, the government began a programme to encourage natural recovery of grasslands through the initiation of seasonal or full-year grazing bans.

The relevant government policies stated that: 'In order to allow natural regeneration of grassland vegetation, the ecologically fragile and severely degraded areas are to be protected from grazing activities by means of physical enclosure'[10].

The implementation of this policy altered the traditional modes of pastoral practice, because it relied on exogenous sources of energy rather than those from within the herding system. This was a break from the past, and it brought many changes to the region with mixed effects.

One consequence of the Grassland Grazing Bans was an increase in the operating costs for herders. Fences or other kinds of barriers were required to restrict the movement of animals so they could no longer graze freely.

Figure 3 Change in production costs for herding household before and after ecological restoration programme (in RMB).



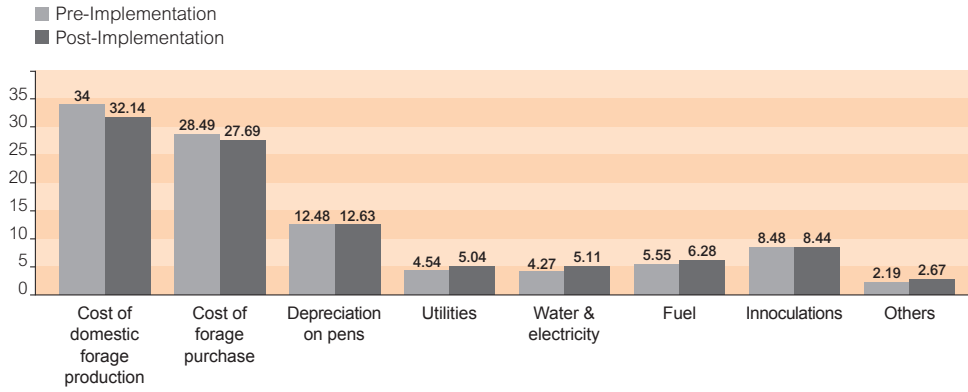
Source: Survey by the Grassland Operation and Management Station, Inner Mongolia Department of Agriculture and Animal Husbandry, of 338 herding households, 2004.

We can see from Figure 3 that since the programme began, the operating costs for herders have risen noticeably, as did their other expenditures. The item which increased most was feed supply, and may reflect the fact that many pastoralists suffer from livestock feed scarcity.

Given the nature of pastoral production and the significant financial and time commitment required to keep productive females, it is not easy for herders to reduce the number of livestock too quickly. This means the higher per head expenditure associated with purchasing feed supply from outside cannot be offset by a timely and significant reduction in the number of livestock.

In their co-authored article 'Grassland restoration through grazing bans: problems and solutions in its implementation', Xue Fengrui and Jiang Dongmei point out that the biggest issue in the implementation of the policy is the financial burden it imposes on herders. Herding households previously spent little on buying forage as most grazed their animals on natural grasslands. Average annual expenditure on forage purchase was only RMB 2,210 (US$ 336) per household. The grazing ban has resulted in an increased reliance on hay, and has resulted in increased annual expenditure of RMB 18,000 (US$ 2,736) per household, an eight-fold increase. Costs of fence

Figure 4 Change in production costs for herding household before and after ecological restoration programme (by percentage)



Source: Survey by the Management Station, Inner Mongolia Department of Agriculture and Animal Husbandry, of 338 herding households (2004).

depreciation, expenditure on utilities, fuel costs, and vaccination costs increased by 1.83, 1.20, 4.0 and 1.45 times respectively (Xue and Jiang, 2006). Before the programme began, the aggregate capital investment by herding households was RMB 3,305,000 (US$ 502,280), but increased by 65 per cent thereafter, to RMB 5,459,000 (US$ 829,635). Meanwhile, the aggregate herding income for the region was originally RMB 3,129,000 (US$ 475,532) and declined to RMB 2,068,200 (US$ 31,641) after scheme implementation, representing a reduction of 35 per cent. The ratio between returns and investment for pastoralism generally in the region was 1.95:1 but dropped after scheme implementation to 1.38:1, representing a 34 per cent decline.

All this means that the grassland restoration programme has a negative effect on herding incomes. Compounding this trend, household expenditure for herding families increased 19 per cent to RMB 11,191.85 (US$ 1,700) per year from RMB 9,393.95 (US$ 1,428) per year (Wang, 2008). In addition to greater labour intensity, increased reliance on hay also meant that herding families had to spend on things such as buying feed processing equipment, extending fences, and drilling wells. All these added to the introduction of exogenous resources. To cope, herders had to increase the marketability of their products to remain solvent. In other words, the grassland grazing bans further intensified the process of intensive livestock production. But when this was applied on a large scale, it negated the natural low operating cost advantage of grassland pastoral production systems. Moreover, developments that drew on exogenous sources of energy, such as for forage production, planted pasture, and water extraction all helped to exacerbate grassland exploitation. Moreover, increases in overheads and inadequate or late government compensation payments further affected herder livelihoods.

Actual herder experiences have shown that ecological compensation may fall short of its intended objectives as a strategy for ecological management. The main problem seems to be that these programmes are increasingly directed and driven by outsiders who are not residents of the region but have invested money in them. A superior approach would be to encourage locals to participate in environmental policy-making, to inspire them to protect the ecosystem, and to put their indigenous knowledge to good use (Wang, 2008).

IV. Conclusion

Research on grassland environment and development issues by Chinese scholars is still under-developed compared with international standards. Nevertheless quite a few Chinese scholarly works have been published on this topic over the last decade (Enhe, 2002; Wang, 2008). Some have been rather useful, but they have tended to focus on purely technical issues such as pastoral economics, ecological protection, and resource exploitation. As a result, they have shed limited light on the situation in herding areas. The fact is that within a little over two decades, rapid 'development' has somehow coincided with grassland deterioration and desertification on an unprecedented scale.

One historical problem with grassland studies in China is that they have tended to overlook the multi-layered and multifaceted nature of grassland protection and development. Issues such as what constitutes a sound location for livestock production, the impact of regional variations in natural and economic conditions, optimal use of local resources, ecological balance and integrity and sustainability are closely interrelated. This means that the rich indigenous knowledge of herders in the region can no longer be ignored. It is thanks to these experiences that local people have been able to practice pastoralism in ways that benefits themselves and sustains the ecosystem. For example, one lesson that can be learned is that some kind of a hybrid between semi-settled and semi-nomadic could, especially under the present condition of high population pressure and grassland degradation, offer a path towards more sustainable grassland communities in these regions.

Meanwhile, grassland-based animal husbandry and user rights systems may be the two keys that unlock this process. Grassland vegetation is suited to grazing livestock, and mobile livestock production requires a low population density. Therefore, if herders decide to settle, their settlements must be scattered across a large area. They will not take the form of highly concentrated residential neighbourhoods such as would be found in an agricultural village. Forced conversion of the former into the latter would end the herding way of life and work. Alternatively, if herders do abandon grazed livestock production altogether, there would be little need for them stay in the grasslands at all. At this historical juncture it is necessary to learn from past experiences. It is imperative that the laws of nature are respected and a proper balance is found between economic, ecological and social aspirations.

1 Agronomically speaking, fluctuations in precipitation in excess of 20 per cent jeopardize income consistency.

2 The Kẻ'erqin (Horqin) and Maowusu (Mu Us) sandy areas were subject to extensive cultivation around this time. This caused loss of ecological function as well as damage to landscape. The same fate befell the Wulanchabu (Ulanqab) grasslands.

3 The previous peak occurred in the 1920s, when the area that is now covered by the Inner Mongolia Autonomous Region had a livestock population of 70 million. At that time a significant wildlife population was also present in the region.

4 Part of the Wu's summer pasture was contracted out by the production team to tourism industry entrepreneurs during the second wave of the user rights campaign in 1998. Since then, the family has had no choice but to graze their livestock year round in the areas previously used only in the winter. According to the Wu's, grassland deterioration intensified with each passing year after 1998.

5 Harmel is an indicator species of extremely over-grazed grassland because it survives where little else can. Animals do not graze it during their peak seasons in the summer and the fall. Only horses eat it when the leaves dry in other seasons. Therefore, areas with a lot of harmel are considered unsuitable for grazing. Before the household contract responsibility system was put in place, pastoral management authorities would arrange for pastoralists to move en masse from areas taken over by harmel, and to return only after the grass had regenerated through natural processes.

6 Since the economic reform policies were launched in the late 1970s, there have been three main drivers of a surge in demand for livestock products: increases in the demand for raw materials from county and rural food processing and manufacturing factories in the coastal and inland areas; increased consumer demand linked to rising incomes; as; and, increasing demand for breeding livestock due to rapid growth of the livestock industry.

7 Livestock head taxes and value-added taxes have since been removed.

8 These are households that are officially registered as herders and own large numbers of livestock, but do not have user rights to grasslands. Most also have other sources of income. They compete with genuine herding households for grazing land. They lease out the livestock that they acquire in good years, but graze them on natural grassland in poor years. This is a highly profitable strategy for these households. Local government tolerates, or even encourages, this behavior because of the local income taxes that they pay. .

9 Before the introduction of tax exemption for livestock operations and herders, taxes were the sole source of government revenue for government salaries employees and for administrative expenditure. Any surplus would be shared between local and higher levels of government. This provided a powerful incentive for residents to contribute to this revenue stream.

10 On December 16th, 2002, the State Council approved a grassland restoration programme for the 11 western provinces and regions. The programs were set to start in 2003, and to last for at least 5 years. The programmes were to be implemented in the desertified grassland areas of western and eastern Inner Mongolia Autonomous Region, Gansu Province, Ningxia Autonomous Region, northern Xinjiang Autonomous Region, and in the eastern parts of the Tibetan plateau (where many rivers originate). The programmes were to be implemented in phases. One billion *mu* (67 million ha), or about 40 per cent of the degraded land in western China, was to be restored first. In Inner Mongolia, the programme commenced in April 2003. Inner Mongolia faced the greatest restoration challenge of all provinces and regions. A total of 12 cities and 65 banners were involved, and the affected area was 600 million *mu* (40 million ha). In the first phase of this huge project, due to conclude by 2010, a total of 450 million *mu* (3 million ha) of degraded land was to be restored, and another 150 million *mu* (1 million ha) was to be restored in the second phase of the project to conclude by 2015.

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5
Ecological Reconstruction in China: An overview and analysis of reforestation on former agricultural land

Xu Jintao, Jiang Xuemei and Yi Fujin

中国生态建设工程的问题扫视和分析: 以退耕还林工程和生态效益补偿制度为例

Reforestation on agricultural land and ecological compensation are two important Chinese government policies. This article examines these policies using economic concepts and methodologies. It is argued that both mechanisms have suffered from excessively rapid expansion, with insufficient adaptation to local conditions. This style of implementation has led to compromises in the quality of reconstruction projects and delayed compensation for farmers, and has also given rise to problems of rights violation involving farmers. These problems render the success or failure of ecological reconstruction projects a matter of great uncertainty. Tackling these issues and improving the outcome of ecological reconstruction projects requires replacing the current model of policy-making, policy-enforcement and project execution by the government with a more pluralistic approach. Recent changes in China's agricultural policies and legal thinking must inform policy-making in this area, so that new legislation can better serve the interests of farmers and promote sustainable ecological reconstruction.

Ever since sections of the Yellow River ran dry in 1997, and the Yangtze River flooded in 1998, ecological deterioration in western China became a subject of widespread concern in the country. In response, the Chinese government conceived and set in motion a number of massive ecological reconstruction projects, including protection of natural forests, reforestation of retired agricultural land, and rehabilitation of degraded areas that gave rise to sand and dust storms in Beijing and Tianjin. These, together with several other policy initiatives that focus specifically on western China, including the construction of basic infrastructure, a regional education programme, and economic structural adjustment, are core components of the 1999 national strategic plan for the development of western China (known as 'Develop the West'). The budget for the ecological reconstruction component of the plan alone was RMB 700 billion (US$ 106 billion), and the projected timeframe for the projects was just under 20 years. For a developing country such as China, this attempt to achieve economic development through ecological reconstruction has been unprecedented and extremely ambitious.

Pilot projects for reforestation of retired agricultural land date back to 1999. By 2005, 343 million mu (23 million hectares) of agricultural lands were slated to be reforested, and the total investment in the entire project had already reached RMB 103 billion (US$ 15.6 billion). Of this total area, 135 million *mu* (9 million hectares) was intended for tree plantation, 189 million *mu* (12.6 million hectares) for afforestation in topographically suitable mountainous or non-mountainous areas, and 20 million *mu* for mountain afforestation. Together, the projects involved 25 provinces (and provincial level units), 31 million households and 120 million farmers. The magnitude of this ecological reconstruction programme is not only unmatched in China, but also internationally. Should these projects be even moderately successful at reaching their intended objectives, they would have enormous and profound impacts on the ecological conditions of the country as a whole and on rural development.

In 2000, the system for ecological compensation was given legal mandate in China. This provided the institutional platform for addressing an issue that had been the subject of fierce debate for years. The inclusion of the costs of ecological compensation in the government budget, which was an immediate implication of the new law, created a secure source of funding for enforcement and implementation. Annual expenditure was to be between RMB 1 and 2 billion (US$152 million and 304 million). Therefore, as projected costs continue to grow, ecological compensation may potentially be of pivotal importance for the long-term prospects of ecological reconstruction in China. Some have gone so far as to argue that this system may even be a suitable follow-up policy to efforts to protect natural forests and reforest former agricultural lands.

In the past six to seven years, the authors of this chapter have studied and analysed the socio-economic impacts of the programme to reforest former agricultural lands and the design and execution of ecological compensation programmes. These studies and analyses make it possible to analyse the outcome of these programmes to date. This chapter applies concepts and theories from economics to evaluate data collected over several years. It is hoped that the findings can contribute to discussions on how to better design and implement policies for ecological reconstruction.

The social and economic impacts of the programme to plant forests on former agricultural lands has been a source of constant concern in Chinese research and policy communities. Some of the issues that have been raised relate to whether participating farmers can expect their income to increase, whether the programme facilitates structural adjustment of the rural economy, and whether it can stimulate the migration of surplus labour, among other concerns. Indeed, whether the programme will be viable in the long term depends greatly on how it affects economic opportunities for farmers.

Between the end of 2002 and 2003, the programme underwent a mid-term evaluation – by both the government and non-governmental bodies. The results of these evaluations varied greatly. The official assessment was on the whole favourable. It was for the most part optimistic on the question of the long-term viability of the programme, and maintained that it had helped promote structural adjustment of the rural economy, facilitated opportunities for surplus labour, alleviated poverty and increased farmer incomes (Zhongguo Luse Shibao, 2004). Some scholars concurred with this assessment. Some contend that participating households experienced, as a result of their participation in the programme, an improvement in their consumption of grain and other foods (Dong Mei, *et al.*, 2004), while others note that structural adjustment had begun to yield positive results, such as increased incomes for some farmers (Zhang Guoming, *et al.*, 2005; Li Ruoning, 2004). These conclusions support the view that this programme is viable in the long term, and that it should continue and even be expanded. The dissenting view, however, holds that no discernible benefits has accrued either with respect to the programme's impact on structural adjustment of the rural economy or in terms of impact on absorption of surplus labour by non-farm sectors of the economy (Xu Jintao, *et al.*, 2004; Uchida, *et al.*, 2004). Studies by Guo Xiaoming *et al.* (2005) even reported a decline in numbers of new livestock businesses and considerably lowered standards of living and levels of economic consumption for some participants in the programme.

In 2003, researchers from the Centre for Chinese Agricultural Policy, at the Chinese Academy of Sciences, conducted household surveys in Shaanxi, Gansu and Sichuan Provinces. The purpose of the surveys was to determine the effects on the ground of the programme between 1999 and 2002. The results of the survey have been reported in Xu Jintao, *et al.* (2004). The analysis in the report took into consideration the short time horizon of the data, namely that in 2002 the programme had only been running for four years. It allowed for the possibility that the programme's effects on structural adjustment, mobility of surplus labour and farmer incomes could take longer to become evident. Therefore, researchers from the Centre performed a follow-up survey in 2005 in order to remedy the limitations of the data from the earlier survey. The evaluation of the ecological reconstruction programme in this chapter is based on what the follow-up survey uncovered[1].

I. Reforestation of retired agricultural lands

1. Mortality rates for planted trees

The outcome of ecological reconstruction projects depends greatly on survival rates for planted trees. Since compensation for participating farmers in the programme is directly tied to this figure, it is in their interest to keep numbers high on their land. However, because trees planted on the first try tend to do rather poorly, it is common for many farmers to make up for this by planting more, and then some more, year after year. Since the official figure for survival rates for planted trees does not control for this, it most likely exaggerates the effectiveness and efficiency of the reforestation programme as well as underestimating its costs, technical difficulty, the demands it makes on participating farmers' time and money, as well as the fiscal burden it imposes on local government.

We calculate survival rate for planted trees using the following formulae:

$$R = 1 - \frac{M}{N}$$

In which R is the revised seedling survival rate, M is the number of seedlings from current year remedial planting, and N is total number of seedlings according to the last official count of the previous year.

As is shown in Table 1, by 2004, survival rates for planted trees for Shaanxi, Gansu, and Sichuan Provinces met the government requirement. Between 2003 and 2004, both the official figure and the revised one based on research calculations had increased, indicating that on the whole, the reforestation programme was making progress, and that plantations are performing better. As they continue to learn from experience, participating farmers are becoming increasingly skilful at planting trees, improving the outcome for the reforestation project. As can also be seen in Table 1, for 2003, the revised figures calculated according to the formula above, which factor in multiple tries, were generally lower than the official figures for all three provinces. The discrepancy for Shaanxi Province was as great as 14 per cent, which is commensurable with what is known about remedial planting prior to government verification. By 2004, the discrepancy had moderately reduced.

Table 1 Survival Rates for Planted Trees: %

Period	2003 (Official)	2003 (Revised)	2004 (Official)	2004 Remedial Planting Rate (Revised)
Shaanxi	89.0	75.2	97.6	86.3
Gansu	80.0	72.4	80.4	79.6
Sichuan	85.3	84.9	91.1	91.0

Source: Yi Fujin, *et al.* (2006)
Notes: 1. Tree survival rates are calculated on the basis of information provided by local residents, whereas remedial planting rates are determined through counting by researchers.
2. The minimum requirement for tree survival rates is 70% of all planted trees for Shaanxi and Gansu provinces, and 85 of all planted trees for Sichuan province.

2. Actual versus required compensation to farmers

How quickly farmers are compensated for participating in the government's agricultural lands reforestation programme matters greatly to their level of commitment. As is shown in Table 2, despite mild improvements, the amount of actual compensation farmers received falls consistently short of the official requirement. Since the commencement of the first pilot programmes, the government's official requirement calls for 100 kilos of coarse grain (150 kilos for the Yangtze River valley region) plus RMB 20 (US$ 3) annually for each mu of land (one fifteenth of a hectare).

In 2004, the in-kind component of the compensation was converted to a cash payout, at the official rate of RMB 1.4 for every kg of coarse grain, which explains why total cash payments were considerably higher for 2004 than for the preceding two years. For 2002, actual compensation was on the whole quite low relative to the government requirement. Li County, in Sichuan province, reported the highest percentage, which was only 60 per cent, and the lowest, 10 per cent, was reported for Yanchuan County, Shaanxi province. The situation saw some improvements in 2003, with the actual payout as a percentage of the government requirement approaching 100 per cent for Sichuan, and rising considerably for Shaanxi and Gansu. The decrease in this ratio for Liquan and Linxia counties and Chaotian district was likely partly due to complications associated with conversion from in-kind payout to cash payment. All told, the 2004 experience represented a considerable improvement over 2002 with respect to this issue. One possible reason for this could be delays in paying farmers, which might explain why, for Li county, for example, the actual payout in 2004 was in excess of government requirements. This would have come about as the result of a delay in partial or complete annual payouts by one year or more. We also found that it is not uncommon for local governments to use compensation payouts as a bargaining instrument in handling disputes with farmers. Payments owed to farmers were sometimes arbitrarily withheld, and sometimes withheld in the name of collecting tax arrears that the local government was allegedly owed. To summarize, despite some abatement, the problems of delay and arbitrary withholding of payout have yet to be fully corrected.

Table 2 Reimbursement Rates Unit: yuan/mu per household

Sample County		Value of actual in-kind (grain) Compensation			Cash			Total: Actual Compensation (in RMB)			State Requirement
		2002	2003	2004	2002	2003	2004	2002	2003	2004	
Shaanxi	Yanchuan	14	28	3	4	29	109	18	57	112	160
	Liquan	75	114	20	6	14	64	81	128	84	160
Gansu	Jingning	52	71	48	17	25	63	69	96	111	160
	Linxia	24	142	74	2	7	16	26	149	90	160
Sichuan	Chaotian	135	204	47	3	12	113	138	216	160	230
	Li	129	204	25	13	16	219	142	220	244	230

Source: Yi Fujin, *et al.*, (2006)
Note: value of in-kind payment with grain is calculated on the basis of prevailing local market prices for the year in question

3. The possibility of farmers returning to farming

The sustainability of the reforestation programme depends on whether participating farmers abandon the programme and take up farming again. This in turn depends critically on how their economic conditions change after joining the programme. One way to assess impacts is to look at changes in farmer income six years from the time of enrolment. According to official guidelines, each participating household must be allowed to retain a certain amount of land to support domestic food consumption (0.5 *mu* (0.033 ha) per person for the Southwest region and more than 2 *mu* (0.12 ha) per person for the Northwest region). However, field investigations show that up to 60 per cent of the enrolees reported that this allowance was inadequate for its intended purpose. As a consequence, once compensation ceased, households were unable to produce sufficient food to

feed themselves from their own land. This is not necessarily such a problem if economic reform creates off-farm income opportunities. However, findings for all three provinces covered suggested a considerable proportion of enrolees experienced varying measures of difficulty in meeting basic needs after compensation was officially terminated. Shaanxi province was the worst, with more than 50 per cent of participants in the reforestation programme reporting hardship, and even Gansu province, where conditions were least difficult, still reported that 35 per cent of enrolees experienced hardship. If this condition does not change for these farmers, there are real chances that they will revert to farming and abandon the plantations (Yi Fujin, *et al.*, 2006).

II. Impact of the programme on current farmer income

The programme to reforest retired agricultural land does not only aim to have ecological benefits. The programme is also expected to increase farmer incomes, facilitate structural adjustment of China's rural economy, and create employment opportunities. In fact, these latter impacts are particularly crucial for assessing prospects for the programme's long-term viability. In evaluating the programme from these points of view, it is necessary to consider not only impacts on farmer incomes in the immediate and the short-term, but also possible longer-term economic consequences, including projected future earnings from tree plantations. However, since policy-makers have likely been overly optimistic on these issues, the pilot programmes ran for only three years before they were hastily (that is on the basis of limited short-term results) determined to have been successful. Consequently, in 2002, the programme was expanded to 25 provinces across the country.

Therefore, the significance of information about the short-term impact of enrolment in the programme on enrolees' economic opportunities and standards of living consists in its usefulness for verifying the government's claim that the programme was ready for large-scale implementation. This verification process should have been an occasion for rigorous evidence-based decision-making.

In looking at the data, this research team, applied what is now the gold standard for project assessment used in economics, namely, Difference–in-Difference (DID). The method involves a comparison of the experiences of the group that has participated in a particular programme or project with that of a control group that has not. This is done by first determining, for each of the two groups, changes in the values of select variables before and after the time period during which the subject group participated in the programme. The difference between the averages for the differences before and after for the two groups, is attributable to participation in the programme. Findings are reviewed below; they are also reported and discussed in detail in Yi Fujin *et al.* (2006).

1. Per capita farmer income

This section begins with a descriptive statistical analysis of changes in income for farmers after leaving farming for tree planting for two groups of participants in the reforestation programme. Table 3 compares changes in income between 1999 and 2004 from different sources for two groups (one which participated in the programme and one which did not). First, leaving aside income from growing crops, both groups saw some increase in per capita incomes from raising livestock, from off-farm economic activities, from other sources, and in per capita total income. More specifically, non-participants in the programme saw their income from raising livestock increase from RMB 30 in 1999 to RMB 95 in 2004, or by 3.1 times, and the increase was even steeper – 3.6 times – for participants in the reforestation programme. Non-participants' income from extra-agricultural activities rose from RMB 759 to RMB 1073 during the same period. Per capita income from non-farm activities for the reforestation programme participants grew to RMB 880 in 2004, and the differential between the two groups for this component of their total income

changed little between 1999, when it was RMB 199, and 2004, when it was still over RMB 190. As would be expected, income from growing crops dropped from 486 to 442 for participants since cutting back on this activity was essentially the purpose of enrolment in the programme. But once government compensation payment to these farmers was factored in, this component of this group's total income for 2004 was RMB 610, higher than it was in 1999.

We also noted some other differences between the groups in relation to changes to their respective incomes before and after the period of interest. In 1999, on average, non-participants earned RMB 227 more from crop growing than participants did. The number is not considered to be statistically significant. But it grew to RMB 330 in 2004. As was mentioned, that this difference is larger for 2004 than for 1999 is as it should be, given that programme participants grew less crops while non-participants were not restricted in this way. But even when compensation paid to the former is taken into account, the difference between the two groups only reduced to RMB 161. To summarize, when we compare the two groups in terms of changes to their income – total as well as when broken down by source, including animal husbandry, crop growing and unrelated to agriculture – there are no statistically significant differences. In other words, contrary to what the government projected or claimed, participation in the reforestation programme did not yield substantial income benefits to participants that might have eluded non-participants.

Table 3 Per capita farmer income (1999, 2004)

Year	(1) non-enrollee		(2) enrollee		(3) Difference	
	1999	2004	1999	2004	1999	2004
Crop	712.50	771.66	485.50	441.90	227.00	329.76
	(1343.43)	(1017.68)	(651.44)	(633.56)	(1.48)	(2.77)***
Inclusive of payment reimbursement for enrollment	N. A.	774.66	N. A.	610.01	N. A.	161.65
		(1017.68)		(179.24)		(1.35)
Livestock	30.32	94.88	49.66	179.24	-19.34	-84.36
	(57.52)	(166.70)	(353.53)	(1105.93)	(-0.85)	(-1.20)
Other	759.20	1073.25	559.98	879.57	199.26	193.68
	(1405.18)	(1478.65)	(855.07)	(1280.42)	-1.22	-1.15
Livestock and other	789.55	1261.43	645.49	1351.11	144.05	-89.67
	(1406.61)	(1798.05)	(1230.00)	(4832.05)	(0.85)	(-0.25)
Misc. other	56.15	279.75	104.94	171.24	-48.79	108.51
	-195.86	-1122.83	-535.36	-939.66	(-1.24)	-0.79
Total income before reimbursement	1562.71	2322.75	1235.74	1857.08	326.96	465.67
	(1932.44)	(2772.23)	(1706.13)	(3249.04)	(1.38)	(1.27)
Total income after reimbursement	1565.71	2322.75	1235.74	2021.74	326.96	301.02
	(1932.44)	(2772.23)	(1706.13)	(3257.51)	(1.47)	(0.82)
No. of samples	79		254			

Source: Yi Fujin, *et al*.,2006)
Notes:1. (1) and (2) are averages, standard error is enclosed in parentheses; (3) is annual variation
2. N.A. indicates negligible value;
3. * Indicates 10 per cent statistical significance. ** Indicates 5 per cent statistical significance. *** Indicates 1 per cent statistical significance.

2. Results and discussions

First, the DID results show that during the six-year period that ended in 2004, the agricultural land reforestation programme had negligible impact on farmer incomes derived from non-farming activities such as livestock raising, from other sources, as well on total income. The reason for this, judging by field research, has to do with the fact that the amount of time participants have had to invest in remedial planting and plantation management has placed restrictions on their ability to engage in alternative income-earning activities such as raising livestock and on non-farm related activities.

Second, the adverse impact of participation in the reforestation programme on participants' income from crop growing is no longer significant. Results from both the 2003 survey and the examination of the remaining 265 samples confirm that reforestation programme enrolees saw their income from crop-growing drop considerably, excluding compensation payments. In 2004, while descriptive statistics show that income from crop-growing for non-participants was appreciably higher than pre-compensation crop-growing income for participants, it is also the case that, as Table 5 indicates, once we control for the state of rural and town economic development, the difference participating in the programme makes to participants' income from crop-growing is no longer pronounced. A number of factors may help explain this. One is that farmers may have adjusted their crop choices, improved their farming techniques and overall efficiency. With smaller areas to farm, they may also have been able to invest more time per unit of land than before. They may also have shifted to crop varieties that are more profitable as well as more labour-intensive, such as vegetables. Another explanatory factor may be that six years into the plantation programme, some of the plantations (the area of which tends to be 20 per cent greater than is required by the government) have gradually begun to bear fruit for their managers.

Thirdly, until 2004, enrolment in the reforestation programme had negligible impact on enrolee income from crop-growing even after the compensation payment is factored in. Xu et al. (2004) believe that compensation by the government was in fact greater than the opportunity costs of participation. They believe, therefore, that farmer income from crop-growing inclusive of compensation payments is comparable to what it was prior to entry into programme, and without, of course, any addition from the compensation payments. However, results from 2002 prove that the contrary is true, that participation in the programme has been associated with significant negative crop-growing related income consequences for participants. As has been noted, this has largely been due to problems with compensation payouts, such as payment delays and arbitrary withholding of payments. Participants' combined income from crop-growing and compensation payments was still lower than pre-enrolment incomes from crop-growing alone. But after 2002, better payment practices have greatly reduced the income loss from crop-growing for participants in the programme.

Conclusion

The foregoing analyses indicate that in its first six years, as problems in compensation payment payout practices continued to be addressed, income from crop-growing for participants in the reforestation problem has on the whole be able to stay constant following participation in the programme. However, the programme did little to increase participant incomes from livestock or extra-agricultural employment, a fact that fell short of government expectations and projections. Therefore, it is our contention that it was premature for the government to conclude that the pilots had been successful and that it acted hastily in expanding the programme on a massive scale in the years 2002 and 2003.

Moreover, the long-term viability of the programme is far from certain. Given its negligible benefits in boosting rural income and in facilitating structural adjustment of the rural economy,

and given the host of problems in its execution, as well as dubious impacts on ecosystems in participating areas (Xu Jintao, et al., 2004), the government should restrict the scope of the programme and the pace of its expansion. Moreover, it should focus more on improving outcomes and designing an improved follow-up programme. Only then can the goals of ensuring long-term viability and optimizing ecological, economical and social outcomes be achieved.

In October 2000, in the policy recommendation submitted to the China Council for International Cooperation on Environment and Development (CCICED) by its Forest and Grassland Working Group, it was pointed out that the chief determinant of the long-term viability of the reforestation programme was going to be the availability of reliable and adequate funding. At a time when the programme was only in its pilot stage, and enjoying international as well as national attention and acclaim, such a claim may have seemed mildly paranoid. But facts prove the underlying worries well-founded: the reforestation programme has indeed suffered from loss of funding or government backing. Starting in 2003, when the programme was, at 110 million *mu* (7.3 million hectares), half its projected final size, the size of annual additions has reduced from year to year. If this trend continues, it seems highly unlikely that the programme will ever reach the 220 million *mu* (14.6 million hectares) total that had been approved by the National People's Congress in 2002.

This funding gap dilemma reflects policy change at the highest level of government. As soon as the eleventh session of the National People's Congress started in 2008, one of the first things it did was to replace its 'pro-active fiscal policy' (which meaans raising the money needed to finance national projects by selling government bonds) with a 'soft fiscal policy' which no longer seeks to rely on selling bonds for raising money. This move has led to the disappearance of a major source of funding for the ecological reconstruction project.

The new session of congress has unveiled many new policies, the most important of which focus on revitalization of the old industrial hub of northeast China and the construction of the New Socialist Countryside. All these are enormously costly propositions requiring large amounts of investment. In the inevitable competition between the government's new projects and continuing projects that the new government has inherited from its predecessor, expensive older projects are bound to be subject to close scrutiny. Accordingly, the government has decided to restrict the scale and the scope of the programme to reforest lands moved out of agricultural production and to try to focus instead on improving its performance at the current scale and on questions about how future programmes should pick up where it leaves off. The farmland conversion programme has been complex and costly. It has offered limited socio-economic benefits and unremarkable ecological payoffs. Caution about future scaling up is therefore a wise choice.

1 Detailed findings are reported in Yi Fujin, *et al.* (2006).

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6
Water Resource Scarcity in China

Chen Shaojun

中国的水资源短缺问题

How well a society manages its water resources can be evaluated from three different points of view: security, economic sustainability and ecological sustainability. From the security point of view, two things are of primary concern: whether the society can reduce damage from floods, and whether its basic water needs can be met. From the economic point of view, the key issue is whether a society's water resources are utilized economically. This includes efficient and effective utilization. Finally, from an ecological sustainability perspective, issues such as water ecology and the aquatic environment are important. This chapter looks at China's severe water scarcity problems, paying attention to security, and economic and ecological sustainability questions. It offers an overview of key lessons learned in this area.

I. Background

1. Water resource scarcity in China

Currently, China ranks number six in the world in terms of total water resources. However it ranks 121 of 150 countries for which data is available on per capita availability, with only 2220 m^3 available per capita per year. It has been projected that by the time the Chinese population reaches 1.6 billion, per capita water resources will have dropped to 1760m^3 per year. China will then be facing serious water shortage problems.

Agriculture is by far the dominant sector in the Chinese economy, and it accounts for 70 per cent of total water use. It is also the economic sector most vulnerable to the impact of the uneven distribution - both temporal and spatial – of water resources. Nearly half of all irrigated area in the country is in the Yellow, Huaihe, and Haihe River valley region, which happen also to suffer from chronic water shortages. The problem is particularly acute in the spring, when the peak season for agricultural water use coincides with the seasonal low, contributing only 10 per cent in precipitation towards total annual runoff. Currently, the average annual agricultural water deficit is 30 billion m^3; the drought affected area is 20 million hectares, which is calculated to result in crop yield losses of around 25 million tonnes.

Drought and water scarcity also have significant adverse consequences for urban areas and for the industrial sector. On average the annual industrial water deficit is 600 million m^3, which accounts for the loss of RMB 230 billion (just under US$ 35 billion) worth of industrial output. Water shortages exist in 400 of the country's 668 cities, and conditions are dire in 200 of these. The daily lives of 150 million urban residents are particularly severely affected as a result.

Other consequences of these conditions include ecological problems such as channel desiccation, lake shrinkage, declining water tables, loss of arable land, grassland degradation, intensified soil erosion, sedimentation, water pollution, and species extinction. The spell of severe drought in southwest China between 2009 and 2010 clearly illustrates these problems.

2. Chronology of water shortages in China

In the 1950s and the 1960s, the problem of floods in China, was more serious than that of droughts. Much of the nation's attention and resources were directed to flood prevention and preparation involving large hydraulic projects aimed at taming major rivers such as the Huaihe, Haihe and Yellow Rivers. The problem of water shortage did not become evident until the 1970s, when droughts caused severe water shortages in Beijing and Tianjin. In response, the central government decided to use Miyun Reservoir, on the outskirts of Beijing, to relieve its water stress, while for Tianjin, the solution was an emergency diversion of water from the Yellow River, a measure that was then followed up by the Luanhe River Diversion project. From that time on, water shortage has gained prominence as a national issue.

Before the 1970s, water needs were mostly met by finding and exploiting new sources of supply, and by drawing on surface water. From the 1980s, persistent drought, rapid urban development and urban population increase combined to push water demand in many municipalities above the limited, and in some cases declining, groundwater capacity. In response, many cities began to tap into the agricultural water supply, turning reservoirs which had traditionally supplied agriculture into important sources of urban water supply. This then pushed the agriculture sector to increasingly utilize underground sources. None of this solved the water shortage problem in any meaningful way, of course, and gradually Beijing and Tianjin began to take the issue of industrial water productivity very seriously.

The problem of drought persisted unabated into the next decade. Cities continued to siphon-off water from reservoirs supplying agricultural water, and they continued to over-pump underground water. Driven by necessity, agricultural producers also over-abstracted underground water, causing precipitous drops in water tables, and ground subsidence. Conservation became a top priority for agricultural water use. There was increasing pressure to find ways to make greater and better use of rain water and soil water. As China entered the new millennium, and as the pace of urbanization picked up, the problem of agricultural water shortages became progressively more serious, resulting in greater reliance on rainfall as a solution. The situation has not eased, and the Northern China region has continued to face severe water scarcity. It was then that some scholars proposed the South-North Water Diversion project.

3. Reasons for the recent escalation in water stress

3.1 Economic growth, population increase and a rising standard of living

Between 1949, when the People's Republic of China was founded, and 2008, the national volume of water withdrawal and consumption has grown from 103 billion to 590 billion m^3. Industrial water use increased from 240 million m^3 to 140 billion m^3, agricultural water use from just over 100 billion m^3 to 360 billion m^3, and municipal residential use from 600 million m^3 to 72 billion m^3. Over nearly 60 years, China's population had increased three and a half times , the irrigated land area was five times bigger, GDP had increased sevenfold, and water use was six times as much.

3.2 Climate Change

Analysis of nearly 50 years (1950 -1997) of precipitation and temperature records shows that within the past 20 years, precipitation patterns have become increasingly uneven between the northern and the southern parts of China, with the former experiencing more frequent droughts and the latter more frequent floods. In the 1980s, the central and northern part of China was hit by protracted drought. The ten-year rainfall average for Beijing, Tianjin, the Haihe and Luanhe River Basin region, and the Shandong peninsula was 5 to 10 per cent lower than the historical norm. In the 1990s, the upper and middle reaches of the Yellow River Basin, the Hanjiang River Valley, the upper reaches of the Huaihe River Basin and the Sichuan Basin all had 8-year average precipitation amounts 5 to 10 per cent lower than the historical norm. The volume of Yellow River water passing Huayuankou was 20 per cent lower than usual. The same was true for the Hailuan and Huaihe River Basins. In the northwest hinterland, average precipitation was lower than the historical average in the 1980s, while slightly higher than for the 1990s. It is only thanks to supplementation by a constant supply of glacier meltwater that the total water volume for major rivers did not drop dramatically over the same period.

Southwestern China has historically enjoyed plentiful rainfall and has been known for having the most favourable water endowment in China. However, by July 2009, partly as a result of climate change it was beginning to experience reduced rainfall, lower reserve volumes, higher temperatures, higher evaporation rates, and reduced soil moisture. These led to droughts in Guangxi, Chongqing, and Sichuan, Guizhou and Yunnan provinces. Of these provincial level units, Yunnan, Guizhou and Guangxi experienced precipitation levels more than 5 per cent below the historical average. In some areas, the percentage was only 70 to 90 per cent of the historical average. The volume of water flow

for many major rivers in the region was at a historical low, and reservoirs held on average 20 per cent less water than had been the norm for the same period the year before. Soil water content was only 20 per cent of what it had been. The situation was extremely grave. At the time of writing, drought conditions in all of Yunnan, much of Guizhou, and parts of Guangxi have persisted for more than 5 months, and show no signs of abating. This has had deleterious effects on people's lives and on the economy. A total of 51 million people in the five provinces, cities and regions mentioned above have been affected, 16 million people and 11 million livestock are lacking reliable access to drinking water, and over 4 million hectares of farmland have been affected. Of this, just under one million hectares have become totally unproductive, costing the national economy RMB 190 billion (US$ 29 billion).

II. Efforts towards 'Water Conservation'

In the past 30 years or so, public understanding of the importance of water conservation in China has gone through several phases. The first phase was from the 1950s to 1970s, when preoccupation with flood prevention gradually gave way to increased attention to water supply as the dominant water-related issue. The second phase was from the 1970s to the 1980s, when the dominant water issue shifted from securing irrigation water for agriculture to securing urban water supplies. In the third phase, in the 1980s, the focus on finding new sources of supply, which had defined the approach to water management prior to the 1980s, was gradually replaced by a greater emphasis on conservation, beginning with urban and industrial water use, and later extending to agricultural water use. The fourth and final phase, which began in the 1990s, saw equal emphasis placed on both resource exploration and conservation. Now, resource exploration, conservation, and pollution control are on a par with one another as different components of a comprehensive water management strategy. Conservation ranks number one among equals.

This same trend, in which exclusive stress on source exploration is replaced by greater concern with conservation and pollution abatement, is also evident in the history of urban water management in China. As the urbanization process has passed through different stages, each with its distinctive characteristics, resource exploration has been gradually strategically de-emphasized relative to the other two issues. All this goes to show that at least in theory, conservation has now become an important part of the national strategy for solving China's water shortage problems.

1. The legislative approach to water conservation

The legal codification of water conservation passed through two phases. The first was the initial passage of China's *Water Law* in 1988, and the second was its amendment in 2002. While the issue of conservation received mention in both the original legislation and the amended version, its treatment was notably different between the two both in depth and in scope.

The importance of water conservation was first officially raised by the Chinese government towards the end of the 1970s, and the issue was granted legal recognition in the *Water Law* passed in 1988, the seventh clause of which includes statements such as 'the country is to abide by water use scheduling, and adhere to the principle of conservation', and 'all levels of government must strengthen measures to promote water conservation, and work places should implement water-saving technologies in order to reduce water use and increase re-use'.

The amended *Water Law* that passed in 2002, states that: 'the purpose of this law is to promote rational exploration, utilization, conservation and protection of water resources, to prevent water disasters, so as to meet the country's economic and social needs while at the same time ensuring the sustainability of our water supply'. Water conservation was thus mandated by law, and the principle of 'integrating source exploration and conservation in use, with special emphasis on the latter as well as reuse', was promulgated.

2. Technological measures

2.1 Cities. At the end of 1970s, widespread water stress in Beijing, Tianjin and the Central North region attracted public attention. The first sector to be subject to conservation measures was industry, which began to be required to recycle and reuse water. The focus of the effort was on the reuse of cooling water. Industrial water reuse rates for Beijing and Tianjin are now above 85 per cent. On the whole, industrial water use intensity, measured by water consumption per 10,000 RMB of industrial output, has decreased by orders of magnitude. Beginning in the 1980s, in addition to continual improvement in industrial water use efficiency, progress was also being made in the area of residential water use efficiency. The system of unlimited use at little or no charge was ended, and replaced by fee-based schemes where residential users pay for what they use. Offices and work places all redoubled their efforts to raise awareness about the importance of water conservation, and took aggressive measures to stamp out water wastage through leaks and drips. As the 1980s progressed and water stress in cities worsened, water conservation also correspondingly improved in many places. Water shortage due to pollution received greater attention, and cities committed more resources to wastewater treatment and recycling. As the new century began, in northern China in general and in water stressed cities in particular, the principle of water conservation has come to define a new type of modern city. What this entails, essentially, is the inclusion of water conservation facilities in urban infrastructure and industrial planning, the establishment of standards for water-saving technologies and measures, the promotion of these technologies and measures, and the requirement that new residential and commercial buildings have their own on-site wastewater treatment facilities, and that industries achieve zero-discharge of wastewater.

2.2 Agriculture. In the 1960s, China was still in the early experimental stage in its experience with water-saving irrigation technologies. In the 1970s, measures such as lining irrigation canals to reduce water seepage into the water, and cropping pattern changes became increasingly widespread. Low-pressure centre pivot irrigation was then introduced on a large scale in the 1980s, and drip, sprinkler irrigation and micro-irrigation systems and other advanced technologies were tested and widely demonstrated. By the 1990s, as they became increasingly sophisticated water-saving irrigation technologies became increasingly the norm rather than the exception across the country. The period after 1996 has seen particularly rapid and successful expansion of these technologies. 300 counties were chartered to lead the nation in the effort to increase crop yield based on application of new irrigation approaches; 200 model districts and 10 nationally-designated model cities were named; 99 large- and 40 mid-size irrigation areas began construction of water-saving support facilities and infrastructure upgrading. Areas in northern China suitable for wells implemented water-saving irrigation methods; in the arid and semiarid regions of the northwest, rainwater is now collected and the soil is covered with plastic sheets to retard evaporation, and subsurface drip irrigation technology is used; in the south, controlled irrigation is used in rice paddies and pastoralist-based development has been experimented with; in the arid regions of the northeast and the northwest, a host of irrigation methods particularly suited for the local water availability conditions are being applied.

To summarize, years of experiments and experience have taught people in different places what water-saving irrigation technologies, techniques and methods best suit local needs. Moreover, different levels of government have augmented their financial commitment to improving agricultural water productivity. By the close of 2008, the total irrigated area in China was 58 million hectares, which amounts to 48 per cent of all agricultural land. Of the 58 million hectare irrigated area, 24 million hectares (42 per cent) use water-saving irrigation methods. Of this 24 million hectares, 10 million hectares have lined irrigation canals, 6 million hectares use low-pressure centre pivot irrigation, 4 million hectares use sprinklers and micro-irrigation, and the remaining 4 million hectares use a variety of other such technologies. On average, on irrigated farmlands of 10,000 mu (667 hectares) or more, under 19 per cent of all canals and 35 per cent of major canals are lined.

2.3 Improved pricing of water. From the start of the new millennium, the State Council embraced the idea of using market prices as an incentive for water-conservation. The National Planning Committee issued an order regarding reform of water pricing. It articulated the rationale for using price mechanisms to achieve the end of water resource conservation.

2.4 Achievements. Since the 1980s, industrial water budgets in many parts of the country have declined, which is an indication of the effectiveness of conservation-oriented structural adjustments and of efforts to improve water-saving measures. Between 1980 and 1997, industrial water productivity, as measured by water use for every 10,000 RMB of industrial output, has been dropping by an average of 9 per cent per year. In 1997, the budget for industrial water use was only 20 per cent of what it was in 1980. Since the 1980s, agricultural water use as a percentage of the national total decreased by 13 per cent, dropping to 390 billion m^3 in 1997. Thanks to substantial increases in the use of water-saving irrigation methods over the previous two decades, agricultural water use has been able to stay put at around 350 billion m^3. Considerable reduction in water use per hectare has also been seen.

From 2000 onwards, water resource utilization plans have been drawn up across the nation at regional and city levels. Guided by the principles of conservation and efficiency maximization, these plans are intended to help achieve the objective of socially optimal and environmentally sustainable use of the country's limited water resources. In addition, key regions and cities have also been selected to take the efforts to more advanced levels in partnership with state-sponsored research and development projects. Many of these plans are now complete.

III. Understanding the co-existence of conservation and wastage

Despite the progress China has made in the area of water conservation, wastage remains a serious problem. Industrial water use intensity in China, i.e., water consumption per 10,000 USD worth of industrial output, is 2419 m^3, which is three times the world average, 2.6 times the level in the United States, and 23 times of the level for Japan. In 2000, agricultural water use intensity in China, i.e., the amount of water consumed to produce every 10,000 USD worth of agricultural output, was 22,323 m^3. This number was slightly higher than the world average. In countries with per capita water resource comparable to China, such as Germany, agricultural water use intensity is about 4,000 m^3. In China the efficiency co-efficient for irrigation water use is about 0.43, which compares with a figure of about 0.7 - 0.8 in developed countries. On average, China produces only 0.95 kg of grain with each m^3 of water, while in Israel, that number is 2.2 kg (Ma *et al.*, 2007).

These comparisons illustrate the persistence of water wastage in China. What then explains the stubbornness of the behavioural patterns underlying these numbers? The next section discusses the problem by looking specifically at agriculture.

1. Challenges to water conservation efforts

1.1 Lack of incentives to save water on the part of agencies in charge

At present the financial well-being of agencies in charge of maintaining water channels is a direct function of the amount of water supplied through these channels. This means that not only do they have little concern for water conservation, but that when their own survival is in peril, they have every incentive to find ways to collect more fees. The same is true of other water-related fee collecting agencies, which often care a great deal less about saving water than they do about collecting money.

1.2 Insufficient government investment in water conservation

Poor coordination at the local level often means matching funds are not found to match government investment. This means that many programmes that would benefit farmers through

improved water productivity on irrigated farmland are abandoned. Furthermore, because neither the central nor the local government has committed very much financially to well construction, it has to be financed by farmers themselves, and as such canal-well irrigation combinations often do not get built where they are most needed and can be most useful. Large-scale projects, which are usually centrally funded, often cannot be put to optimal use after they are built because local supporting measures and structures are inadequately funded and cannot be put in place. In addition, many aging hydraulic structures that are badly in need of repair and upgrade continue to operate despite a lack of funding.

1.3 End-users lack incentives to conserve water

For most of the irrigated cropland in the country, the cost of supplying water is greater than the fee farmers are charged for using it, which is typically between 3 and 5 RMB (US$ 0.45 and 0.75) for each 100 m^3. Even if charges are increased, it would probably still cost farmers more to install water-saving measures. There is, therefore, a disincentive for farmers to invest in them. Whatever value true-cost water pricing policies have in principal for addressing this problem, their implementation in practice is fraught with complications. For example, inconsistencies between the pricing schemes for surface water and for underground water lead to inefficiencies in the use of regional water resources. In other cases, the incompatibility between canal structures and water metering systems makes a mockery of the idea of charging according to use. So instead, farmers are often charged according to area, which means that how efficiently they use water to irrigate their field matters relatively little to how much they pay.

Over the years, water resource conservation has always been a familiar issue in China. It involves three main parties: (1) water management agencies, (2) users and consumers and (3) investment decision makers. The parties' functional roles are closely interrelated, such that if any one of them should fail to do its job in furthering the cause of water conservation, it will not be possible to reach the goal. This goes to show how delicate the whole endeavour can be and how vulnerable it is to logistical and bureaucratic entanglements.

To conclude the discussion so far, the main reason why China's vast potential for water conservation has yet to be fully realized is not incompetence on the part of concerned agencies. It is rather the fact that society as a whole suffers from an incentive deficiency. Water use policies are not to blame for this. Instead, the problem has much more to do with external circumstances and the necessary conditions – of which there are three – for the right incentive structure. These three conditions are: first, management agencies must not have built-in conflict of interests. Insofar as they are charged with the task of serving the water needs and interests of the society as a whole, they must not be allowed at the same time to profit from performing this task. Secondly, end users of water must pay the full cost of this resource, or at least enough to meaningfully maintain supplies. Thirdly, government agencies charged with making investment decisions must be genuinely concerned with and committed to the cause of water conservation.

Evidently, whether these conditions are met will necessarily depend on (1) the government's ability to discharge its responsibilities in the areas of social coordination and provision of social services, (2) the role of the market in allocating water, and (3) reform in government investment as well as more sensible macroeconomic planning at the state and local levels. None of these is as easy as it sounds, which may well have been the reason why a large report put out in 2000 by the Chinese Academy of Engineering on China's water resources concludes that 'making water-conservation a social and cultural norm will require nothing less than a revolution' (Qian, 2000).

2. The coming era of 'supply dictates demand'

2.1 From 'water demand dictates supply' to 'water supply dictates demand'

Water management in China has been undergoing a gradual shift from unconstrained increase in supply to a dynamic coordination between supply and demand. A milestone in this transition was

the government's promulgation, at the beginning of the new millennium, of China's Water Resource Management Strategy. This promoted a shift from a conventional, engineering-oriented approach to an ecologically-modern, stewardship-oriented approach. Within two years, the notion that water demand ought to be customized according to supply has increasingly gained traction and is being applied in different areas and a variety of ways. This principle, which has gained momentum worldwide, should be the core of a new water resource management philosophy. Its central tenet is that: 'a comprehensive approach to water management must place the emphasis on the budgeting of water use. Each river, for example, must be considered as a whole system that includes as parts its source, the end-users of its water, and every stage or link in between. The overall management goal must be a healthy equilibrium between supply and demand that is socially and environmentally sustainable' (Gan *et al.*, 2002: 66). Other experts stress the importance of making sure that macroeconomic planning takes the nation's water supply and availability into account to ensure that: 'Plans for economic structural adjustment are informed by the recognition that China has a serious water scarcity problem, and that no decision of moment concerning the nature and the direction of China's economic development should be made without due consideration of the country's water constraints' (Huang, 2002: 21).

At the institutional level, as was noted earlier, the government has already made a number of administrative changes to the way in which agencies in charge of water management do business. These include instituting user permits, quotas (in conjunction with the capping of total usage), user fees and pricing reforms.

2.2 A new era of water resource allocation under the market system

Despite many unresolved problems and relatively slow progress, when we step back and take a sweeping view, there is no denying the fact that water resource reallocation has been continuing apace in China, driven largely by the market. Evidently, in China, while a 'water market' is still mostly a concept, in practice, unofficial and spontaneous trading of water rights that reduce inefficiency has become more common, even without the blessings of laws and policies, which lag behind.

Case 1 'The right approach is for cities to help farmers in surrounding areas to pay for the installation of water-saving equipment, and use the water saved to supplement urban water supply. This would be a mutually beneficial scheme that is also feasible' (Liu and He, 1995). Thanks to this arrangement, which has been in place in the Beijing metropolitan area since the 1980s, water-saving methods such as sprinkler and drip irrigation have been in wide use on surrounding farmlands. In 1991, Shunyi, a county in the greater Beijing area adopted sprinkler irrigation for an area of 50,000 hectares. Consequently, agricultural water use in the downstream areas served by the Miyun reservoir was reduced to 100 million m^3, and this was achieved without any significant reduction in the size of the irrigated area. Meantime, Beijing became the largest single user of the reservoir, drawing most of its water from it. This kind of activity is tantamount to informal trading of water rights among interest groups or agencies.

Case 2 The water in Miyun and Guanting reservoirs, both of which are on the outskirts of Beijing, originates mostly in the watersheds of Chengde and Zhangjiakou cities in Hebei province. The three parties negotiated an 'Ecological Compensation Contract', where residents of the source region agree to 'refrain from developing water-polluting industries' in exchange for financial assistance from downstream cities. Through 'fair negotiations' these cities purchase from water source residents a portion of the latter's water use entitlements (or, in other words, share with them the cost of source protection). This indicates that one party tacitly recognizes the other's 'water rights'.

Case 3 In November of 2000, Dongyang and Yiwu, two cities in Zhejiang province, signed an agreement where Yiwu agreed to pay Dongyang RMB 200 million (US$ 30 million) for use rights to 50 million m^3/year of water for an indefinite period of time.

2.3 Facilitating the transition towards 'water supply dictates demand'

Even as China moves steadily towards a new era of water management, wastage continues to be widespread and shortages are common. Meanwhile, the water crisis is deepening all the time. This has much to do with the fact that, while management agencies are committed, even if only nominally, to the principle of 'water supply dictates demand', society at large has yet to fully embrace it. Even though market dynamics have taken the efficient reallocation of water resource in a positive direction, many longstanding social problems remain. This helps explain why even when the era of unconstrained increase in supply is officially over wasteful use of water is still pervasive in many places. Local governments' entrenched bias in favour of source exploration has also greatly undermined the effectiveness of water conservation efforts.

I. The need to overcome the 'explore sources first, conserve later' mentality

a. *The meaning of 'conservation first'*

Conservation is one of two main solutions to the problem of water scarcity in a particular area or region. The alternative is to take water from external sources. This might be done by relaxing relevant quota restrictions, or even drawing from publicly-owned underground sources.

For water conservation, we can further distinguish between two main approaches. The first is to increase water productivity through technological innovations, and the other one is to improve allocative efficiency of water use. These are examined below.

Water conservation through technological advances is purely a 'technical fix' to the problem of water shortages. Technical fixes allows for reduction of waste discharge per unit of economic output, to treat polluted water, to increase water recycling and reuse. However, this approach does not address the question of what water is used for or where it comes from.

Improving allocative efficiency involves optimizing the distribution of a given amount of water supply among different uses and users. Less economically wasteful water allocation generates water saving.

While any of these approaches may be individually effective for temporarily relieving local or regional water stress, solving the problem at the national level and in the long-term requires integrating them into a comprehensive and cohesive overall strategy. The larger point is that 'water conservation' should not and cannot be the private business of a few agencies that set their own targets and then conduct self-evaluation based on their own standards. Conserving water is the business of the entire country. But conservation independent of the larger context for the future development of the economy is bound to yield limited success. In China, there is much room for improving water conservation through either 'technical fixes' or more efficient water allocation. Indeed, the principle of customizing demand to adapt to constraints in supply will play a key role in efforts to reduce allocative inefficiency.

b. *Entrenched engineering biases constrain sensible allocation of water supplies*

Theoretically speaking, especially in a market economy, the problem of water shortage ought to be solved using market instruments, because they allegedly optimize economic efficiency. But in fact, decision-makers often do not base their decisions on considerations of economic efficiency but on their pre-existing preference for sourcing water externally and their pre-existing bias against water conservation. These inclinations are most probably the product of years of professional involvement with hydraulic engineering projects, and they constitute a potent obstacle to the implementation of water conservation measures. What local official would want to do the hard work of improving water use efficiency if shortages can be mitigated by taking the water an area or region needs from elsewhere, especially if others (typically the central government) will ultimately pay for this? To this day, the point is still sometimes vigorously made when project proposals are being evaluated that '[the project] must go ahead because it is in the interests of the nation'. This is a classic example of an engineering as panacea mentality.

Consider the South-North Water Diversion project: even many of those who are in favour of it in principle are concerned that it might further perpetuate dependency on water from outside sources to relieve local shortages. Some have even suggested that if provincial and city governments in the north do not take conservation seriously by striving to improve water productivity, wastewater treatment and recycling, they should not be permitted to use the water this project makes available to them, lest the magnitude of the project only be matched by that of the waste, pollution and corruption it would likely engender. There is a real danger that the intended beneficiaries of the diversion project could become less motivated to become more water-independent. Indeed, if the government can afford to spend tens of billions of RMB on the diversion project, then it is not beyond reason to hope that some of that money can go towards strengthening water conservation everywhere. The long series of large-scale diversion and storage engineering projects in the nation's history to date have yielded limited benefits. They have not addressed the root cause of the problem to which they have been the intended solution. Worse still, they have brought with them a host of serious social and ecological problems.

c. *Reducing arbitrary exaggeration of water needs*

Early on in the South-North Water Diversion project process, governments of water stressed provinces in the North that were candidates for receiving water from the South submitted huge water deficit figures. However, when the central government decided to change the investment mechanism so that provincial governments would in effect have to pay for the water they got, many adjusted their water deficit figures downward by a significant margin. This has been particularly intriguing because it seems to expose the tendency to inflate water needs on the part of local governments. The difference between the amount of true water need as determined in accordance with the norm of economic efficiency and the amount of reported water need is what experts call 'extra-economic demand'. The demand, if met, benefits large projects of dubious economic, social and ecological value at the expense of the economy and society as a whole. There are several reasons for this pervasive phenomenon. The first relates to thinking about political reputations. Most politicians know that theatrically large projects that bring in water from outside tend to yield visible results relatively quickly, and are therefore good for scoring political points and for building a legacy. By contrast, water conservation, which requires harder and less visible work that may require one to go up against entrenched and vested interests is a particularly inefficient way for politicians to make a name for themselves. The second reason has to do with the history of competition for public resources in China. For a long time, having free or inexpensive access to publicly owned natural resources has been an important reason why many local economies have been able to grow extremely fast. To attract funding from the central government, local governments often unrealistically pursue large or even colossal water source exploration projects when they ought to choose mid-sized or even small projects, follow-up and supporting projects and water conservation projects. Consequently, projects that get funded and built tend either to be too large or run too inefficiently because local support structures are not in place.

The third reason for the phenomenon of 'extra-economic demand' is localism. After 1998, water resource management and control have been centralized and become the sole responsibilities of water resource management agencies at the central government level. However, since economic planning is done at the administrative unit level, horizontal and vertical compartmentalization of water resource management and control is still very much the norm. The amended *Water Law* passed in 2002 explicitly requires that each river basin manage and control its water resources systematically and coherently. But empirical studies suggest that there are as of yet no clear or actionable legislations, rules or procedures in place to make sure this happens. This means that at the current and early stage in the transition towards 'water supply dictates demand', the authority of any water resource management and control agency is recognized only by water users at administrative levels below its own, and has no hold over economic decision-making entities at the same administrative level.

II. Protecting farmers' rights and interests

a. *Use-right trading and the disenfranchised*

So far as the issue of water rights is concerned, the standardization of a code of conduct for transfer is of particular importance. This trade is supposed to be mutually-beneficial for the parties involved. But in practice, some of the specific questions that deserve careful consideration are as follows: (1) Under the condition of state-owned water rights, do local governments have the legal authority to transfer use-rights? (2) The rights to build a hydraulic project are not the same as rights to the water resources linked to a given project. And (3), how to handle the possibility of damage to the interests of a third party, such as farmers? While they are often the *de facto* users of the water rights being traded, they are often excluded from decision-making processes.

b. *Water prices and the triple problems of 'Agriculture, the Countryside and Farmers' (san nong)*

Increases in the price of water have had some positive effects on water conservation efforts by some cities and towns. However, similar outcomes have not materialized in agricultural water use, the sector where water productivity has historically been the lowest and waste the most serious. The first reason for this has been touched upon above, and it has to do with confusion and ambiguities in the chain of command. The second reason is the inelasticity of agricultural expenditure on water, and the fact that farmers can ill-afford to pay higher prices. The reason for the inelasticity of agricultural water prices has nothing to do with water supply *per se*, but everything to do with the fact that agricultural commodity prices typically do not keep up with cost increases. Since the state no longer sets the price for agricultural commodities, water price inelasticity can only be attributed to the limited scale of the market for agricultural commodities. The problem is that many farmers not only have difficulty selling their products but also in changing what they produce. This gives rise to the need to perform some serious analyses about setting prices on the basis of marginal opportunity cost. However, the concept of Marginal Opportunity Cost (MOC) is inapplicable and invalid in places where there is a strong rural-urban divide. MOC comprises of Marginal Producer Cost (MPC), Marginal User Cost (MUC) and Marginal Environmental Cost (MEC). MUC is the greatest utility that can be generated from an alternative use of a scarce resource. Two conditions must be met for this concept to apply. First, the natural resource in question must be scarce in a material sense. This is certainly true of water in water-stressed areas. The second condition is that there must be real alternatives to the way in which a scarce resource is used. And it is precisely this second condition that is not satisfied in many poor rural areas in China. This is because farmers and their livelihoods and the rural areas they live in, have on the whole been neglected by the government. This has placed them at a decisive disadvantage relative to other groups, urban areas, and economic sectors. The root cause of many of the problems in agricultural water use can in fact be traced to this sorry state of affairs.

The labour power of many farmers in China still lacks 'market (exchange) value' (this means that its marginal opportunity cost is zero). So, making farmers pay more for water to induce greater savings simply makes no sense. But if the resources they depend on are assigned exchange values by the market (if, for example, a developer decides that water resources in a poor rural area have commercial potential as, say, a tourist attraction), then these farmers may be 'counted' so far as a market economy is concerned. However, even then their bargaining power would still be weak.

To summarize, farmers remain particularly vulnerable. Their interests have repeatedly been sacrificed in the name of promoting some other, allegedly larger, social good. Rhetoric about benefits for farmers (whether in terms of security, economic efficiency or ecological significance) is common. However, the fact is that farmers have had to pay extraordinarily high prices to realize these benefits, and have often not been able to realize them. This is too often been forgotten or overlooked.

2.4 Water resource use and ecological sustainability

As human exploitation of water resources intensifies to satisfy society's growing appetites, it has given rise to many ecological problems that affect both rivers themselves and their surrounding areas. Examples abound: dam construction on the Heihe River has reduced water flow and caused lakes in the downstream region to shrink; dam construction in the Shiyanghe River Basin has caused rapid ecological deterioration of an oasis in Minqin County; dam construction has damaged Aibi Lake in the Xinjiang Uighur Autonomous Region; and dams constructed to divert water are threatening biodiversity in Qinghai Lake, to say nothing of the human suffering generated by the massive resettlement associated with these large dam projects, and their deleterious ecological consequences. Experts have also pointed out that the Haihe River Basin ecosystem has been ravaged (through drying of lakes, over-abstraction of underground water and ground subsidence) by numerous resource development projects. Meanwhile, parts of the Yellow River have become desiccated due to large dam construction. Last but not least, large-scale water diversion projects (such as the middle route of the South-North Water Diversion Project) will involve the transfer of vast quantities of water from the Hanshui River Basin ecosystem, which will result in severe imbalances and may trigger a whole host of social and economic disasters.

These are just a few examples that help to illustrate the enormous potential of hydraulic projects to wreak havoc on both nature and society. Many of these projects have resulted in unforeseen ecological impacts during their construction. Steps need to be taken to protect the natural ecological functions of rivers and to strive towards their sustainable use. In particular, the following problems need to be addressed:

- The lack of transparency and public participation in different stages of hydraulic projects.
- Proposal evaluation that focuses narrowly on the technical and economic aspects of the projects, and tends to have nothing to say, or ask, about their ecological and social implications. Even when these issues are considered at all, they tend either to be treated perfunctorily or to be taken up too late in the evaluation process to make any real difference.
- Once they have been completed and become operational, many hydraulic projects are subject to little monitoring or post-construction evaluation.

Therefore, in planning for water resource use involving hydraulic projects and rivers, it is imperative that ecological matters be taken into consideration, especially with respect to both water quantity and water quality. Issues relating to social and even cultural impacts must also be included within project design and evaluation processes. Monitoring must also be maintained once projects are operational, so that society and decision-makers can learn from experiences and mistakes.

To solve the increasingly complicated water scarcity problems facing China, it is essential to adhere to the national policy of resource conservation and environmental protection. It will be necessary to institutionalize strict resource management and control in order to quicken the transition from over reliance on supply to meet demand to a policy of adjusting demand to honour the inherent limitations in supply. This would entail shifts from unscrupulous exploitation to rational utilization, from crude use to smart use, and from remediation to prevention. Only when these transitions are complete will it be possible to achieve sustainable economic development by means of the sustainable use of water resources.

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7
Some Thoughts on International Environmental Cooperation After Copenhagen

Xu Songling

后哥本哈根谈判论纲

I. Prelude: Some thoughts on Copenhagen

The international climate summit held in Copenhagen, Denmark, at the end of 2009 ('COP15' hereafter) was a key point in the history of the Intergovernmental Panel on Climate Change (IPCC). It was attended by 190 countries and by 110 high-ranking government officials, including heads of states. The conference, having been called 'Hopenhagen' initially, ended in resounding disappointment as 'Brokenhagen' (Funder, 2009; Mataka, 2009). In its aftermath, and in conjunction with the imminent renewal of the *Kyoto Protocol*, hopes for further progress must depend on post-Copenhagen negotiations. Therefore, it is imperative that lessons are learnt from Copenhagen to ensure greater success in the future.

Former British Deputy Prime Minister John Prescott had played an important role in negotiating the *Kyoto Protocol*. However, he predicted before the conference that Copenhagen was going to be ten times more arduous and challenging than the 1997 Kyoto negotiations (The Guardian, 2009a). This is not only because representatives from a much larger number of countries attended Copenhagen than the 47 countries that participated in Kyoto. More importantly, the Copenhagen conference had to deal with far broader issues in greater depth. These issues touched on the national interests of participating countries.

Copenhagen got off to a bad start, as it became mired in the so-called *'Danish Text'* scandal on the eve of its opening. Controversies surrounding the *Text* persisted throughout the conference, and exacerbated the fierce clash of national interests that was its defining characteristic.

This conflict could be seen in the way developing countries were roundly critical of the *Copenhagen Accord* (UNFCCC, 2009). It was passed by the Conference 'taking note of' its content: 'The Conference of the Parties (COP), at its fifteenth session, *took note of* the Copenhagen Accord of 18 December 2009 by way of decision 2/CP.15' (authors emphasis) (UNFCCC, 2009). The *Accord* was a product of reluctant compromises between different countries with differing national interests. On the one hand, it eschewed all the controversial issues raised by the *Danish Text* episode, as well as the most sensitive and hotly debated issues in the negotiations. Yet it was also deeply informed by the internationally-shared political will that has been forged over the years through the *Framework Convention on Climate Change*, the *Kyoto Protocol* and the *Bali Road Map*.

Secondly, the *Accord*, from its conception to its eventual demise, was a powerful illustration of the profound influence of national interests on international climate diplomacy. In his comments on the *Accord*, Ed Miliband, then the British Climate Change Secretary, accused China of having 'hijacked' the Copenhagen negotiations. Most notably, he said: 'We did not get an agreement on 50 per cent reductions in global emissions by 2050 or on 80 per cent reductions by developed countries. Both were vetoed by China, despite the support of a coalition of developed, and the vast majority of developing countries' (The Guardian 2009b).

The so-called '50 per cent- 80 per cent emissions reduction target' was the focal point of the Copenhagen negotiations. Originally formulated in the G8 *Declaration* that came out of the summit in L'Aquila, Italy (G8, 2009a), this target was at that time unable to gain the support of five emerging economies (G8, 2009b). This formulation was only a variation on two others, namely, holding the increase in global temperature below 2 degrees Celsius, and keeping the atmospheric carbon density below 450 parts per million (ppm). These three formulations are equivalent and based on the most current climate science. Commitment to any or all of them entails the following scenario: before 2050, developing countries will reduce their respective aggregate emissions of greenhouse gases, and become subject to an emissions cap in a similar way to developed countries. Developed countries, for their part, would not only be forgiven for their historical role in the current crisis but also be allotted a 'carbon space', associated with their 'carbon rights', which would be two to five times that allotted to developing countries. Both of these conditions encourage the perpetuation of global economic and social inequality.

The 50 per cent to 80 per cent emission reduction target will undoubtedly continue to be a pivotal point in post-Copenhagen climate negotiations. But what is both more important and more difficult to achieve is the formulation of a mid-term emissions reduction target, comparable to the long-term target for preventing warming of more than 2 degrees Celsius, which is specifically for developed countries. It is also necessary to make sure that those areas in which political agreement has been achieved through the *Copenhagen Accord*, including action, investment and technology transfer, the 'measurable, reportable and verifiable' requirement, and forest protection are concretely implemented, especially through passage of national legislation. In terms of scope and depth, all these issues exceed anything addressed through the *Kyoto Protocol*. Prospects for new and more meaningful international climate and environmental treaties depends on capacity to grasp the pressure points within the post-*Kyoto* international geopolitical landscape, to appreciate the interests and concerns of different countries and regions, and to bring relevant ethical theories to bear on them.

II. Global climate change responses: how human understandings have evolved over the last 20 years

To a considerable degree, the international clash of interests that dominated the Copenhagen conference reflected changes over 20 years in the way human beings have understood climate change and how it might be dealt with.

Scientific research and practical experience implementing the *Kyoto Protocol* have advanced understandings of how to respond to global climate change since the *Framework Convention* was signed in 1992. Three main insights that have emerged are: (1) the inherent uncertainty of global climate change; (2) the delicate balance between 'mitigation' and 'adaptation' strategies; and, (3) the difficulty of negotiating a global response to climate change.

1. Uncertainty in climate change and its effects

Appropriate responses to issues of uncertainty are at the heart of scientifically-informed and methodologically-sound decision-making to address climate change. This uncertainty is not the uncertainty inherent in the facts themselves but rather a type of epistemological limitation - namely uncertainty in human knowledge about the world. Indeed, in terms of global climate change and its effects on nature and society, it is not possible to be certain about the accuracy of basic data and relationships between different variables. This necessarily makes it difficult to decide how to collectively respond to the situation.

The nature of global warming due to anthropogenic carbon emissions can be understood in one of two different ways. It can be treated as an event with 'poorly-known probability and high impact' (Dessai and van der Sluijs, 2007) or it might be considered, as in the AR2007 report of the IPCC, to be an event that is 'very likely', that is, with a probability greater than 90 per cent (IPCC, 2007a). The first scenario presupposes a large measure of uncertainty in understandings of the relevant facts, while the second is consistent with a high degree of certainty in current understandings. The two positions have very different implications for policy deliberations. The issue of which position is more defensible is becoming more contentious than ever. Furthermore, following the so-called 'Climategate' affair, the debate is no longer confined to academic circles and is now taking place among the general public.

There are two aspects to the mishandling of the issue of uncertainty by AR2007. First, according to the most recent criticisms of the IPCC reports, especially AR WG1-2007, AR2007 mismanages the issue on three distinct levels: the empirical level, the theoretical level, and the technical level. On the empirical level, the report falls short in terms of basic data, facts and information; on the theoretical level, the report is seriously wanting in terms of the soundness of the statistical and

causal inferences it makes; and on the technical level, it fails to articulate an appropriate set of methodologies that would adequately accommodate epistemic uncertainty in decision-making. To compound the situation, the 'Climategate' episode has only further shaken the credibility of the conclusions made by AR WG1-2007.

Secondly, AR2007 altogether fails to formulate a conceptual framework for addressing the issue of uncertainty in relation to climate change and its effects. Such a framework ought to make it possible todifferentiate between four sub-categories of uncertainty that relate to this large topic: (1) uncertainty in naturally-occurring climate change; (2) uncertainty in anthropogenic climate change; (3) uncertainty as to the effects of climate change on ecosystems; and finally, (4) uncertainty of human responses to climate change. Even though all three of the individual group reports mentioned the concept of uncertainty, none of them actually took up the issue in depth and addressed the question of how these different dimensions are interlinked with one another.

Today, human beings no longer think of global climate change in apocalyptic terms, and most people are able to consider the issue sensibly and rationally. While many are willing to allow the possibility that human activities may be to blame for recent warming trends, they nonetheless cast doubts on the specific conclusions drawn by the AR2007 report. It is worth remembering that how issues of uncertainty are handled greatly affects responses to global climate change. It determines what basic and general strategies to use, which specific courses of action to take, and how the social and economic costs of various approaches are to be calculated. Since the ethical ideal of 'climate justice' remains a long way off, the (climate) fates of nations may well depend on how these complex issues are handled by the international community.

2. The delicate balance between 'mitigation' and 'adaptation' strategies

'Mitigation' and 'adaptation' have been the two main strategic options in the human response to global climate change. Since the beginning of IPCC talks and negotiations, mitigation has been the strategy of choice. Its most representative and well-known application is in the Kyoto Protocol. However, the undeniably disappointing results of mitigation efforts over the last twenty years, in the light of social and economic development worldwide, give reason to doubt the efficacy, feasibility, and long-term sustainability of this general approach.

According to IPCC estimates, aggressive emission reduction measures will be necessary if the increase in global temperatures is to be held below 1.5 and 2 degrees Celsius. Measures would have to be more demanding still if emissions are to return to 50 per cent of 1990 levels. Various obstacles will need to be faced to meet either of these targets. Firstly, the countries in the Annex I Parties are principally responsible for the carbon accumulation in the atmosphere that has caused global warming. As such, they should be principally responsible for meeting these targets. However, they have agreed to reduce their respective aggregate emissions to only 80 per cent of the 1990 level. This would mean a much feebler global response to climate change than could (and should) actually be achieved. Secondly, emissions reduction targets inherit the uncertainties embedded in the scientific understanding of the basis on which they are set. Moreover, the more aggressive the reduction targets are, the higher the demand for certainty from decision makers by those affected. Therefore, even if aggressive mitigation measures are called for, it remains an open question as to their practical feasibility and scientific credibility.

A further conclusion to be drawn from these considerations is that it is perhaps unwise to put all eggs in one basket in responding to climate change. If the scientific soundness, practical feasibility, and effectiveness of mitigation measures remain in dispute, more attention should be paid to adaptation strategies. The two approaches may well turn out to be of equal importance, and indeed, the importance of adaptation may increase over time. At this point, however, an adaptation-focused strategy has three advantages: (1) it can guarantee the survival of the human population; (2) it is more cost-effective than a mitigation- focused strategy since it is more flexible (Stern, 2006);

and (3) it also makes room for integrating climate policies with social and economic policies to maximize the positive externalities of adaptation measures (IPCC, 2007b).

In fact, some countries have already made adaptation the main component of their climate change response package. For example, the Netherlands is more vulnerable than most other countries to the effects of global temperature rises as it has the largest portion of its territory below sea level. It is little wonder that it has historically been an enthusiastic supporter of mitigation through carbon emissions reductions. However, at the present time, its national climate strategy contains three components, namely, adaptation, emissions reduction and international cooperation (Desai and van der Sluijs, 2007). If the Netherlands sees fit to organize their priorities this way, a similar strategic shift may be in order worldwide.

Of course, developed countries are far more capable in dealing with the effects of global warming than developing ones. This may tempt them to apply a double standard of employing an adaptation approach domestically while subjecting other countries, especially developing ones, to stringent mitigation requirements.

3. The dynamic relation between international cooperation and international competition

The strategic shift just described, from a mitigation-focused to an adaptation-focused response to climate change, has enormous implications for international geopolitics. It would likely leave deep imprints on the way in which developing and developed countries work together, although this may not necessarily be the case.

The premise of the *Kyoto Protocol* was that reduction in carbon emissions holds the key to the maintenance of a global climate which is safe for humans and for the national security of each country. This belief, not surprisingly, has generated a remarkably high level of good will in many countries and a genuine willingness to work together toward reducing anthropogenic greenhouse gas emissions.

However, if the world focuses more on adaptation as a response mechanism, there would be correspondingly less willingness to cooperate internationally. This is because each country's security depends first and foremost on its own ability to make the necessary domestic adjustments to accommodate gradual or sudden shifts in external ecological conditions, and has little direct dependence on how other countries may perform. One likely result of such a strategic shift would be a weakening of international cooperation and increased international competition.

International competition would heighten national self-interest. The market mechanism plays a key role in international efforts because of its capacity to help improve the efficiency and cost-effectiveness of mitigation measures. But the rise of market dynamics in the global climate response would also create opportunities for countries to pursue their national self-interest as part of global competition. Of course, it is both permissible, and necessary for countries to consider their own self-interest when interacting with one another, and when this is done correctly, it could result in a 'win-win' situation, in which the self-interested behaviours of each lead to mutual benefits for all. However, if this were not done correctly, competition and cooperation could become unbalanced. This would place the entire global effort to address climate change in jeopardy.

The one area in which the combined effects of weakened international cooperation and intensified international competition are bound to be most evident is in bargaining between developed and developing countries. Thanks to their economic power, developed countries have always dictated the terms of international discussions on this issue and where the balance is struck between greater international cooperation and competition. The following areas have been particularly vulnerable to these influences:

- Developed countries apply what essentially amounts to a double standard in which adaptation is the domestic objective and mitigation is imposed on other nations
- The amount of financial and technological support provided by developed countries to developing ones is reduced over time
- Developed countries offer assistance on the basis of their national self-interest rather than to those at greatest risk or in most need
- International assistance programmes are increasingly designed to benefit the donor

III. The geopolitics of climate change and its effects

After almost 20 years of experience, it is possible to summarize the basic geopolitics of the global response to climate change can be characterised as having three key elements. These are as follows:

The first issue is the fundamental one of existence. This should be a primary concern for every society. Existence can be addressed through mitigation (such as carbon emission reductions or carbon sequestration) or adaptation, if mitigation is impractical, ineffective or just unpalatable.

The second area of concern is social and economic security. This refers to a concern with the capacity of a society to withstand the impact of climate change on its social life in general and its economic activities in particular. According to the comprehensive estimate completed by Stern, the cost of inaction would be an average five per cent of GDP, and twenty per cent if we take risks from other environmental changes into consideration (Stern, 2006). Moreover, national responses to the potential effects of climate change have far-reaching consequences. This means that climate policies must be formulated in conjunction with other social and economic policies and objectives (Stern, 2006).

The third area of concern is external security. Global warming will likely trigger a series of international conflicts and disputes over issues such as natural resources, energy, food availability and safety and cross-border migration, among others. Because these issues invariably have economic, political, and even military implications, they will increasingly become the foci for studies of the connections between global climate change and national security. This kind of research is now well underway in the United States and also the European Union.

Countries differ in terms of the relative weight they attach to each of these three issues. For example, developed countries tend to be relatively secure in terms of their basic survival, economic and social security, and so their ability to prevent global warming from retarding their economic growth is a more pressing issue. For highly developed and powerful countries like the US, Britain, France, Germany and Japan, but particularly the US, external security is also high on their priority list of climate change related issues. Judging from extant literature on the subject, the issue of external security has already surpassed that of domestic economic and social security in importance, at least for the US.

The situation is different in developing countries. Naturally, self-preservation is the top national concern for small island states. The same is true for the poorest countries in the world, albeit because extreme poverty itself constitutes a threat to survival. Middle-level developing countries face a level of survival risk from global climate change that is between that of the developed and the poorest countries. What dominates their interest is the impact climate change might have on their domestic economic growth.

IV. Diplomatic positions on climate-related issues in the post-Copenhagen era: Annex I Parties

The combativeness of the diplomatic face-off between developed and developing countries during the Copenhagen conference has made it abundantly clear that developed countries have undergone a fundamental shift since the *Kyoto Protocol* in how they define their national interests in relation to climate change. These changes are discussed in this section, and focus on the European Union, particularly Britain and Germany, and the umbrella group, particularly the United States.

1. Britain and Germany

The social, economic, and topographical conditions of Britain and Germany can be considered representative of other European Union member states in relation to the issues discussed here.

Basic security is affected by geographical conditions, including location and size. Both Britain and Germany are likely to face measurable threats to their territorial integrity from global warming. However, this threat is largely neutralized by their economic and technological capacity to adapt. Therefore, both countries are likely to suffer few threats to their basic security and territorial integrity in a warmer world.

The economic and social security of both countries owes much to their historical and current responsibility for carbon accumulation in the earth's atmosphere. According to the studies by Stern, it is better to proactively spend one per cent of GDP on domestic and international mitigation and adaptation measures before major climate change disasters strike than to spend five or even twenty per cent of GDP afterwards (IPCC, 2007b). But of course, even one per cent of GDP is not a small amount for even the developed countries, especially during periods of economic downturn. However, after the 'low carbon economy' was announced, the climate policies of European Union nations such as Britain and Germany shifted drastically since each stands to gain from competing in the newly emerging international market for green technologies. Compliance with carbon emission reduction targets was previously a drag on the economies of Britain and Germany, but their technical proficiency has transformed it into an engine for economic growth (Brown, 2008). This experience is similar to the impact of the IT revolution on the US economy and the impact of the environmental industry on the German economy (RBSC, 2009). This shift explains why the EU sets aggressive domestic emission reduction targets for itself and for developing countries in climate negotiations. The intention is to speed the formation of a 'global low carbon economy', with themselves as the dominant players (Brown, 2008). This helps explain Ed Miliband's rage over Chinese opposition to the 50 per cent to 80 per cent carbon emission reduction target.

The third of the three issues is external security. This would likely involve international affairs and relations and will have large implications for how affected nations position themselves in relation to other nations. Broadly speaking, what will be at stake for each country is the substantive content, relative weight and reach or scope of their interests in global or international politics. These issues present both a challenge and an opportunity for EU countries, which have attached enormous significance to them, and are acting on them in earnest (IISS, 2011). In fact, Britain has proposed that 'global climate change and national security' be included on the regular agenda of the UN Security Council to position itself advantageously in case an international conflict or dispute over interests should arise in relation to climate change matters (UN, 2007).

2. The United States

Despite its refusal to ratify the *Kyoto Protocol*, the US has always been very concerned with global climate change issues. However, it also has rather different interests to EU countries, and its focus has changed over time. During the 1980s and 1990s, the main concern of the United States was to ascertain how global warming would likely affect its own economy and social development.

Despite openly and vociferously opposing the *Kyoto Protocol*, the US has still considered voluntary emission reduction measures, and conducted a good amount of policy research in this area. In the present century, the US has become increasingly concerned with the potential external security impacts of climate change, and this shift lies behind the Obama administration's desire to rejoin international efforts. In addition, strong skepticism about the reality of anthropogenic global warming among part of the scientific community and the general public in the US also constitutes a formidable force shaping both its public discourse and policy debates.

The huge territorial mass of the United States of America spans high, middle and low latitudes, and so the nation has considerable geographical room for adjustment in response to climate change related calamities. It is also more resilient than many EU countries in this regard. And finally, it continues to be the world's superpower, a status that affords it still more security against any threat, natural or otherwise, to its territorial integrity.

Recent studies in the United States have been more optimistic than earlier studies from the 1980s and 1990s. These more recent findings also show greater complexity and depth. They indicate that the negative economic impact of climate change would amount to no more than plus or minus one per cent of GDP (Smith, 2004), which is less than Stern's estimate for EU countries. Some also indicate that it is likely that global warming may end up benefiting the US more than hurting it. Therefore, the implication is, emission reductions of the kind that EU countries are pursuing would be more economically and socially costly. This is why most Republicans and their sympathizers are vigorously opposed to committing the US to internationally-negotiated emission reduction targets. And while the Obama administration is beginning to support low carbon economy efforts, it is less enthusiastic than Europe.

The connection between global warming and external security was first made by the US, and it continues to lead the world in this area of research. Participants include those across the spectrum from the Congress to the Department of Defence and from the Central Intelligence Agency to non-governmental think tanks. Researchers seek to determine what is likely to happen in different regions and countries with a warmer earth and also try to connect climate change with external security issues (Schwartz and Randall, 2003; Busby, 2007), and address what interventions, including military ones, the US might need to pursue in the future (CNA Corporation, 2007). Indeed, America's degree of fixation with these issues is inversely proportional to its aversion to joining the global effort to reduce carbon emissions. This is a profoundly significant point to ponder because it seems to suggest that the United States is almost indifferent to the possible negative global impact of climate change, but as the richest and the most powerful country in the world, would nonetheless be more than happy to clean up the aftermath should disasters come to pass.

3. Post-Copenhagen negotiations between Europe and the United States

The interests and concerns of the European Union and the United States partially overlap on climate change. This is reflected in differences between them over why and how they might participate in international efforts. Relations are characterised by a mixture of cooperation over issues on which they agree and competition over issues on which they do not.

Cooperation between these two Annex-I parties can be seen in the following areas:

- Strong on long-term commitment, but short on mid-term commitment
- Requiring developing countries to reduce both carbon emissions per unit of economic output and aggregate emissions
- Subjecting financial support for transfer of technology to developing countries to so-called MRV requirements (measureable, reportable and verifiable); and in their stance on external security issues.

They do not fully agree in the following areas:

- The EU shares the view of developing countries that the US emission reduction targets are far too lax
- The EU is more committed than the US to a low-carbon economy, whereas the US is far more interested in national security
- In crude terms, the EU is considered to be less antagonistic and more forgiving towards developing countries than the US
- The EU is more concerned than the US with its ethical standing and image in the international community

The EU has sought and to a large degree succeeded in achieving the power and the authority to lead the world in responses to global warming since the *Kyoto Protocol*. Indeed, renewed US interest in rejoining these EU-led international efforts largely represents a desire to take over that leadership. Struggles over this issue are bound to become a key or defining feature of future diplomatic relationship between the two parties. This international contest of will and power no doubt has implications for domestic politics as well. However, the US is unlikely to succeed in supplanting the EU and becoming the world leader in this area as long as its current diplomatic stance on various climate-related matters remains unchanged.

V. Diplomatic positions on climate-related issues in the post-Copenhagen era: non-Annex I Parties

The non-Annex I parties present a more complicated position. Several countries qualify as Upper Middle Level countries, and some of these have formed their own Environmental Integrity Group to voice their climate-related national interests and concerns[1]. Non-Annex I parties are mostly developing countries, customarily collectively called the Group of 77, or G-77. Sub-groups have formed and represent special interests within the G-77 countries, such as the Alliance of Small Island States (AOSIS), and the Least Developed Countries (LDCs). This section will focus on how G-77 countries seek to assert and protect their respective national interests in post-Copenhagen climate talks and negotiations. It will also address the issue of the special interests of the small island developing states and the least developed countries.

1. Shared interests

Existential security and economic and social security are the most important climate-related concerns for G-77 countries. This is because their limited geopolitical capital means external security is not always in their own control.

In general, the G-77 countries can be considered to be aligned in terms of their existential and economic and social development interests. The basic reasons are that they tend to share a similar colonial or semi-colonial past; are comparable in their current states of development; have similar roles on the international stage; tend to be causally and historically innocent in terms of contributing to anthropogenic global warming; and they tend to be victims of the current crisis.

The national interests and concerns which the G-77 countries hope to table in post-Copenhagen climate talks and negotiations fall into the three categories already discussed: existential security, economic and social security and external security. G-77 countries most want to avoid facing problems as a result of any measures that they take or are required to take on account of climate change. Their special interest in terms of external security is to receive appropriate financial and technical assistance if they are required to adopt international mitigation or adaptation measures.

An obvious implication of these shared interests and concerns is that G-77 countries are unprepared and unwilling to sign on to the 50 per cent to 80 per cent emission reduction target, even in the long term. Instead, they are far more inclined towards renewing the set of mid-term targets articulated in the *Kyoto Protocol*.

2. Divergence in interests

Differences in natural endowment and economic and social conditions also lead to the G-77 countries differing over various issues. For analytical purposes, we can divide these countries into three sub-groups: (1) those experiencing fairly vigorous socio-economic growth and development and at no special risk from climate change; (2) the least developed; and, (3) the small island developing states. The majority of the G-77 countries belong to the first of these three groups, and shared interests of this group are the strongest shaper of the collective interests of the G-77. The second of the three groups mainly consists of the sub-Saharan African countries, whose per capita incomes and human development index (HDI) tend to be low, and are economically fragile. For them, nothing is more urgent than poverty reduction. Therefore, it is important that the measures they implement in response to climate change are consistent with that objective. Some of the small island developing states of the Atlantic, Pacific and Indian Oceans are better off than others, but all face existential threats from the prospect of global warming and sea-level rise. Consequently, for them, the primary objective of mitigation or adaptation measures should be to ensure their basic existence. The shared interests of the extremely poor and small island developing states are consistent with the collective interests of the G-77, but their situations do call for their interests receiving precedence in some areas.

3. Cooperation among G-77 countries during post-Copenhagen climate talks

There are two key issues which the G-77 must handle with great care and dexterity during post-Copenhagen climate talks. These are how the G-77 negotiates its relationship with Annex-I Parties and how its member states, especially those in different sub-groups, negotiate their own relationships.

The pivotal issue in the talks between the G-77 and the EU and the US is the long-term and mid-term targets. Until some kind of resolution is reached, the commitments and efforts that began with the *Kyoto Protocol* stand no chance of being extended into the future. Details about financial and technical support for non-Annex I Parties from Annex-I Parties are also related to these targets, and include discussions of MRV requirements. Talks over these issues will not be easy. Difficulties will not primarily be due to uncertainties in scientific understandings of the problems or to dubious ethics. Rather, they will result from the dynamic and contentious nature of any power bargaining. G-77 countries can show force only if they stand united, and their unity is in turn contingent on their ability to synchronize and harmonize their various interests and concerns in the areas of existential security, economic and social security and external security.

Because the least developed countries and small island developing states stand to gain the most from the realization of 'climate justice' (while wealthy nations of Europe and North America have the most to contribute towards this goal), the claim of the G-77 to moral authority in negotiations with Annex-I Parties is only as strong as its own level of respect and concern for these countries.

Accommodating the special needs of the neediest countries is relatively straightforward. There are already provisions within the IPCC climate response strategy to serve this purpose, such as the National Adaptation Programme of Action (NAPAs) (Decision 28/CP.7, 2002) and the Least Developed Country Fund (LDCF, 2001). It is now necessary to determine how to make these programmes run effectively and ensure that the available funds are used as efficiently as possible.

One knotty problem concerns the existential interests of small island developing states. For these countries, adaptation to climate change has unique significance because issues of physical integrity and even the very existence of their territories are literally at stake. Preservation requires action to

reduce greenhouse gas emissions and to halt global warming, and effective adjustments to the reality of a warmer earth.

Aggressive emission reduction measures typically face two types of difficulty - theoretical and practical - on two dimensions - scientific and ethical. From the scientific point of view, the main difficulty has to do with epistemological limitations such as uncertainty in relation to understandings of the issues discussed in Section 3.2. From the ethical point of view, the main difficulty has to do with the lacklustre response of those whose historical actions brought about the current crisis. But even if we leave aside the issue of historical responsibility and look at the matter ahistorically, it is unconscionable and morally perverse for wealthy countries, with per capita carbon emissions many times that of developing countries, to demand that the latter shoulder the burden of global reductions in emissions. This would be tantamount to perpetrators extorting compensation from their victims. The very intractability of international disputes over these moral questions renders the choice of emission reduction as the overarching climate change response strategy less feasible than it might otherwise have been.

The superior strategy for small island developing states might well be to increase the emphasis on adaptation rather than staking their existential security entirely on mitigation measures. As the *Alliance of Small Island States (AOSIS) Declaration on Climate Change 2009* indicates: 'We underscore that adaptation must be an urgent and immediate global priority' (AOSIS, 2009). There is reason to believe that prioritizing adaptation can be both effective and feasible. Geo-engineering, which involves literally transforming the physical landscape in order to accommodate the inhabitants, is a first choice. When this is not an option, emigration would need to be considered. Indeed, some of these adaptation measures may, if well designed and well executed, generate long-term social and economic benefits for these countries.

VI. The ethical foundation for post-Copenhagen climate talks

Post-Copenhagen negotiations, especially the Cancun round (COP16), are likely to be hard work. If any international agreement is to become a meaningful sequel to the *Kyoto Protocol*, it must address the following issues:

- The nature and the proper handling of the problem of uncertainty
- Establishing clear interpretations for: the goal of capping global temperature increases to below 2 degrees Celsius; the relationship between mitigation and adaptation; and, formulation of long- and mid-term emission reduction targets
- How best to handle the so-called 'common but differentiated responsibilities' of both Annex-I Parties and other parties during this period of renewed commitment
- How to allocate financial and technological responsibilities between the two groups
- How best to customize MRV mechanisms according to the type of measures implemented and the type of funding structure
- How to improve the efficiency of both mitigation and adaptation measures

The ability to adequately tackle these problems hinges on one key factor, namely, a sound normative framework (Leinen, 2009). The moral basis of the *Kyoto Protocol* was that what countries do today should reflect and respond to what they did in the past. In other words, that document presupposes the moral significance of 'historical responsibility' in defining international obligations in international climate diplomacy. But for post-Copenhagen climate talks, clarification or even acknowledgment of historical responsibility no longer seems sufficient to determine the international duties of different nations in responding to climate change. Yet the absence of a new and more comprehensive normative framework may be partly to blame for the failure of the Copenhagen talks (Leinen, 2009).

The purpose of such an improved framework would be to support the pursuit of 'climate justice' (Posner and Sunstein, 2007). As noted in the *Framework Convention on Climate Change*, climate justice comprises three basic normative parameters: equality, common but differentiated responsibilities, and capacity. The *Kyoto Protocol* gave recognition to the latter two, but was relatively silent on the first. As a normative framework, climate justice is supposed to provide ethical orientation with respect to the following set of issues: (1) carbon emission rights; (2) carbon emission reduction responsibilities; (3) security; (4) efficiency, mutuality, and the right to develop; and (5) uncertainty. The next section looks at these issues in more detail.

1. Carbon emission rights

This refers to each person's entitlement to the amount of ecological space necessary to safely absorb personal carbon emissions, consistent with the same rights for others. This right is in essence a type of human right, and the notion lies, or ought to lie, at the foundation of institutions designed to address climate change related issues. All human beings are morally equal, and all of the various expositions of carbon emission rights come down to the individual as the unit of analysis. Equality, in this context, should mean equality among individuals in terms of the right to emit carbon. Although this idea is only schematic, it is nonetheless substantial and significant. Insofar as equality is a foundational normative notion in discourses on human rights and on other moral topics (ICHRP, 2008), equality of per capita carbon emission rights is also increasingly being accepted in the international discourse on this issue.

More specifically, the equality of per capita carbon rights refers to equality in per capita cumulative carbon emissions, as opposed to equality in per capita carbon emissions beginning in 2050. This is a basic principle that must be honoured by post-Copenhagen climate negotiations. This means that citizens of countries in non-Annex I Parties and citizens of countries in Annex- I Parties are entitled to the same carbon emission rights. And obviously, those of the former have been largely under-used (directly or commercially) in the past.

2. Carbon reduction responsibilities

This is the idea that each country is to be held to account for reducing its carbon emissions to the atmosphere. Discussion of this issue in post-Copenhagen talks has been richer and more nuanced than during the Kyoto conference. For example, these later discussions have made the important distinction between two perspectives from which the issue of carbon responsibility can and should be looked at – namely, when and by whom.

From the temporal point of view, responsibility for reducing carbon emissions can be attributed in one of three different modes: historical or backward-looking, based on the current situation, and forward-looking. When historical responsibility for reducing carbon emissions is attributed, the focus is on the period from the Industrial Revolution until 1990. The type of norms relevant here are moral not legal ones. The attribution of carbon emission reduction responsibilities in the current period covers emissions from 1990 to the start date of further commitments that extend those codified in the *Kyoto Protocol*. This attribution has legal backing. 1990 has been legally designated as the base year from which reduction targets are formulated and referenced. Historical aggregates for both carbon emissions and carbon emission reductions are now legally required to be used in processes of target setting. Lastly, attribution of carbon emission reduction responsibilities in the forward-looking mode essentially involves the definition of commitments to future emission reductions beyond the timeframe of official international agreements. This is at best an estimate, and is not legally binding.

Carbon emission reduction responsibilities can be divided into reduction responsibilities for producers and reduction responsibilities for consumers. The former is a familiar notion but the latter is relatively new. The scope of consumer carbon emission reduction responsibilities includes carbon emitted during the consumption process itself and also carbon emitted during the production

process for goods and services consumed. For example, if a person eats food prepared by others at an eatery, that person ought to be accountable for the carbon emitted during the production process. The alternative to eating-out would be for the person to cook and eat at home, which would of course also generate carbon. In other words, what the consumer pays ought to cover not just the labour costs but also the environmental costs of the carbon emitted to produce the services being purchased. The same logic ought to apply in international trade. Importing countries ought to be held responsible for the carbon emitted during the production of the goods and services that they import. This suggests that the notion of consumer carbon emission reduction responsibilities is broader in scope than that of producer carbon emission reduction responsibilities, and is also scientifically sound. And just as important, from a normative point of view, it is consistent with the demands of climate justice. Indeed, the concept of carbon emission rights may be improved if it is recalibrated according to the same insights gained from reflection on carbon emission reduction responsibilities.

The concept of carbon emission reduction responsibilities should enable us to correct some of the popular misconceptions in the current debate about climate change. The international discourse on this subject commonly employs designations such as 'major source countries', 'big emission countries', 'major emitters', and refers to China as 'the biggest emitter'. Such ranking is based on national aggregate carbon emissions rather than per capita emissions. However, as we have seen, what climate justice requires is equality in per capita carbon emission rights, and so national aggregates are largely irrelevant. These designations obfuscate the issues and mislead and confuse the public. They badly need to be replaced by more accurate and informative terms. One suggestion would be to further distinguish between two types of 'major source countries' and 'large emitting countries', namely, countries with unsustainably high levels of per capita carbon emissions, and others. The former should be called 'carbon responsibility countries', and the latter 'carbon expectation countries', which would indicate that although these countries are not held responsible for excess carbon emissions, they are nonetheless expected to contribute towards efforts to reduce overall emissions. This terminological correction would be both scientifically sound and legally significant.

This important revision ought to be recognized in all post-Copenhagen talks and be incorporated in any resulting document.

3. Existential security

Existential security and territorial integrity under climate change must be the top two concerns for any country, rich or poor. As we have already mentioned, these concerns can be addressed through mitigation or adaptation. International experience on the mitigation front gives us reason to believe that it may be time to elevate the relative importance of adaptation. Moreover, Least Developed Countries and Small Island Developing States ought to be given special attention in this respect.

4. Efficiency, mutuality, and the right to develop sustainably

Smart implementation is the key to maximizing the efficiency and minimizing the cost of mitigation and adaptation measures. Efforts to design such implementation mechanisms will no doubt benefit from those aimed at realizing 'climate justice'. Specifically, it is imperative that the consideration of 'mutual benefit' not be marginalized by the pursuit of efficiency.

The application of market mechanisms for improving efficiency may be desirable in many cases. But 'mutual benefit' is somewhat different as it concerns both parties to the project or, in the case of an aid programme, the aid provider and aid recipient. Here, we are referring to benefits that derive from the right to development.

The development needs of poor countries that are on the receiving end of financial and technical support are particularly deserving of respect and worthy of promotion. Those who give aid ought to take this right seriously and design their aid packages accordingly. Aid that contributes to an

increase in the wealth gap between rich and poor countries would contravene the principle of international cooperation in responding to global climate change. This kind of aid could even contribute to increased global insecurity and domestic social unrest.

The global war on terror after the September 11th attacks has illustrated the enormous dangers that can come from feelings of chronic oppression. If those attacks can be traced in part to the plight of the Palestinian people who have historically been denied the right to development, and to the festering resentment within the Arab world on account of that, then the lesson to be taken from this is that there is much to be gained from taking the right to development of African countries seriously. In responding to a global ecological crisis, the emergence of an African Palestine must not be allowed to occur.

5. Uncertainty

In the *Framework Convention*, it is stated, in 3.3, that 'lack of full scientific certainty should not be used as a reason for postponing precautionary measures to anticipate, prevent or minimize the causes of climate change and its adverse effects' (UNFCCC, 1992x). But as awareness of the science of climate change and its possible causes and likely effects increases, it is necessary to also become more honest about the crucial question of whether serious climate change is an event that is 'very likely', that is, with a probability of occurrence greater than 90 per cent, or an event with 'poor known probability and high impact'. This honesty is in itself a moral norm.

Uncertainty is an important factor in deciding how to respond to climate change in the post-Copenhagen era, and how it is understood and handled has enormous implications for what kind of strategy and approach is chosen. This in turn has consequences for the economic, social, and political interests of all nations and regions which might either promote or impede the realization of climate justice. Mishandling the issue of uncertainty would in all likelihood hurt developing countries, and the least developed and the most vulnerable ones would be hurt the most. This is why it is absolutely imperative that this issue is treated as a moral matter and a scientific matter.

VII. Key issues of contention in post-Copenhagen climate talks

The objective of post-Copenhagen climate talks is to produce a meaningful sequel to the *Kyoto Protocol*. Whether this objective can be achieved is critically dependant on the degree to which the political will for international cooperation forged during the Copenhagen conference and documented in the *Copenhagen Accord* can be given substance. Desirable action would include resolution of some of the most contentious issues that were debated during the conference. These included, but are not limited to, the long- and mid-term targets for mitigation measures, the balance between mitigation and adaptation, funding, transfer of technology, and implementation mechanisms. The next section looks at each of these in more detail.

1. Capping global temperature increases by 2050

Signatories of the *Copenhagen Accord* agreed to try to reduce emissions so as to cap the increase in global temperature at below 2 degrees Celsius by 2050. The necessity of such a target and how to fix it in a scientifically-sound and practically feasible way continue to be contentious issues. However, there are advantages to handling matters in this way. After all, the very point of reducing carbon emissions is to stabilize the climate. Therefore, unless some kind of target is set, the notion of 'stabilization' does not seem credible. Given global knowledge and collective wherewithal, the choice of 2050 as the time horizon is also appropriate because it allows sufficient time to adjust global strategies and actions. Shorter timeframes would likely imply greater risks for missing the targets altogether.

How to set the target is an inexact science, and this lack of precision reflects both epistemological limitations and the differential social, economic, and political impacts any set of reduction measures would have across the world. While a 2 degrees Celsius cap is more relaxed than a 1.5 degrees cap, both are subject to revision and adjustment. Therefore, it might be more accurate to qualify this target so that it reads 'holding the increase in global temperature below a maximum increase of 2 degrees Celsius.'

Given the current state of human knowledge the temperature increase cap and atmospheric carbon density cap should not be linked together as yet. The relatively weak scientific basis for the very notion of atmospheric carbon density renders it less useful and legally non-binding. It is appropriate that it should have received no mention in the *Framework Convention*.

2. Long-term targets for 2050 and mid-term targets for 2020

Unlike episodic events such as earthquakes and volcanic eruptions, global climate change is a protracted and continuous process. Different timeframes are necessary in designing a response and should have their own targets as a concession to uncertainty and to allow for greater flexibility. Specifically, it should be permissible to revise long-term targets as progress is made towards shorter-term and mid-term targets.

In the current context, the most contentious issue is emission reduction targets relating to links between the long- and the mid-term climate response strategies. Uncertainty and climate justice are two key considerations that must be brought to bear in determining long-term reduction targets. One implication is that the 50 per cent to 80 per cent emission reduction margin is poorly formulated and needs revision. First, the global temperature increase cap (1.5 to 2 degrees Celsius), makes 5 per cent appear redundant. Second, 80 per cent against 1990 levels should not define the upper limit of reduction emissions, but should rather be the minimum. The principle of equality in per capita carbon emission rights and the temperature increase cap, ought to permit upward adjustment. Thirdly, non-Annex I parties should also be subject to some kind of aggregate carbon emission restriction. In summary, then, the revision of the '50 per cent to 80 per cent emission reduction' requirement would become 'to hold the increase in global temperature below a maximum of 2 degrees Celsius and to achieve carbon emission equality among all persons, Annex I parties must reduce their carbon emission to at least 80 per cent of the 1990 level and non-Annex I parties ought to commit to doing whatever they are able towards the same goal.'

Annex I parties have agreed to an incremental increase in mid-term reduction targets (from 20 per cent, to 30 per cent and then even to 40 per cent) but non-Annex I parties demand that they reduce their emissions by 40-50 per cent. Annex I parties are capable of meeting the more stringent requirements but are unwilling to do so.

How should Annex I parties determine the right amount of emissions reductions to aim for (or in other words, how should this be determined)? There are three factors to consider here. The first is capability. EU countries and the US have already agreed to reduce their aggregate carbon emissions to 80 per cent of the 1990 level by 2050. If a constant annual reduction rate is assumed, it is entirely possible to reduce it by 30 per cent of the 1990 level by 2020. This is not an unreasonable mid-term target for them. The second consideration is the economic impact of emission reduction measures on these countries. EU countries, the USA, Japan, Australia and Canada already treat the construction of infrastructure for a low-carbon economy as a new national economic development strategy, and an engine of growth. Within this context, emission reductions would not be an economic burden, but a great economic opportunity. According to the general pattern, a period of intense innovation is followed by large-scale application of the innovations. The period to be covered by further commitments beyond the *Kyoto Protocol* would coincide with such a period of widespread application and implementation of low-carbon, clean technologies now under research, development and testing. This should yield considerable emission reductions during

the same period. In fact, reduction rates during this period may surpass those for subsequent time periods, since the 30 per cent emission reduction target mentioned earlier is based on an assumption of constant annual reductions and may prove conservative.

The third factor on which the mid-term reduction target for Annex I parties depends is the global carbon market. On the whole, developing countries welcome the idea of low-carbon transformation in the developed economies. This transformation would facilitate global carbon emissions reductions. From an economic point of view, a highly developed and technologically advanced low-carbon economy in the developed countries would create obvious benefits for developing countries as it not only promotes the transfer of clean technologies at relatively low costs, but also opens up the market for green products.

The conclusion to be drawn from this analysis is that it is not only conservative for developed countries – Annex I parties – to set their mid-term reduction target at only 20 per cent, it is wrong for them to do so. It increases antagonism between developed and developing countries. Even increasing the figure to 30 per cent would be far from excessive. Indeed, if developed countries are to truly lead the world in emission reduction efforts, a mid-term target of 35 per cent reduction against 1990 levels would be quite appropriate, and 40 per cent would strongly welcomed by developing countries.

3. Balancing mitigation and adaptation

Both the *Framework Convention* (section 4) and the *Kyoto Protocol* (section 10) stress the importance of adaptation, but mitigation continues to be the main focus of IPCC negotiations, at the expense of discussions about adaptation (IPCC, 2007b). In post-Copenhagen talks, this need to change and the relative weight of mitigation measures and adaptation actions must be revised.

If global warming is thought of as an unknown probability, but large impact event, then mitigation and adaption should be accorded equal importance. The failure to date to meet emission reduction targets – which are constitutive of the mitigation-focused approach – set for developed countries, provides ample reason to begin to shift overall response strategies. As developed countries continue to be subjected to aggressive emission reduction requirements, it is also necessary to allow developing countries to evolve suitable adaptation mechanisms. Specifically, cooperation between developed and developing countries, and aid from the former to the latter, ought to focus on the following areas: adaptation measures necessary for ensuring the existential security of the least developed countries and small island developing states; adaptation projects necessary for protecting and preserving the most ecologically vulnerable areas – such as the Yangtze River Delta, coastal drainage basins and drainage lakes – in developing countries; and general purpose adaptation projects in developing countries, such as those for combating drought, floods and other natural disasters. A range of approaches can be used for designing and implementing these measures, including geo-engineering, migration and cross-border emigration. Developing countries should be given whatever support is necessary as they pursue these options. In addition, it is important for these adaptation actions to be designed and executed to complement mitigation measures or the overarching goal of sustainable development. This point has been well articulated in AR WG 3 2007 (IPCC, 2007b).

4. Funding: sources and allocation

Adequate and timely availability of financial resources is critical for effective response measures to climate change. Climate justice calls for allocative fairness.

Indeed, the financing of mitigation and adaptation measures is another area in which the issue of historical responsibility is of critical importance. However, IPCC has not yet been able to achieve the specificity on funding structures and mechanisms that it has been able to set for emission reduction targets. It has not been very specific about how much is needed for what, where the money will come from, and what allocative principles will apply. This situation cannot continue. Three areas of concern deserve special mention here.

First, with respect to the issue of fund-raising targets, Stern (2006) suggests making 1 per cent of GDP available to cover climate change response-related expenditure. The second issue relates to differential contributions toward this amount. All the money to be used for responding to climate change should not be treated in the same way. For this discussion, a distinction can be made between three types of funds: namely, compensation, assistance, and capital investment funds. The first is to be paid by countries that have been historically responsible for atmospheric carbon accumulation to countries that are now bearing the brunt of the adverse ecological and social consequences of global warming. This is not only mandatory, both morally and legally, but its size ought to reflect the inappropriateness of past actions and current economic capabilities and financial wherewithal.

The second category is voluntary aid from developed countries to developing countries. Its size is dependent on the donor's own understanding of the various issues involved and the intensity of its desire to help. Capital investment is meant to support businesses involved in the response to climate change. Its size will depend on the specific needs of the business and also on their performance in corporate governance and social responsibility.

Among the three types of funds, compensation is the largest and the most important. Its burden should be shared according to the principle of equality of carbon emission rights. It is imperative that a calculation method is established that is scientifically, economically, and morally sound.

The importance of fund allocation cannot be overstated, as it has yet to be adequately addressed by the IPCC. Both equity and efficiency require different types of funds to be allocated according to different principles. It would not be appropriate, for example, for those who pay into compensation funds to decide how the money is divided among intended recipients. Instead, IPCC should set up a special committee whose sole mission is to make those decisions. In the case of voluntary aid, donors should have some discretion in deciding where their money goes, but should still consult with an IPCC special committee. Investors should also be able to decide on their own where and how much to invest, but not without some input from outside parties.

How these two issues of sourcing and allocation of funding for climate change response measures are addressed will define the new international economic landscape of the post-Copenhagen era.

5. Transfer of Technology

This is an issue that has been nominally important in each round of IPCC negotiations but has not been effectively resolved. As early as *Agenda 21*, the issue of 'technical cooperation for facilitating capacity-building at the country level' was brought up (UN, 1992). However, it still remains an open question just what kind of technology would qualify. Must it be the case that only technologies used in providing public goods and services are included? And must they be made freely available to all who need it? The intractability of these questions has become a major obstacle to technology transfer from developed to developing countries.

Currently, decisions are often made on an *ad hoc* basis according to the needs of individual projects. When it is designated as 'for free', this just refers to the transfer having been financed by the source country, sometimes in conjunction with international organizations. A still larger portion of transfers is funded through CDM market mechanisms.

The significance of technology transfer in international cooperation for mitigation and adaptation should not be underestimated, and it is incumbent upon those participating in climate talks beyond Copenhagen to make certain that clear and operable guidelines are formulated in this area. These guidelines must specify, among other things, how responsibilities are to be divided up among governments and business, and between source and recipient countries; and what type of technology should be transferred by what mechanism (with the choice between market and non-market methods). The achievement of this would have historic importance.

6. Operating mechanisms

The operating mechanism is both the key and a sticking point for future climate talks. A sequel to the *Kyoto Protocol* must more than improve on the current three mechanisms by which the treaty is implemented, namely, Joint Implementation (JI), Emissions Trading (ET), and the Clean Development Mechanism (CDM).[2] It must also offer innovations. Even as it is acknowledged that effective and efficient operating mechanisms will be heavily reliant on the market system, it is necessary to be sensitive to finer distinctions between market and non-market mechanisms, between market and proto-market mechanisms, and between all these and mixed mechanisms that feature some organic combination of both command mechanisms and the market. It should be demanded that these mechanisms are consistent with the principles of 'efficiency, mutual benefit and the right to development' and of climate justice. In fact, this topic is already the subject of active debate in current international climate discourse. For example, the notion of 'sectoral crediting' that has been used by the EU, proposals by the Harvard Project on International Climate Agreements, and those formulated by researchers in Sweden and Germany on the basis of the idea of 'equality in carbon emission rights' have all been put forth expressly to address this very subject. Two new points of view from which the issue might be considered can also be put forward.

The first is a credit trading system for carbon emissions based on the notion of equality of cumulative per capita carbon emission rights. This would entail using 1990 as the base year and calculating the per capita allowance of cumulative carbon emissions for all countries. This could then be fine tuned in accordance with the actual results of the implementation of JI, ET and CDM as specified in the *Kyoto Protocol*. A carbon emission account for each country would then emerge. This account would show amounts of credit, withdrawals, and emission balances. Starting in 2013, countries that have overdrawn their allowance would need to buy emission credits from other countries in order to continue to be able to emit more carbon into the atmosphere. The execution of this scheme would rely on the market to some degree depending on circumstances.

The second suggestion is for an integrated accountability system for mitigation and adaptation. Annex I parties ought to shoulder most of the burden of emission reductions and to assist non-Annex I parties in their efforts to adapt to a warmer earth. But practical constraints may well prevent any particular country from discharging both obligations simultaneously or equally satisfactorily. Indeed, developed countries are especially wont to fall short on their international obligations to reduce emissions. One remedy for this is simply to demand that these countries do more in other respects to make up for where they have fallen short. As a corollary, developed countries that exceed their emission reduction targets ought to be allowed to adjust their other international obligations downward accordingly.

Finally, this paper ends with some thoughts on 'carbon tariffs'. This concept was first introduced by scholars in Europe and the US to strengthen the competitiveness of developing countries in an international carbon market. However, such a system would seriously upset the economic relations between developed and developing countries, and could have adverse overall impacts on international trade. The reasons are not hard to see. Firstly, developing countries should not carry the bulk of the burden for global reduction in carbon emissions. They ought not to be penalized if they refuse to take on this responsibility. Secondly, differences in economic structures between developed and developing countries should imply that what each produces is not mutually substitutable. As such, developed countries stand to gain little from a penalization system. There are, in other words, no good reasons for the imposition of a carbon tariff.

1 These include Singapore, South Korea, and Mexico.

2 In theory, JI, ET and CDM as articulated in the Kyoto Protocol will continue to be effective. Of course, some changes in the way they are operationalized will be in order. For example, so far as CDM is concerned, since some developing countries will take mitigation measures, their BaU business as usual level will need to be adjusted. Here BaUThis represents the anthropogenic GHG emissions that would occur in the absence of the proposed activity and continue current trends in population, economy, technology and human behavior.

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Part Two
Case studies

8
A New Approach to Conservation in Western China

Shen Xiaoli, Li Shengzhi, Lu Zhi

中国西部自然保护的新探索

Western China harbours unique and internationally important biodiversity. The mountains of southwest China in particular are an especially rich biodiversity hotspot. This region is also the source of several major rivers, making conservation of the biodiversity and ecosystems in this area crucial to China and its Southeast Asian neighbours. As a result, many nature reserves have been established in western China in recent years. However, due to insufficient investment and human resources, these nature reserves do not function effectively. They fail to protect this vast landscape. Western China is primarily inhabited by ethnic minority groups. The minority cultures are rich in knowledge about conservation and the sustainable utilization of resources. A system of sacred mountains and lakes in Tibet is a prominent example of this type of cultural tradition. This chapter is based on in-depth field research examining the management systems used for sacred lands. The research found that sacred lands are widely distributed, cover large areas, and are managed through extensive local participation. Protection of sacred lands can therefore offer lessons for conservation of nature reserves. Linking traditional conservation with current nature reserve management presents an effective strategy to promote regional conservation in western China.

I. A new model is needed for nature reserve management in western China

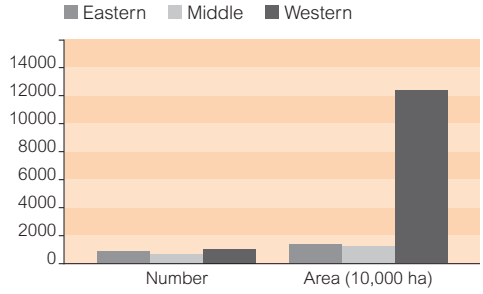
Conserving the biodiversity and ecosystems of western China has strategic global significance. In addition to highly diverse wild plants and animals, six major international rivers originate from this area, affecting over 3 billion people in China and in South Asia. For this reason, western China is sometimes known as the 'water tower of the world'.

Consequently, over the last century, and particularly in the new millennium, the Chinese government has established a large number of nature reserves in western China aimed at biodiversity and ecosystem conservation. It has taken only ten years for the number of nature reserves in western China to equal the total number of nature reserves in eastern and middle China combined. Areas designated as nature reserves in the west of the country, now amount to three quarters of all the nature reserves in China by area.

Although the concept of 'co-management' has been growing in importance, nature reserves in China, especially those established some time ago, manage their resources independently. Not only does this mean less transparency, but it also poses a great financial and efficiency challenge, as funding for daily management activities, such as monitoring and patrolling, are sorely lacking. Before 2000, cumulative infrastructural investment in the entire national nature reserve system, under the management of the Forestry Department Administration, was only RMB 3.6 billion (US$ 547 million), most of which was distributed to a few national panda reserves. Annual total investment in daily management activities by the state is less than RMB 2 billion (US$ 304 million), about US$52.70 per km^2. This represents one of the lowest levels of government investment internationally, even among developing countries (Chen, 2005). To further compound the problem for western nature reserves, funding for daily management is most often the responsibility of local governments, which have limited fiscal capacity, meaning that nature reserves in the region receive lower relative amounts of investment than in coastal and central China. It is unlikely that the issue of funding will be resolved in the near future. As an alternative solution, a new and more efficient conservation and management model, which can survive on low levels of funding, should be developed for nature reserves in western China.

Western reserves are very different from their eastern and central counterparts in terms of both geological conditions and conservation objectives. Compared with those in the west, reserves in eastern and central China have steeper topographies, more forest ecosystems, and smaller areas

Figure 1 Regional distribution of Chinese nature reserves in 2004



Source: Chen, 2005

for animal habitats. Reserves in western China, in contrast, are expansive and flat, offering large areas of open land for wildlife. This is particularly important for species that make long yearly migrations. Because of these rather significant differences in physical characteristics, it has proved to be largely ineffective to adopt the same management model in the west as that used for reserves in eastern and central China.

Further differences reinforce the need for a different management model in western Chinese nature reserves. For example, in eastern and central China, communities living around nature reserves are more economically developed, meaning that threats to nature reserves generally come from the surrounding communities. On the other hand, in western China, especially in minority areas, many people still live harmoniously with nature for traditional and religious reasons. As a consequence, communities in western China are more supportive of conservation, and it is often communities that are enforcing conservation efforts.

Most nature reserves in western China were established in the late 1990s. They adopted the same management model as reserves in eastern and central China. Given the differences in topography, financial support per unit of land area, and management knowledge, this turned out to be a disastrous approach, which did not result in efficient management of western parks. For example, despite large land areas - some parks cover hundreds of thousands of square kilometres - and more rugged natural conditions, some western reserves still copied the eastern and central 'intensive management' model, focusing their time and money on small-scale habitat restoration activities, such as tree planting and enclosure. They almost entirely overlooked the need for integrative conservation. Adopting these kinds of management strategies, combined with insufficient investment, drastically undermined the ability of western reserves to function, and many ultimately became so-called 'paper parks'.

The indigenous cultures of minority groups in the west of China are rich in knowledge and practices that contribute to conservation and sustainable utilization of natural resources. Preserving sacred mountains and lakes in Tibet is one of these cultural practices, which is why today most of the biodiversity in the region occurs in and around sacred Tibetan mountains and lakes (Lu, 2006). Conservation-based resource management thus fits naturally with local traditions and social structures. For successful management in this region, it is imperative to understand local cultural traditions and not to simply make management decisions based on reserve management in other parts of China.

The Tibetan practice of maintaining 'sacred mountains and lakes' does not completely exclude human utilization, but works to harmonize conservation objectives and the needs of local people. As a system already practiced and enforced by local communities, it has the capacity to manage large areas of land at little cost, with high efficiency, and maximum conservation sustainability.

Also, as a system that balances the demands of development and conservation, it delivers both economic development and environmental protection. This kind of biodiversity conservation system is also in-line with cutting-edge international thinking on 'landscape conservation' and sustainable development. In a way, the Tibetan 'sacred mountains and lakes' tradition is both an ancient and modern nature conservation model.

The US-based NGO, Conservation International (CI) works to conserve biodiversity in southwest China. Since 2003, CI has worked with the Centre for Conservation Biology at Peking University on the 'Sacred Mountains and Lakes' project. The most distinct feature of the project is the use of a multidisciplinary approach to understand traditional Tibetan conservation models. The project works to integrate these traditional conservation approaches with formal systems of management, concretely linking traditional conservation with modern management of nature reserves.

II. Survey investigation

This section describes ongoing research investigations focusing on the traditional 'sacred mountains and lakes' conservation model. This research has been conducted since 2004 in Yushu prefecture in Qinghai province and Garzê prefecture (Ganzi in Chinese) in Sichuan province. Several sites in Deqing prefecture in Yunnan province and in Changdu District in Tibet were also visited. Research methodologies were mainly designed by the Centre for Conservation Biology. Biological approaches were combined with other methodologies from other disciplines such as anthropology and Tibetan studies. The survey was carried out by local government staff and people from two NGOs: Green Kham in Garzê and the Great Land Snow River in Yushu; together with experts and graduate students from Peking University, Sichuan Academy of Social Sciences, and Sichuan Forest Inventory and Planning Institute, among others. In effect, a research network was built among research agencies, government, NGOs and communities. This has created a space for stakeholders to share their knowledge and gain a deeper understanding of traditional Tibetan conservation practices.

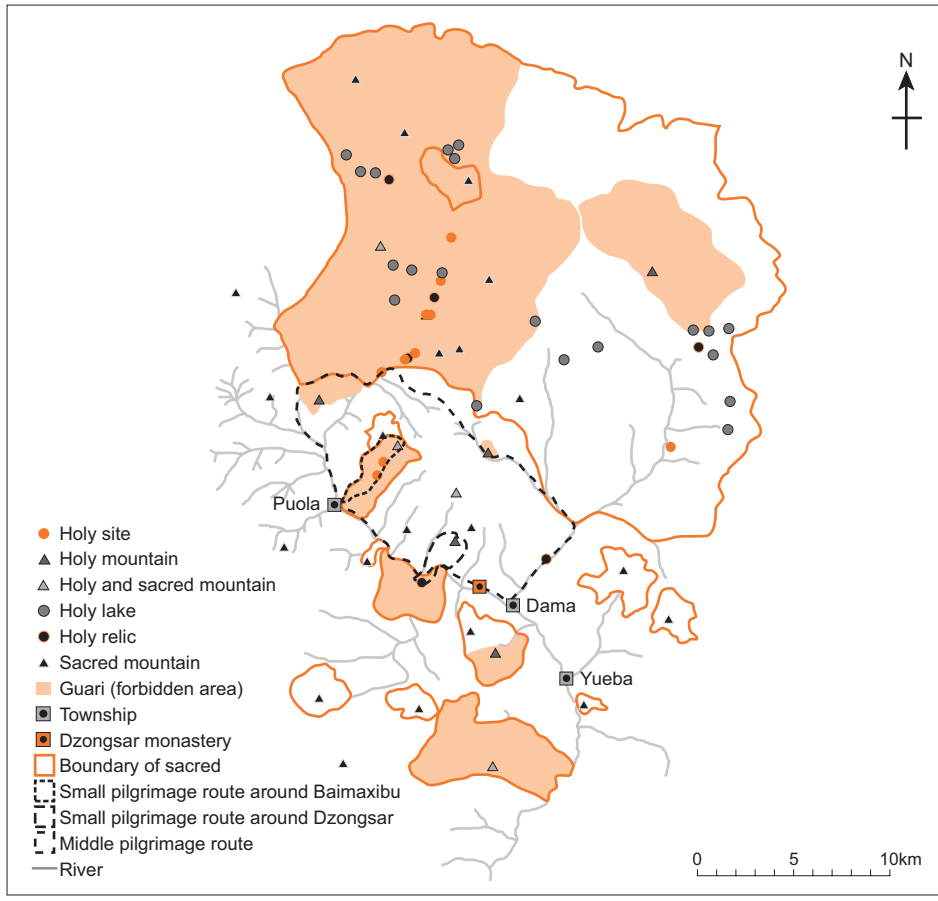
III. Key findings

1. In spite of being a seemingly abstract religious or cultural category, sacred lands do have distinct demarcations, and it is possible to map their locations and boundaries reasonably accurately.

By conducting participatory assessments, the investigation found that both local monasteries and communities can describe the specific location and boundaries of sacred lands. Around 62 per cent (136 of a total of 219) of sacred mountain boundaries surveyed have now been mapped using GIS technologies. As a result, the total area covered by sacred mountains and lakes can be calculated and biodiversity and ecological values can be assessed.

Sacred lands in Tibet have various forms. For example at Dzongsar Monastery in Derge County (Dege in Chinese), sacred lands can be divided into several categories according to their religious origins[1]: sacred mountains, holy lakes, forbidden areas (*gua ri* in Chinese), holy sites, holy relics and pilgrimage routes (Figure 2). When sacred mountains and lakes, and forbidden-areas are referred to it generally means large land masses that contribute to ecosystems on a landscape scale. Forbidden areas are the most strictly protected of all the area types. There are very strict taboos about usage for these areas. In the case of Dzongsar, there are three kinds of pilgrimage routes around the monastery, delineated as large, medium, and small.

Figure 2 Sacred lands around Dzongsar Monastery

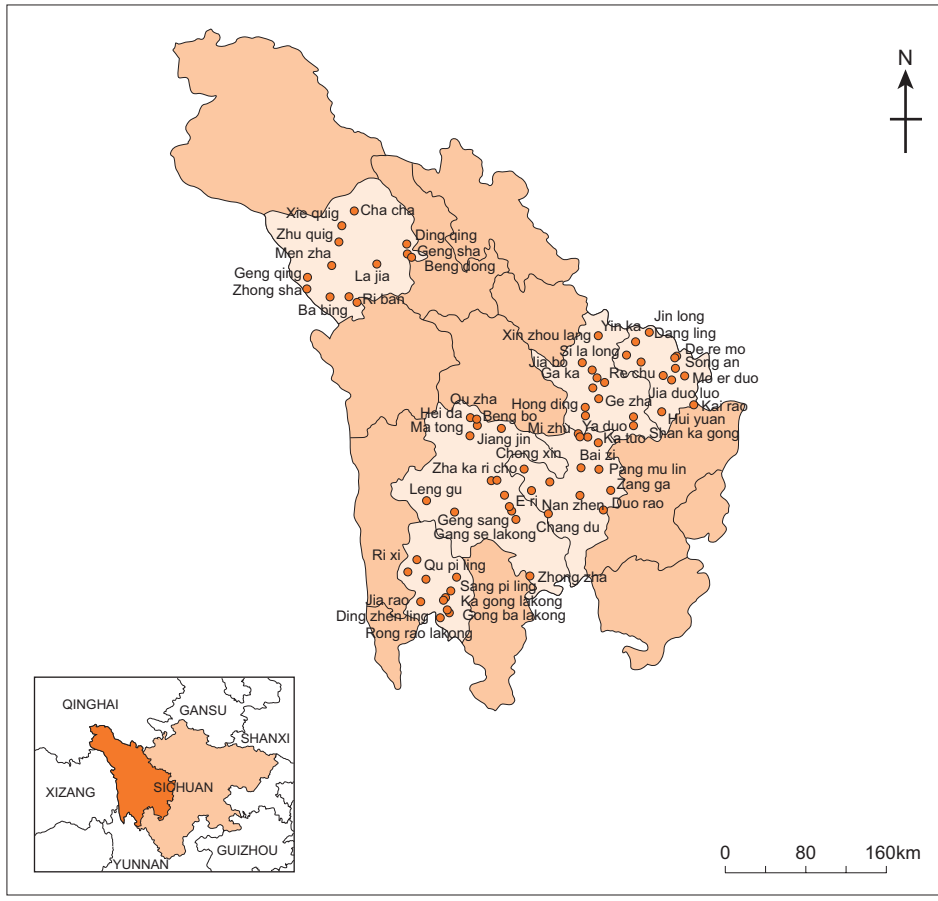


2. Sacred lands are widely distributed throughout Tibetan areas

Recognizing that monasteries play a leading role in cultural continuity in Tibetan society, the research team primarily selected monasteries as bases for interviews. Seventy-nine monasteries in 11 counties were visited in Sichuan and Qinghai provinces. Two hundred and nineteen sacred mountains and 39 sacred lakes were recorded. Seventy-four monasteries were visited in the 6 counties in Garzê Prefecture: Derge, Danba, Daofu, Yajiang, Litang and Xiangcheng, representing 14 per cent of the total monasteries in Garzê. In addition, 136 sacred mountains and 23 sacred lakes were mapped topographically. The total area of sacred mountains in the regions surveyed was 383,780 hectares, with each mountain covering on average over 2800 hectares.

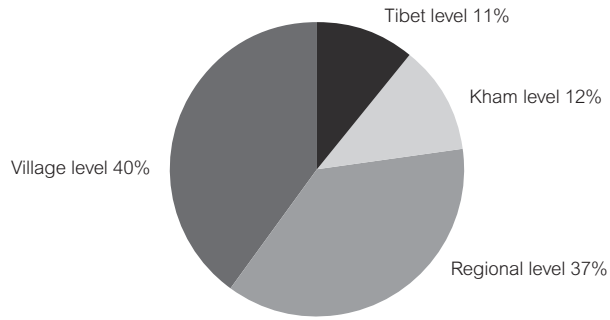
A common misperception is that, like Kong Rinpoche and Kawaboge, most Tibetan sacred mountains are snow-covered mountains with limited biodiversity. This is largely a result of the media, who prefer to focus on mountains with visually appealing clouds and sweeping views. In actuality, except for a few famous mountains, most Tibetan sacred mountains are worshipped locally by a very small group of people. Each Tibetan village has its own sacred mountain. To the community, the wellbeing of the mountain is tied to the wellbeing of the village, and there is a special ceremony each year to worship mountain deities. The more famous the sacred mountain is, the more people it attracts for veneration.

Figure 3 Monasteries surveyed in Garzê prefecture, Sichuan province



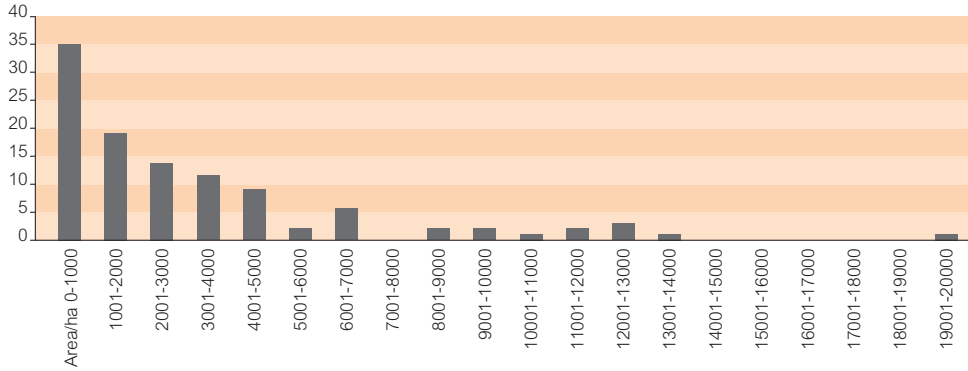
The research team classified sacred mountains according to the physical origin of the people who worship on any given mountain. Four categories were identified: village level, regional level, Kham (state level) level, and Tibetan regional level. As expected, the sacredness of a mountain is inversely proportional to the number of mountains of that type. For example, there are many village level sacred mountains, and very few pan-Tibetan level sacred mountains.

Figure 4 Four categories of sacred mountains shown by percentage of total



Compared to other forms of sacred land, Tibetan sacred mountains are characterized by large land areas. In India, for instance, the average area of a sacred grove is 9.6 hectares (Malhotra et al., 2001), while the area of the sacred mountains surveyed for this research was anywhere from 24 hectares to 10,000 hectares. Around half of all sacred mountains cover areas of more than 2000 hectares. The largest sacred mountain covers an area of 19,000 hectares, which is equal to the area of a nature reserve. Although not included in this survey, it is known that some of the more famous Tibetan sacred mountains are even larger. This is positive from a conservation perspective, as large land areas can bear more complex and diverse ecosystems and are more stable than smaller land areas.

Figure 5 Distribution of sacred mountains by area
(y = Number of sacred mountains)



A more prominent sacred mountain usually has a larger land area, while the area for a village level sacred mountain is generally smaller than that for the other three levels of sacred mountain. There is also often a relationship between the care of a sacred mountain and its prominence, or how many people it attracts for worship. Sacred mountains that belong to a few or more villages are more often exposed to external damage. However, for sacred mountains at the village level, worshiped by only few villages (or even only one), the duty of protection is clear and management within communities is relatively easy. Thus, village level conservation is often more effective than protection efforts for more sacred mountains. This relationship between protection effectiveness and the level of sacredness of a mountains remains to be further studied.

The survey sampling done in Garzê was large enough to determine the quantity and size distribution characteristics of sacred mountains in that region. It is estimated that there are about 1,400 sacred mountains in Garzê, and sacred lands cover an area of about 5,104,000 hectares, occupying 33% of the prefecture's total land area (which is 15,300,200 hectares).

Nature reserves in Garzê cover an area of about 3,700,000 hectares. The area for sacred mountains exceeds the area covered by nature reserves (although this does not account for the overlap between the two). Due to religious beliefs, local people have insisted on limited development and resource use on sacred lands. When nature reserves were established in Garzê, mostly after 1995, most of them were placed on sacred mountains and lakes, with some nature reserves even adopting traditional sacred names, such as Kasa Lake Provincial Nature Reserve, Gongga Mountain National Nature Reserve, Yading National Nature Reserve, and Chaqingsuoduo National Nature Reserve. Before nature reserves were established, it was the traditional management practices associated with sacred mountains and lakes that had historically protected natural resources. Even during the large scale commercial logging campaigns in the last century, some areas survived because of their sacred status. Furthermore, during and after the Cultural Revolution, many wild animals disappeared because of mass hunting. It was around monasteries and on sacred lands where many of these wild animals first began to reappear.

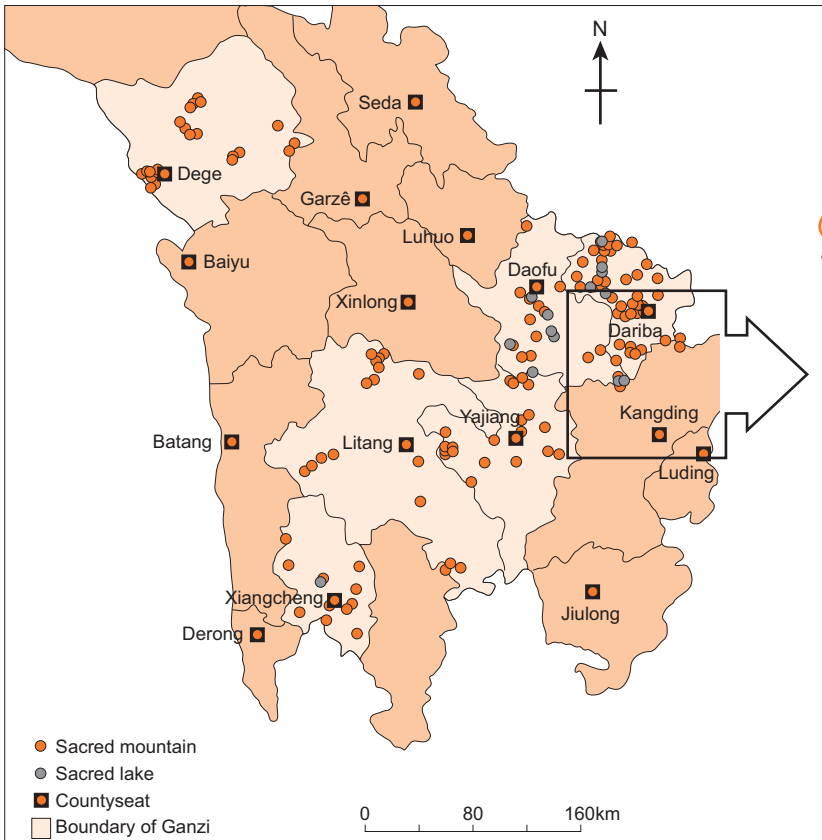


Figure 6 Sacred mountains and lakes recorded in six counties in Garzê

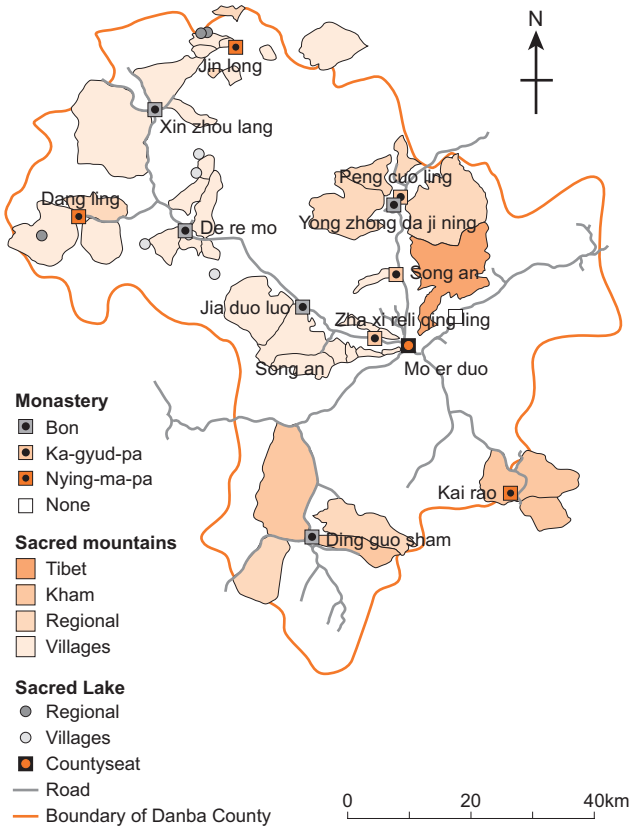


Figure 7 Sacred mountains and lakes recorded in Garzê county (within Garzê prefecture)

3. Sacred mountains and lakes are often effectively protected by local communities

From a conservation perspective, management of sacred lands is a traditional form of management that relies on religious taboos and ancient knowledge to restrict development. This specific type of management is characterized by religious beliefs, moral restrictions, village regulations and community participation.

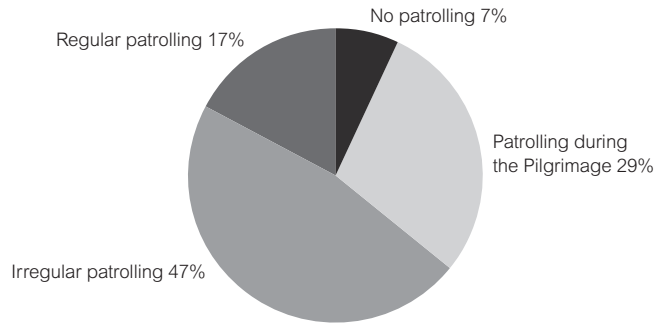
In Tibet, sacred mountains have a profound influence over communities. The wellbeing of the sacred mountain is directly tied to the interests of local people, and they believe that once a sacred mountain is destroyed, regardless of the origins of the damage, their lives will be affected. Tibetans believe that destruction of sacred lands will result in more sheep being taken by wolves and an increase in farm pests, floods, hail, and other natural disasters. Thus, the well-being of the sacred mountain and the community is linked, providing a strong incentive for the community to protect the sacred lands.

The traditional culture of sacred lands is passed on from generation to generation in two main ways. One is through folk stories. The other is through lessons and rituals organized by the monastery. The monastery usually plays a leading role in establishing and maintaining folk regulations.

Most monasteries take action to protect sacred lands based on traditional protection beliefs as their management capabilities increase. Lamas educate villagers in how to appreciate sacred lands. 70 per cent of monasteries assign specific people to organize protection measures, and 94 per cent of monasteries organize patrols around sacred lands, although the reach and frequency of patrols varies widely and depends on the level of conservation awareness and the monastery's capacity. Patrolling can be divided into three categories: patrolling during annual pilgrimages, irregular patrolling, and regular patrolling.

1 Patrolling during annual pilgrimages
   During the annual ritual to worship mountain deities people travel around sacred mountains. Although not patrolling in the traditional sense, this pilgrimage, to a certain extent, serves a patrolling function, as it can lead to detection of hunters and poachers, and identification of their hiding places.
2 Irregular patrolling
   Monasteries generally do not have strong formal patrolling organizations or management systems. Lamas voluntarily go to the mountain in their spare time to check for hunting snares and illegal logging. In some cases, lamas and villagers will monitor places that attract hunters, although this kind of patrolling is passive and not a long-term, systematic management behaviour.
3 Regular patrolling
   Specific persons, lamas or villagers, are sometimes assigned by the monastery to patrol sacred land. The number of people, lengths and frequencies, and patrolling routes are all fixed. Some monasteries even offer payment. This kind of patrolling is well organized and can be an effective way to prevent and stop hunting and illegal logging.

Figure 8 Patrolling status for surveyed monasteries by percentage



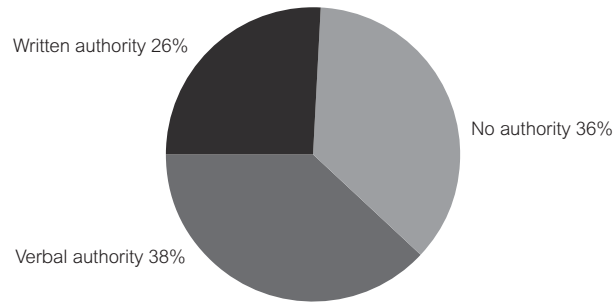
Monastery patrolling is very different from that employed in nature reserves. Villagers act as an early-warning system, and traditional community-based conservation is effective in managing internal threats from the Tibetan community. However, the mechanism's effectiveness is diminishing as more threats arise from outside of communities, such as mining, dam-building, road construction, and hunting by incoming groups. The need for community patrolling has become a part of daily existence. Unlike patrolling done by nature reserves, hunters are not pursued because they may be hunting endangered or illegal species, but because of the Buddhist belief that no creature should be hunted or harmed. This is why conflict around fishing rights has also become a common problem in Tibet.

4. Some monasteries have officially participated in conservation with authorization from local governments.

According to the monasteries interviewed, 38 per cent have verbal authorization and 26 per cent have written authorization to engage in conservation. This comes from local governments - mainly from County Forest Department Bureaus.

Most of the commissions the monasteries referred to were fire prevention contracts signed with local Forest Department Bureaus. However, there are four places where local governments formally acknowledged that sacred mountains and lakes were under the management of monasteries. These were Dzongsar Monastery in Dege County, Zeri Monastery in Shiqu County, Rili Monastery in Zaduo County and Ga'er Monastery in Nangqian County. However, despite some official recognition, governments have never given enforcement power to community conservation efforts. According to the communities interviewed, most illegal loggers and poachers are migrants, and communities are not authorized to legally apprehend them. Thus, the main source of conflict in relation to conservation of Tibetan sacred lands results from the fact that traditional common property management institutions are not legally empowered by local governments through appropriate policies and laws.

Figure 9 Authority status for management of sacred lands for surveyed monasteries



5. The management model used for sacred mountains and lakes is similar to the zoning management system used by nature reserves

Based on religious practices, the vast areas surrounding monasteries can be separated into three major categories: forbidden areas, sacred mountains and lakes, and areas of general influence. Each type of area has unique guidelines regarding resource utilization. In some parts, there are no restrictions, some parts allow resource use to a certain extent, and in some areas no utilization is permitted.

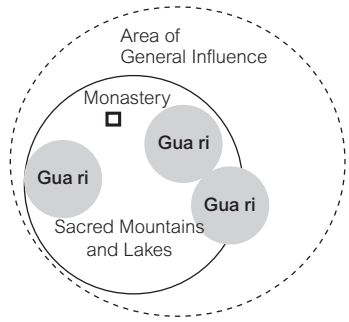
Gua ri/Forbidden areas:
Forbidden areas have important religious significance designated by rituals and history. There are different taboos in different forbidden areas. Some forbidden areas do not permit any kind of use or changes to be made to the area. Others, however, may permit things like seasonal livestock grazing.

Sacred mountains and lakes:
Generally, hunting, logging, farming and any other kind of exploitative activity is forbidden on sacred mountains. Fishing and activity that could result in pollution of sacred lakes is also forbidden. However, livestock grazing and collection of forest products is often allowed on sacred mountains.

Areas of general influence:
This is the area where people from the community in which the monastery is located live. Historically this area was managed by the monastery. In essence, the monastery plays an important role in educating and guiding villager activity. In these areas, there are no taboos on resource use, as long as people follow ahimsa, that is the Buddhist principle of non-violence.

Sacred areas with well defined religious boundaries are generally firmly respected by most communities. As a result of differences in 'zoning', different areas are associated with different levels of protection effectiveness. Over the centuries people lived harmoniously with nature. Villagers believe that hunting animals on sacred mountains or destroying sacred mountains will displease mountain deities and result in outbreaks of disease and disasters. Land surveys suggest that Tibetans chose the most valuable ecosystems to designate as sacred areas. This, and the use of zoning management, has protected the functionality of key ecosystems, ensuring that villagers' basic needs for resources are not affected by the protection of sacred lands. In other words, this system harmonizes the relationship between humans and nature, resulting in truly sustainable communities.

Figure 10 Zoning system around the monastery



As noted above, the zoning system used around monasteries is similar to that used by nature reserves. Forbidden areas, sacred mountains and lakes, and areas of general influence are equivalent to core areas, buffer areas, and experimental areas, terms used in conservation discourse. Nature reserves use the same strategies as traditional resource management, identifying important areas of biodiversity and protecting them by limiting human activity in those areas.

6. Traditional cultural integrity is positively correlated with richness of biodiversity

Rapid ornithological assessments were conducted at four sites: Dingguoshan Monastery in Danba County, Tonglin Village in Kangding County, Middle Decha Village, and Pamulin Monastery in Yajiang County. A four-day survey was conducted at each site to determine the status of bird resources, and 15 villagers were interviewed at each site to assess the state of the traditional culture.

The results of these avian fauna assessments are outlined in Table 1. A higher Shannon-Wiener Index indicates richer biodiversity. A higher Equability Index means the bird community is more stable and less disturbed. Relative bird diversity for the four sites was determined to be as follows: Decha, Pamulin>Dingguoshan>Tonglin. In this case, biodiversity is positively correlated with elevation.

Table 1 Avian biodiversity at the four survey sites

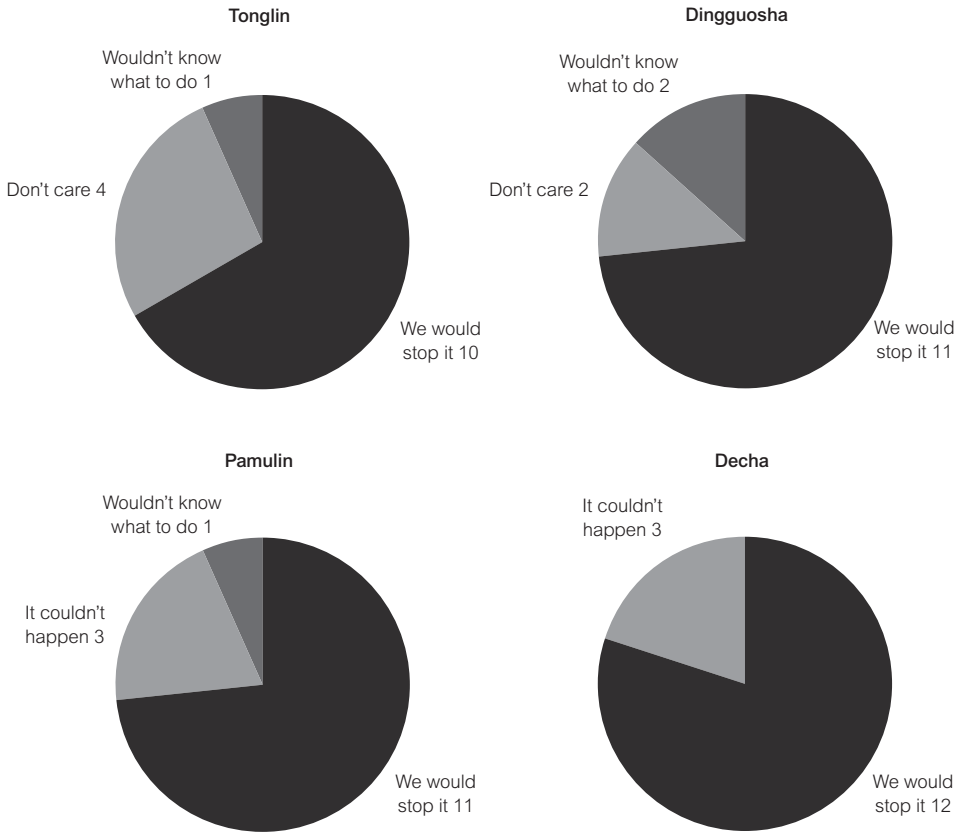
Site	Elevation Range (m)	No. of bird species	Shannon-Wiener Index	Equability Index
Decha	3280-4200	70	3.53	0.83
Pamulin	3000-4000	69	3.54	0.84
Dingguoshan	2900-4200	57	3.42	0.85
Tonglin	2300-3100	51	3.02	0.77

The interviews covered four areas: the state of traditional culture, conservation consciousness, conservation activities, and conservation capacities. The state of traditional culture is reflected in adherence to a traditional lifestyle, including whether the villagers invite the Living Buddha to name their children, wear amulets, have a sutra hall in their home, offer smoke offerings on auspicious days, and recite the basic sutras.

The survey results of conservation activities and conservation consciousness were similar. Patrolling is organized by monasteries at all sites except for Tonglin. Villager participation at each site was different, as determined by the number of people who knew there was patrolling organized by monasteries and the number of people who took part in patrolling. At Decha, Pamulin and Dingguoshan, the proportion of villagers who were aware of monastery-organized patrolling were 100 per cent, 80 per cent and 13 per cent respectively, and the proportion of villagers who had taken part in patrolling at some point were 73 per cent, 20 per cent and zero respectively.

Villager conservation consciousness at Decha and Pamulin was much higher than at Dingguoshan and Tonglin. When asked what they would do if they encountered people hunting or logging on the sacred mountains, there were three villagers each at Decha and Pamulin who answered that such things could not happen because there had been no hunting or logging on the sacred mountains for a very long time. At Tonglin and Dingguoshan, there were four and two villagers respectively who answered that they did not care about this kind of activity.

Figure 11 Responses of fifteen villagers at each site to the question: 'What would you do if you encountered logging or hunting on the sacred mountains?'



The preliminary results show that the integrity of traditional culture positively correlates with biodiversity. Where respect for traditional cultural practices was lower, biodiversity was also in decline, and vice versa. At the four survey sites, where traditional culture was stronger there were greater protection efforts and more local participation, which produced more effective conservation. Thus, because protecting the sacred mountain is a major part of traditional culture, places where communities are more traditional have richer biodiversity.

The protection of sacred mountains and lakes is a typical form of community-based conservation. Community Conserved Areas (CCA) are now officially recognized and certified by many countries worldwide and are receiving more and more attention. In 1992, the Convention on Biological Diversity agreed that community knowledge, technology, innovation and practices related to biological diversity should be emphasized in conservation. UNESCO issued the Universal Declaration on Cultural Diversity in 2001, which called for cooperation between modern technology and folk and traditional knowledge systems, and CCA is one of the sixth types of conservation area recognized by IUCN. Added to this, the Durban Accord, during the 5th World Parks Congress in 2003, announced:

> "The establishment of protected areas is the result of conscious choices of human societies to conserve nature, biodiversity and areas of special cultural value and significance. Individuals and communities often use protected areas for spiritual reasons, because they inspire and heal them and/or provide them with a place for peace, education and communion with the natural world...
>
> Protected areas serve as fundamental tools for conservation of nature, and thus are an expression of the highest desires and commitments of humankind for the preservation of life on the planet, and that as such, those areas constitute places of deep reverence and ethical realization." (IUCN, 2003)

Congress attendees recommended that their governments draw-up and carry out legislation and policy that recognizes the effectiveness of innovative conservation management models, such as 'community conserved areas', involving indigenous or local communities. China is currently drafting new legislation regarding protected areas, which should embody the principles of the Durban Accord.

IV. Conservation incentive agreements: Exploring a new method of conservation

In order to combine the practice of community conservation and China's existing nature reserve management system, as well as connect traditional cultures and scientific conservation, Conservation International (CI) introduced its conservation incentive agreement programme in Sichuan and Qinghai. As a new conservation concept, the conservation incentive agreement aims to transfer obligations for land conservation and resource management to groups with a commitment to protect the natural environment. An incentive agreement does not involve transferring land ownership, and in this way it is similar to the practice of creating operational rights. Conservation incentive agreements can achieve the goal of conservation and establish an incentive mechanism to encourage broad public participation.

Although conservation incentive agreements are a new conservation concept, similar practices have historically existed in China.

For example, around 1980, Danba County in Garzê prefecture, Sichuan province employed a conservation strategy with some of the characteristics of conservation incentive agreements. At that time, the county gave local villages the management rights to national forests that were too remote for the county itself to look after. Forests were managed by the village collective, while the assessment criterion was established by the local forest department. Village collectives did not receive their 'reward' from the forestry department until they passed a yearly forest quality assessment.

The reward consisted of two parts. Firstly, the 'Five-Point Award' (well maintained paths, areas, personnel, and task completion, resulting in a reward), with a standard of 0.1 RMB per *mu*. The village with the least area of forest received RMB 15,000, while villages with the most land could receive anywhere from RMB 50,000 (US$ 7600) to RMB 60,000 (US$ 9100). The second part of the reward was the 'Three No's Award' (no excessive logging, no hunting, and no forest fires). The prize for enforcing the three no's could be an award of anything between RMB 500 (US$ 76) and RMB 5,000 (US$ 760), depending on the area of the forest and the effectiveness of the management. The awards budget came from a logging tax.

There are some basic characteristics of conservation incentive agreements that can be identified from this example, including: the involvement of two parties, a specific region, a time limit, rights and obligations for both parties, and clear objectives and evaluation criteria.

The Cuochi Conservation Incentive Agreement

CI has created a conservation incentive agreement with Cuochi village in Sanjiangyuan Nature Reserve. This nature reserve covers about 150,000 square kilometres, but has only eight employees and two field stations. With such limited resources, it was unrealistic that the reserve could achieve effective conservation in such a vast region. Introducing a conservation incentive agreement became an important means to fulfil the reserve's conservation obligation and encourage local communities in the reserve to engage in conservation. The incentive agreement has inspired local communities to improve the effectiveness of conservation activities.

Cuochi village is located in the core area of Sanjiangyuan nature reserve along the Chuma River and occupies an area of about 2,000 square kilometres. There are two main reasons why local villagers have a strong desire to conserve nature. Firstly, they are concerned with the current degradation of grasslands, which they have relied on for generations as nomads; secondly, they have a cultural respect for creatures and sacred lands. As a result, villagers spontaneously organized a conservation association called Wild Yak Watchers and instituted regular monitoring of the creatures living on their land. In a further effort to protect the habitat of the wild yak, a member of the Association even voluntarily moved out from the wild yak habitat. By their own initiative, each villager also offered some of their own pastureland to help that family to relocate. On the basis of these voluntary actions, with the financial and technical support of CI, Cuochi and the management bureau of the nature reserve signed a formal agreement in September 2006. According to the agreement, Cuochi is authorized to conserve an area within its region. The nature reserve and the local community also set common conservation objectives. The nature reserve is responsible for providing guidance and evaluating the effectiveness of community conservation, and financial support from CI provides an incentive mechanism for the community to meet sustainable development needs.

An official conservation incentive agreement like this is the first of its kind in China, Western China, as discussed, is an ideal area for more of this kind of action. Many nature reserves in western China cover vast regions, with local communities living in core areas. A common problem is insufficient investment, and lack of capacity to manage such large areas of land. As a result, there is a discrepancy between current management policies and the situation on the ground. For example, according to the zoning policies of nature reserves, core areas are prohibited from production and living activities. This is an unrealistic policy as there are residents living in these core areas, including in Sanjiangyuan. Under the circumstances, conservation incentive agreements could be an effective method to allow local residents to participate in conservation through an agreement with the nature reserve, especially in places where it is clear that local people care about the environment and have the ability to support conservation.

V. Community-based conservation and the creation of 'harmonious societies'

China is now in a crucial period of development and transformation. On the one hand, rapid economic growth has brought Chinese people material abundance after a long period of social unrest and material shortages. However, material abundance often comes at a great social and environmental cost. Air, water, and soil pollution, and rapid loss of biodiversity, all indicate that the quality of the environment in China has severely declined. Environmental problems have not only resulted in major life and property losses, but have also severely decreased the quality of life for many urban and rural populations and, in some cases, have largely destroyed people's sense of security.

The central government has recognized that maintaining current GDP growth is unsustainable, and, as a result, has introduced the concept of the 'harmonious society'. Creating a 'harmonious society' will require the full consideration of social and environmental needs in economic decision-

making. Economists often cite the Kuznets U-shaped curve, which follows the development patterns of western nations, reflecting the relationship between the environment and economic development. According to this theory, public demand for a better environment only increases when economic growth reaches a certain level. Today, China also seems to be following this development pattern. However, with the pressure of an already stressed natural environment and constrained available resources, China, like other developing countries around the world, is forced to consider other possible development patterns. The example of sacred lands provides an excellent opportunity to create an alternative model of development to that suggested by Kuznets theory, as people's concern for the environment is not only decided by economic and material development, but also by their personal and societal values. According to the Kuznets model of development, the Tibetan economy is far from the vertex point of the Kuznets curve where people would begin to care about environmental protection. However, because of traditional Tibetan conservation values, it is possible to create a conservation model that transcends the correlations expected by the Kuznets curve. In other words, the 'harmonious society' can be attained through a model that represents communities that have not achieved extensive material wealth but value both economic development and environmental protection.

According to most societies, the ultimate objective of development is to enable people to live happier lives. However, the basic elements of a happy life cannot be accurately represented solely using economic indicators, as is currently practiced. Peace, security, and satisfaction, for example, are all essential elements for a happy life; these are not reflected in a nation's GDP. Unfortunately, value systems that correlate consumption and material wealth with happiness have already become dominant in modern societies. Tibetan culture, rooted in a respect for nature could pose an alternative model to currently dominant development concepts. Such an alternative could lend substance to the 'harmonious society' concept.

VI. Regional development and harmonious development

To build a harmonious society, economic development must fit with environmental capacity now, and in the future. In other words, there must be sustainable development. This makes it necessary for a nation to design a development plan that balances demands for natural resources and environmental conservation as a whole.

The Eleventh Five-year Plan introduces the concept of constructing regional development based on different regions playing different roles. It is essentially a zoning system whereby each region should create a development plan utilizing four types of zones: optimized development areas, key development areas, limited development areas, and forbidden development areas, all with specific functions supported by policy and a concrete evaluation system (National People's Congress, 2006).

Optimized development areas are areas where national land development intensity has been high and the capacity of the environment to absorb the impacts of development has begun to decline. In optimized development areas, the focus should be on improving industrial technologies, solving environmental resource bottlenecks, and upgrading the level of participation in international competition. These are the areas that should drive economic and social development (National People's Congress, 2006).

Key development areas are areas where there is still relatively strong environmental resource bearing capacity and the economic structures and population densities are relatively favourable. In these areas, development goals centre around strengthening infrastructural construction, boosting capacity to attract greater investment, employing more advanced technologies, and both advancing and limiting the pace of industrialization and urbanization. These are the areas that will eventually become the new backbone of economic development and population growth.

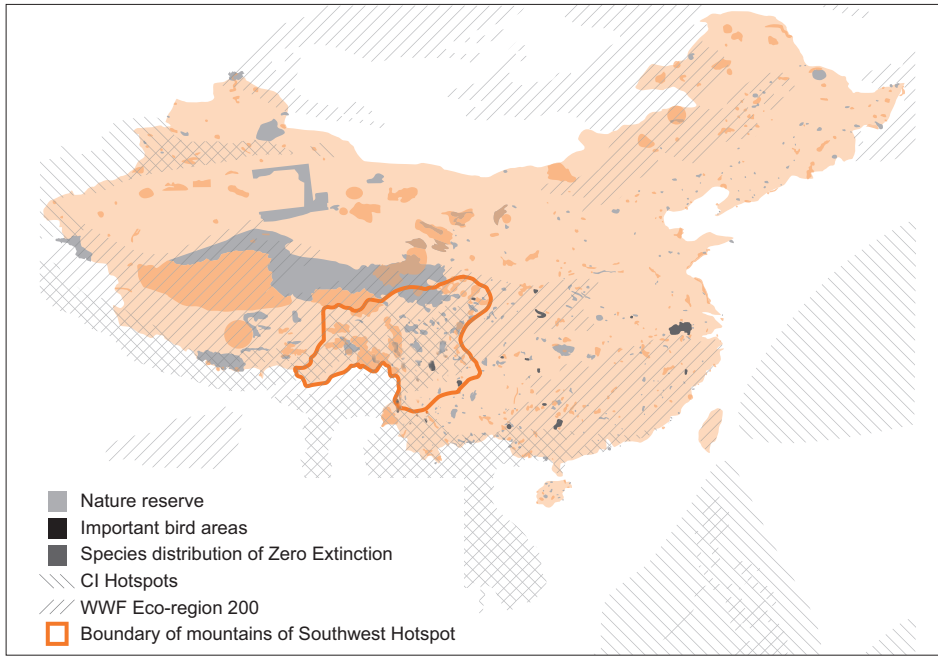
Limited development areas are areas where the ecological environment, economic development and population dynamics are not favourable. Priority is given to ecological protection and appropriate exploitation. The goal in these areas is to strengthen and repair the ecological environment and only develop industries that the local ecology can support. There is also a focus on encouraging people in overly urbanized areas to move, in an organized way, to key and optimized development areas.

Forbidden development areas refer to all nature reserves protected by law. In forbidden development areas, there is legally mandated protection that precludes any development activities that are inconsistent with the functions of nature reserves (National People's Congress, 2006).

In order to alleviate the polarization of rich and poor regions, the Eleventh Five Year Plan also creates a building, resource, and environmental tax system that compensates limited development areas and forbidden development areas for their ecosystem services. A series of measures and incentive mechanisms for industrial development, land use, and cadre performance evaluation criteria should also be developed for optimal development areas and key development areas.

The principles behind this new type of development zoning are clear and persuasive. The next step is to build specific regional development objectives and indicators for the different development areas. The location and boundaries of zones also need to be defined. Figure 12 illustrates the most important biodiversity areas in China. Developing similar information on the spatial distribution of resources, land use, and economic development would be useful in designating these zones and delineating boundaries.

Figure 12 Areas of important biodiversity in China (based on data compiled by WWF and Conservation International)



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9
Natural versus Human Disturbances of Old-Growth Forests

Shen Xiaohui and Piao Zhengji

原始森林的自然干扰与人为干扰:以长白山自然保护区为例

On August 28th 1986, strong winds from Typhoon 15 reached the southern and western slopes of the Changbaishan Nature Reserve (CNR). The winds felled nearly 10,000 hectares of trees, in a phenomenon known as 'windthrow'. Ninety-eight per cent of the windthrow affected area was inside the core area of the reserve.

While many trees were lost, the winds left the forest ecosystem largely unscathed. Its functioning as an integral unit was unaffected. The windthrow event, therefore, was an instance of natural disturbance intrinsic to natural succession and ecological processes in the old-growth forest. It was human intervention, in the form of two campaigns that followed – each lasting as long as seven years – that led to the removal of fallen logs and reforestation through artificial regeneration. These human activities irreversibly destroyed the local ecosystem. They undermined the natural characteristics of the windthrow area and retarded nature's self-regeneration process by almost a century, and altogether reversed the process in others, turning parts of the forest into secondary subalpine meadows.

It is patently in contravention of government policies to allow the removal of logs on the ground as a result of windthrow in the core area of a reserve. The illegality of this is not in dispute. This article will consider the matter from the point of view of forest ecology. The questions to be addressed include the following: why is it that windthrow, a form of natural disturbance, is ecologically beneficial and constructive, whereas human disturbances such as the systematic removal of fallen logs are ecologically harmful and destructive? How should natural disturbances be understood? How can nature reserves be protected from acts of human disturbance induced by either ignorance or illegal intentions? Clarifying these issues will not only help the public better understand science in general and the natural environment in particular, but it would also have important practical implications for democratic and scientifically-informed policy-making.

I. Ecological evaluation of wind fallen logs

A forest is far more than a stack of woods; it is an ecological system consisting of a diversity of both biotic and abiotic elements, inextricably linked in a web of complex relationships. Forest ecosystems have their own ecological processes and succession patterns. A proper understanding of both is imperative for sound and effective forest management, and it is all the more crucial for resource conservation and management in nature reserves that feature large areas of forest.

Hurricanes, lightning, earthquakes, fires triggered by lightning, glacial activities and volcanic eruptions are all common and recurrent forms of natural disturbance that affect forests. From the point of view of disturbance ecology, even though symptoms consist of temporally and spatially localized destruction of biological systems and/or their basic elements, natural disturbances are nonetheless significant for the preservation of biodiversity and for biological evolution. In the Changbaishan area, winds constitute the most biologically significant form of natural disturbance. In fact, wind disturbance can be viewed as the primary mechanism for natural regeneration of forests in the area.

By contrast, more often than not, human disturbances such as logging, the construction of bridges, roads and dams, and conversion of forests into agricultural lands, impair the ecological functions of forests while also reducing their aesthetic value. With the exception of those that have been meticulously designed to mimic natural disturbances, and executed under the guidance of forest ecology, human disturbances tend to be disruptive of forest ecosystems and destructive of their biodiversity. The seven-year long campaign to remove fallen logs through intensive and highly mechanized means in the Changbaishan area is a classic example of anthropogenic environmental destruction, and it deserves to be closely scrutinised.

Wind disturbance is a common form of natural disturbance in the Changbaishan and Xiao Xing'anling region, and is an essential part of the environment. The soil in CNR, formed predominantly from volcanic ash, volcanic gravel and pumice stone, is characteristically thin, and the root systems of local vegetation are generally shallow. Therefore, once forest communities reach maturity, wind gusts become a key agent in succession processes. In fact, a 1960 follow-up survey of forest resources in CNR revealed that there were more than 1 million m^3 of fallen logs.

The wind disturbances of 1986 led to vast areas with canopy gaps and the felling of many trees. This outcome, however, is perfectly consistent with the forest's ecological and succession processes, and therefore need not cause concern. Fallen logs of varying diameters as well as standing trees form a harmonious and integrated whole. Species such as red deer and hazel grouse continued to be found in the area. Canopy gaps of varying sizes facilitate the growth of mid- and small-sized stems of different species. The weight of downed logs can help buttress and stabilize the root structures of standing trees, and thereby prevent them from falling. A survey of naturally generated saplings conducted three years after the wind disturbance event showed that regeneration rates were over 1200 per hectare for broad-leaved Korean pine and over 2000 per hectare for mixed conifer forest. These rates are sufficient for complete restoration of the original community to occur. Therefore, there can be little doubt that, had it not been for the human disturbances that ensued, these saplings would have quickly grown into maturity within the canopy openings created by the wind disturbance. In stands of large trunk diameters, natural succession consists of secondary succession through transition from pioneer species. In stands of relatively small trunk diameters, spatial succession is the primary mode of natural succession. The result of both would have been the restoration of the late successional community (or 'climax community'), characterized by maximum net primary product and biodiversity, that had existed prior to the wind disturbance.

However, the natural succession processes of the forest have been utterly disrupted by persistent and aggressive human disturbances. In addition to the work done by small contractors that use mostly labourers and draft animals, numerous heavy machine operators employed by five large state-owned corporations in the timber industry were also involved in the harvesting of fallen logs in the core of the reserve. On average, 4000 people worked in the reserve, and as many as 5000 during the peak season. A total of about 200-300 truckloads of materials went in and out of the reserve everyday. According to conservative estimates, at least 1.7 million m^3 of wood was hauled out of the area. This amount was far in excess of the volume of wood in the downed logs, which stood at just over 1.2 million m^3. The additional 500,000 m^3 of wood came from standing trees which were also felled and removed. The scope of the pillage even extended to some of the surrounding areas, where some trees became the victim of secondary felling as turbulence from intensive machine operations caused soil in the forest floor to loosen, while others were cut down. Meantime, 20,000m^3 of trees on 160 hectares were destroyed for the construction of 140 km of roads and 10 work stations.

These massive, intensive, aggressive, highly mechanized and prolonged human activities have had devastating and irreversible consequences for the Changbaishan forest ecosystem. They include, but are not limited to the following:

1 Natural regeneration processes of the forest were obstructed due to extensive damage done to ground and surface vegetation. Heavy equipments such as tractor trailers and bulldozers decimated saplings and seedlings, and destroyed soil structure as well as surface vegetation. One effect of all this was severe soil erosion. Humus soil was completely pared away in some places, exposing the volcanic ash underneath. Many carriageways used for transporting logs turned into tracts of gravely eroded soil. Studies have shown that the campaign to remove fallen logs destroyed as much as nearly 70 per cent of the original surface vegetation in the area, and reduced the number of naturally generated saplings to below 600 per hectare. This represented a destruction rate of fifty to seventy per cent.

2 The forest became unsuitable as a habitat for many wildlife species. Noise from heavy machinery and labourers broke the tranquillity of the nature reserve, compromising the ability of the area directly affected by the wind disturbance and those surrounding it to serve as a wildlife sanctuary. The harvesting and removal operations were organisationally complex, and involved large numbers of workers many of whom lacked environmental awareness. They liberally hunted hazel grouse, tree frogs and other animal species, and picked rare plants (including Boschniakia and Rhizoma Gastrodiae). The use of rat poison by forest restoration companies killed many alpine pika, this in turn harmed the carnivores that feed on them, thereby disrupting the local food web.

3 The natural succession process of the forest was obstructed. After the harvesting campaign removed all the fallen logs, subsequent clean-ups of the area also removed enormous volumes of debris from the forest floor in the form of various kinds of wood material. This made a bad situation worse because the material removed performs crucial ecological functions, including nursing of seedlings and saplings, facilitating nutrient recycling, and maintaining soil productivity.

4 The windthrow event became a trigger for clear-cutting. Intensive and mechanized operations deprived standing trees in the wind disturbed area of the added support to their root structures that would have been provided by fallen logs. This can potentially lead to a domino effect where fallen trees beget more fallen trees. The landscape of areas that have undergone wind disturbance should have an uneven and discontinuous outlook. However, clear-cutting typically turns the area into vast and continuous spans of bare land. Since clear-cut areas are directly exposed to sunlight, saplings of shade-tolerant species that may have survived the clear-cutting stand very poor chances of surviving far beyond it. After their 1996 visit to and investigation of the windthrow area in CNR, experts from the State Forestry Administration determined that the systematic removal of fallen logs slowed down natural regeneration processes of the forest below the altitude of 1,600m by more than a hundred years.

5 Subalpine meadowland, which formed as a result of regressive succession, became a significant fire hazard. Because of its relatively high altitude, low temperature, high humidity, and relative freedom from prior human disturbances, the old-growth forest in CNR had been naturally fire-resistant. Thanks to its high water content, the stacks of decaying wood on the forest ground worked well as a fire deterrent and prevented ground fires from spreading. This explains why CNR had had a superb track record with respect to forest fires. But these conditions that had been so favourable to fire management inside the reserve have now been destroyed. After the clear-cutting of the windthrow area, increased light exposure, ambient temperature, wind speeds and evaporation and decreased soil moisture content allowed weeds to thrive. These sun-loving weeds grow dense and tall and do not rot easily after turning yellow in the autumn, and became a major fire hazard. In particular, secondary meadowland at elevations above 1,600 metres formed as a result of artificially induced forest regression has become a tinderbox that it is now a major headache for the government of Jilin province and Changbaishan city, as well as the CNR Bureau of Management. Each year, a back-up police squad would be sent in, charged with the nearly impossible task of fire prevention. In 2005, the western slope of Changbaishan was completely closed to tourists, and the entire mountain region was locked down. These drastic measures are abundant evidence of the gravity of the situation.

6 Artificial reforestation is a form of human disturbance. Opinions differ on how to regenerate forests destroyed by windthrow effectively. Some people are against natural regeneration and favour artificial regeneration. They argue that 'we cannot just let nature take its course' and that 'it is important that human beings direct and control the regeneration process'. In practice, this usually means clearing the harvested areas, and covering them with uniform deciduous trees, which some businesses have already done. However, these areas were soon invaded and overtaken by sun-loving weeds that grew out of control. Instead of rapid recovery of the wind destroyed forest, as had been intended, the area further deteriorated and turned into grassland, bringing human disturbance to a decisive and disastrous conclusion.

That these areas should turn, or rather deteriorate, into grassland can be seen as nature's retribution for human arrogance and callousness. In some sense, however, the disastrous failure of the artificial regeneration campaign may have been a good thing, for its success would have meant the awkward existence of a homogeneous, closely managed plantation right in the middle of an old-growth forest with which it is ecologically discontinuous and incompatible. Not only would such an implant have done nothing to increase forest diversity, it would have compromised the integrity of the entire reserve forest ecosystem.

II. Natural or man-made disaster?

What are the environmental implications of such large-scale, intensive and persistent human disturbances for CNR? This is a question that must be carefully studied by all conscientious and concerned government officials and scholars. On the western slope of the Changbaishan mountain, there is a piece of between-stand open space called Yimianpo. At an elevation of 1,500-1,600 metres, the site features a mixed spruce and fir conifer forest. In the 1950s, before CNR was established, the area had been converted into agricultural land. After the reserve was established, and human disturbance ceased, the converted agriculture land at Yimianpo was abandoned.

Succession in abandoned agricultural land in the Changbaishan and Xiao Xing'anling region typically begins with the growth in the early successional stage of pioneer tree species such as mountain aspen and white birch, which is then followed by the emergence of Korean pine saplings. When this kind of two-tiered forest reaches a certain age, mountain aspen and white birch, which have relatively short life-spans die out, and are taken over by the longer-living Korean pine. This process would, if uninterrupted, eventually result in the complete restoration of the broad-leaved Korean pine forest that had dominated Yimianpo prior to its conversion to agricultural land.

However, rather than self-regenerating according to these natural orders, and the abundance of indigenous tree species notwithstanding, Yimianpo deteriorated into alpine grassland instead. Because Yimianpo is on a sloping plateau in the mid-section of the Changbaishan mountain, and as such of relatively high altitude, it was already in close proximity to extant mountain birch forest and alpine meadowlands. Therefore, after the area became denuded, sun-loving weeds overcame pioneer species in a competition for resources. But when and where these weeds achieve dominance at a site, germination of tree species becomes virtually impossible. Such highly stable grassland communities in former forest areas are called 'transformation climax vegetation', and are not the original climax vegetation of the forest but an alternative to it. Under these circumstances, the original climax vegetation is unlikely to recover fully even if human disturbances were halted. So Yimianpo offers a telling illustration of a transformation climax that resulted from a human-induced regressive succession. Its results are decidedly inferior to the original old-growth forest with respect both to biomass and to net primary productivity.

What happened at Yimianpo stands in sharp contrast with what happened in Changbaishan 1,100 years ago following a volcanic eruption. The volcanic eruption was a quintessentially natural event, and it nearly obliterated the vegetation coverage within a 50 kilometre radius of Tianchi. Yet what was lost has now been completely restored. It is right on top of the volcanic ash, and even retains its original vertical distribution structure. Examination of samples of carbonated wood retrieved from underneath the volcanic ash indicates that the forest in Changbaishan today is virtually indistinguishable from what existed prior to the volcanic eruption both in terms of the type of forest and in terms of its compositional structure. Present day Changbaishan represents, therefore, a late seral community of maximum nutrient content, informational content and biodiversity. This community is the result of secondary succession.

How is it then that a forest ecosystem manages to heal itself after catastrophic natural disturbances such as volcanic eruptions, which can quickly destroy thousands of square kilometres of forest, but

cannot seem to survive human disturbances even when these have apparently been confined to a few hectares? The Changbaishan case shows that for ecological systems and biodiversity, human disturbances are fundamentally and qualitatively different from natural ones. The latter only appears to be destructive, and is actually constructive. By contrast, the former is more often destructive, appearance or intention to the contrary notwithstanding. This reality should serve as a wake-up call to all concerned with the sustainability of forest ecosystems.

Unfortunately, even before the campaign to harvest and to remove fallen logs was complete, concerns voiced from this research team had already correctly pointed out that the emergence of secondary alpine grassland as the transformation climax of a regressive succession process, as had occurred at Yimianpo, was unfolding in the windthrow area on a massive scale. The seven-year campaign stripped the area of standing trees as well as fallen logs, and even the two per cent of fallen logs required by the State Forestry Administration to be retained for scientific research were not spared.

In 1996, soon after this first chapter of human disturbance of the CNR forests came to an end, some people again sought permission to cull whatever downed logs they claimed still remained in the windthrow area. As an effort to help forestall further ravages, one of the authors of this paper published an article titled 'Changbaishan: Typhoon overnight brings a decade of human-made disaster' in *China Forestry* (Shen, 1996). This article finally succeeded in capturing the attention of high-level officials in the State Forestry Administration. Teams of ecologists were subsequently sent to CNR to carry out research on the impact of human disturbances on the area. Adopting some of the recommendations made in the final report of the study, the State Forestry Administration banned the granting of new permits for removal of fallen logs, among other things.

However, nothing really changed. A proposed expansion of the CNR core area was not implemented; neither was there evidence of significant heightened awareness of CNR's ecological importance. Worse still, only three years later another chapter of manipulative and malicious human-engineered disturbance with even wider and longer-lasting ecological consequences was set to befall CNR.

III. Human disturbance by collecting Korean pine seeds

Throughout over 20 million years of evolutionary history, Korean pine forests have achieved a high degree of structural and functional complexity and biodiversity. These forests now represent the most biologically diverse class of vegetation and ecological system in northern Eurasia. Most of the world's Korean pine forests can be found in an area of 5 million km^2 centred around Changbaishan and Xiao Xing'anling in northeast China. The area reaches to Russia in the north and extends to the Korean Peninsula in the east. 60 percent of this area is inside Chinese territory.

Until the 1950s, Korean pines were present in large areas in the eastern mountainous region of northeast China. For a long time, however, due to a poor understanding of the ecological significance of Korean pine forests and pressures of economic development, the area was used mostly for lumber production. Decades of over-logging mutilated the old-growth forest, replacing them with a mix of over-logged, secondary forests and managed plantations. Within the span of a quarter of a century, from 1960 to 1986, the size of the Korean pine forest in the Changbaishan Mountain region was reduced by 70 per cent decreasing from nearly 2 million to around 580,000 hectares. The volume of aggregate timber reserves was reduced by 80 per cent from 67 million m^3 to just less than 13 million m^3.

A total of about 42,000 hectares of Korean pine forest still remains. Most of this area is inside CNR. It constitutes a relatively intact ecosystem, and represents the only remaining gene bank for this type of forest.

However not long after having been pillaged in the campaign to harvest and remove fallen logs, which went on for seven years, this last gene bank for old-growth Korean pine forests fell victim to a campaign to harvest and remove Korean pine seed. This second wave of human disturbance would have gone on much longer had it not been forcefully discontinued after six years.

Korean pine forests in CNR are located at elevations between 720 - 1,600 metres, covering an area totalling more than 70,000 hectares, which is larger than the size of the old-growth Korean pine forests. Ten percent of this area was used for experimental applied forestry, 20 per cent is a buffer zone, and the remaining 70 per cent is the core area. More than 1.1 million of the Korean pines have diameters greater than 30cm, and they produce 20 - 30 million kg of seeds annually.

Broad-leaved Korean pine forests rely on animal species that feed on their seeds to pass on their genetic material from generation to generation. The cones of Korean pines do not open up when ripe, so the seeds are not self-dispersed. Instead, they are spread following consumption by squirrels, chipmunks, nutcrackers, jays and other bird species. Experiments have shown that without the ecological services provided by these species in the shelling and the dispersal of seeds, self-renewal of the Korean pine forests would have been impossible.

However, in removing almost all the Korean pine seeds from the ecosystem, human beings have aggressively and massively intruded into this biological system. As a result, both the survival of animal species that depend exclusively on these seeds for food and the ecological equilibrium and continuity of the old-growth Korean pine forests have been seriously jeopardized. While this problem can be addressed in Korean pine forests managed by businesses, albeit very imperfectly, through artificial regeneration, this is not true for old-growth Korean pine forests since artificial regeneration, as a form of human disturbance, is disallowed in the forests. This being the case, regeneration and renewal of old-growth Korean pine forests in CNR has become an acute problem.

Prices for Korean pine seeds have been escalating since the 1990s. Market demands and the profit motive have driven many to go into CNR illegally in order to collect them. In response to such abuse, which went on unabated year after year, rather than consulting with local residents and allowing them to participate in decision-making in relation to the protection and management of local resources, CNR management decided to follow a commercial exploitation model, and put the rights to collect seeds up for sale in open auctions and tender processes. Those who made this momentous decision did not bother with 'planning', 'expert testimonies', or environmental impact assessments.

According to statistics, during 2000, the first year of open auctions and contract bidding for Korean pine seeds, nearly one million Korean pines within CNR with diameters larger than 30cm covering a total of over 40,000 hectares were auctioned off to 38 contractors. In that same year, about 2,000 seed collectors worked in the area, some for up to two months, keeping watch on the ripening crop and then harvesting it. This situation lasted for several years.

In six years, the many and varied problems associated with the campaign to commercialize Korean pine seed collection in CNR became increasingly evident. Key issues are as follows:

1 Human disturbance of the reserve has been further aggravated. As the abuses became more and more organized, they have also become more potent, and more capable of contributing to significant destruction of the reserve.
Before open auction and contract bidding took effect, illegal seed collectors would typically come to the reserve in small groups on brief trips. Since they could not stay overnight, few could reach far into the innermost areas of the reserve. Therefore, their activities were mostly restricted to areas most easily and conveniently accessible from the outside. This meant that a considerable proportion of the total number of Korean pine cones was spared and continued to support seed-eating species and the self-renewal of the Korean pine forest. By contrast, under the new system of open auction and contract bidding, labour was hired by contractors to work exclusively on the plots they had rights to. Streamlined crop watching, crop harvesting, mechanized shelling

and hauling ensured that the reserve, including the deepest parts of it, became almost completely emptied of Korean pine seeds. This has led to the severance of the broad-leaved Korean pine forest food chain. The shortage of seedlings in broad-leaved Korean pine forests, which are age heterogeneous, multi-layered, and multi-generational, has led to a decline in generational overlapping processes, thereby threatening the sustainability of the forest. In an attempt to solve this problem, CNR management has tried planting Korean pines by aerial sowing. This approach however is scientifically baseless, and has also been demonstrably ineffective.

2 The commercialization of Korean pine forest management turns ecological resources into economic ones, thereby fundamentally altering the essential nature of CNR. It is no longer a site for protecting and conserving natural resources, but a business zone that does little more than churn out Korean pine seed products.

Every year, during the seeding season, the normal tranquillity of the forest gives way to a cacophony of noise as seed collectors and processors move in. Large fleets of taxis, farm vehicles and tractor-trailers roll into the reserve from all directions. Thousands of labourers, who have brought their families, food and other lodging supplies with them, set up camp inside the forest. They construct numerous worksheds in gutters and intersections, using wood from small trees that they have cut down; they cook on makeshift stoves constructed from rocks and dirt stripped directly from the earth, and use fallen logs and dead undergrowth as fuel (the latter factor alone accounts for the consumption of the more than 3,000 m^3 of wood annually). Just as commonplace are indiscriminate picking of mushrooms and medicinal species, fishing, and toad hunting. More serious still, some people engage in the poaching of high-value wildlife species such as hazel grouse, wild boar, roe deer, Korean deer, and sable. To make their work more efficient, many of these collectors amputate or behead trees; and to make hauling their bounty away easier, some cut down trees to build tracks and bridges. Rather than promoting resource conservation and husbandry, Korean pine seed harvesting only aggravated the mismanagement of the local forests.

3 Severe trampling of the forest ground has resulted in vast networks of footpaths that leave few corners of CNR inaccessible.

Presently, there are footpaths leading into the reserve from the highways that go round the reserve, coming off it at one kilometre intervals. Each footpath merges with a thoroughfare that runs along a river and cuts across the entire reserve area. On the northern and western slopes of the Changbaishan Mountain, there are now 26 footpaths that go into the reserve, 9 of which are big enough for automobiles. On the southwestern slope, the numbers are 27 and 6, respectively, and 113 and 27 respectively for the entire reserve. In addition to these, there are 8 routes used exclusively by tourists. These roads have made visits to the area – whatever the purpose – considerably less difficult and time-consuming than they would otherwise have been, and this has helped increase visits to the reserve's core significantly. The total number of discrete visits to the mountain region during the autumn is between 380,000 and 950,000. There are hardly any parts of reserve untouched by human activities.

4 An increase in the spread of communicative diseases among animals and the invasion of non-native plant species.

Large amounts of wastes – discharge from production processes, residential waste, sewage, and of course, mounds of Korean pine seed shells – generated by human beings and draft animals have become a major source of serious environmental pollution in the reserve. Moreover, they have contributed to the increase in the spread of communicable diseases between animals and the spread of invasive plant species. In particular, wild boar disease epidemics have already been discovered.

This annual abuse of the forest ecosystem and systematic looting of biological resources have drastically decreased the value of the broad-leaved Korean pine forests in CNR as a seed bank for maintaining local biodiversity. Moreover, interest in Korean pines as also affected adjacent mixed conifer forests, which also contain the species.

IV. The ecological significance of Korean pine seeds

1. The impact of intensive Korean pine seed collection on wildlife species

According to field studies, there are 26 wildlife species, including 11 species of birds and 15 species of mammals that feed on Korean pine seeds. Relative to humans, wildlife is at a decisive competitive disadvantage. When and if we take their food away, their only options are starvation, change of diet, population decline, and emigration (if, that is, there are still habitable places left for them to go).

A five year study carried out by researchers at CNR, involving samples from 120 animal specimen zones and 30 plant specimen zones shows that since 2000, humans have consumed possibly 98 per cent of all the Korean pine seeds produced within the broad-leaved Korean pine forests inside CNR. The only exception was 2004, when pest invasions resulted in lower-than-usual rates of human consumption. Other species, by comparison, have consumed less than two per cent of the annually available total of Korean pine seeds. In mixed conifer forests, the percentage for human consumption ranges from 88 to 96 per cent compared with 3 to 7 per cent for animal consumption. This large disparity helps explain the following problems:

1 Sharp decline in populations of affected wildlife species. Between 2000 and 2004, in the broad-leaved Korean pine forest areas, hazel grouse, woodpeckers, jays and squirrels experienced negative population growth. In mixed conifer forests, nutcrackers, chipmunks, wild boars, bears and sable experienced negative population growth.
2 Human interference in the food web has led some animal species to change their diets. Population decline for squirrels and other small rodent species has lead to population decline for their predator species, including sable and weasel, and forced them to change their diets. As the latter have been forced to prey on hazel grouse, jay and nutcrackers instead, there have been impacts on the entire food web, perturbing the forest ecosystem as a whole.
3 Some wildlife species are also no longer able to find enough food to survive winter. Korean pine seeds are rich and nutritious, and are therefore invaluable to bears and wild boars in their preparation for winter. Consumption of these seeds in copious amounts allows these animals to store sufficient fat under their skin to see them through months of cold weather. At the present time however, food shortages have made it difficult for bears living in CNR to hibernate properly, while wild boar piglets regularly die from malnutrition. In fact, the wild boar population in CNR had seen an increase in the period leading up to 2000, but since then it has declined as a result of over-consumption of Korean pine seeds by humans. Age distribution within the wild boar population has become out of balance, and the high mortality rate of piglets will eventually lead to extinction.
4 The massive loss of Korean pine seeds has caused some wildlife species native to Korean pine forests to emigrate and look for food in areas dominated by Mongolian oaks. But overcrowding in their new habitats renders these migrant populations highly vulnerable to metal wires traps used by poachers. This has greatly increased the incidence of death-by-entrapment for these animals. In 2004, during the few months between early and late winter, the population of wild boar dropped by 60 per cent.

2. The implications of intensive Korean pine seed harvesting for the self-regeneration and self-renewal of Korean pine.

The self-regeneration and self-renewal of Korean pine requires the satisfaction of two conditions, each of which being individually necessary but also insufficient: a sufficient amount of ripened seeds, and an adequate number of biological agents to disperse them. Species such as squirrels, chipmunks, jay and nutcrackers function both as consumers and as disseminators of Korean pine seeds. This means that a very large supply of seeds must be available if the natural regeneration of Korean pines is to be feasible: there must be enough seeds to ensure that after the needs of animals that depend on them for food are adequately met, there are still enough left over to be dispersed and grow as saplings.

Each seed year, old-growth Korean pine forest can yield 500,000 - 1,000,000 seeds per hectare. Typically, 10,000 - 88,000 would be found to have been stashed away in the soil. Out of this stock, some would go towards meeting the on-going dietary needs of wildlife, some would for one reason or another fail to germinate or die prematurely. This leaves an average of 2,000 - 4,000 seeds per hectare that will germinate and grow into four year-old Korean pine seedlings. This means that the total number of seeds produced must be at least 10 – 50 times the number of seeds stored in the soil, which is in turn 10 – 40 times the number of four year-old seedlings of Korean pine per hectare that will actually materialize. Moreover, all of the seeds produced must stay within the forest ecosystem, and depend on natural mechanisms for their dispersal.

Since the practice of open auction and tendering for the right to harvest Korean pine seeds started, the quantity of seeds left stored in the soil in CNR has decreased sharply, and a very small number of seedlings have emerged as a result. A 2004 study by Piao Zhengji of soil samples confirmed that numbers of pine cones and seedlings were extremely small (Piao, 2004).

3. The implications of intensive seed harvesting for the growth dynamics of Korean pine

1 Cones form primarily on the crown and at the top of side branches of Korean pines. The use of foot holders attached to trunks to climb up trees damages bark, causing large amounts of pine resin to be released. Breakage of the branches also does serious damages to the branches at the cone-forming level of the Korean pine, adversely affecting them with respect to growth, seed production and pest resistance. Pest infestation involving Korean pine cones had been quite rare in the past. But in 2005, the infestation rate was as high as 60 per cent, resulting in a drop in seed yields of over 50 per cent. During the same period there have also been frequent problems with rat populations. As forest rats lose access to seeds high up in the trees as a result of the mutilation of Korean pine barks by human beings, they also lose an important source of energy and nutrition. In response, they have turned to chewing the tree bark to compensate for this loss.
2 Typically, old-growth Korean pine forests produce seeds every three years, but in the Changbaishan area and since intensive Korean pine seed harvesting began, they have been doing so every year. Paradoxically, the actual number of seeds yielded has not increased, but actually declined each year. Frequent and repeated human disturbances have so disrupted the natural rhythms of the Korean pine, it seems, that they now require greater energy expenditure than before to perform normal activities such as seed-production at the same level. These and other long-term consequences of human disturbances for Korean pines with respect to timber quality, growth dynamics and life-span are still poorly understood and have yet to be carefully studied.

To summarize, human disturbances have accelerated the depletion of the Korean pine seed bank. The current stock of Korean pine seeds in the Changbaishan forest is woefully inadequate either for feeding the wildlife species dependent on them or for the regeneration of the forest. For concerned wildlife species, the results have been sharp declines in population, in some cases even complete elimination. For the Korean pine forest, not only has the composition and food chain structure been altered significantly, growth dynamics and ecological stability have also been adversely affected. There can be little doubt that had it not been for the decision in 2006 by a newly-established CNR management committee to halt the practice of open auction for the rights to harvest Korean pine seeds, CNR would have been turned into a commercial centre for pine seed production, and gradually cease to be a viable part of the Korean pine forests. Had that scenario materialized, it would have meant either the replacement of old-growth forest by artificial ones cultivated through seed-sowing – which has been the standard practice of businesses in the timber industry – or the gradual disappearance of Korean pine forest altogether and their replacement by forests with smaller or zero Korean pine representation. Either way, it would have meant the end of the last old-growth broad-leaved Korean pine forest in CNR by human causes. All this could conceivably have been avoided had decisions made years earlier been based on sound science.

V. Recommendations for preventing human disturbance

It is important to put an end to destructive human disturbance of CNR. The following recommendations are offered:

1. Existing local statutes as well as the two national statutes issued in the 1980s and 1990s pertaining to nature reserves are becoming increasingly inadequate both in terms of legal scope and practical implementation. Rapid economic development and social change have exposed these inadequacies. Since the drafting of legislation to protect nature reserves is on the legislative agenda of the meeting of the Tenth Standing Committee of the National People's Congress, the following supplements and revisions to the proposed legislation are proposed based on experience from CNR:

1 Legislation should clearly recognize and promulgate national ownership of nature reserves, including their ecosystems, their flora and fauna, and their natural scenery. These are natural capital that belongs to the country as a whole. They are not the property of any local government or agency, which are rather charged with protecting and managing the nation's nature reserves. It falls upon them to enforce relevant laws, and they do not have the right either to alter or manipulate these laws for economic purposes. Where some of these changes have already taken place, effort must be made to ensure that positive trends are not reversed.
2 The core area and the buffer zone inside nature reserves must be free from all human interference not explicitly permitted by law. Should particular circumstances call for human interference, it should fall to the agency in charge of environmental protection (and not the reserve management or other administrative agencies) to conduct scientific studies on the subject by bringing together different agencies and experts from different disciplines. Critical views must be allowed, carefully considered and recorded, whether or not the critics' suggestions are adopted in the end. Should permission for the project be granted, the agency in charge of environmental protection must closely monitor, test, and supervise execution from start to finish, and evaluate outcomes. Problems must be promptly corrected to avoid irreversible damages.
3 Environmental and ecological experts must be given veto powers in decision-making over economic and commercial development in nature reserves. Policy-making, scientific evaluation and expert analysis must all be conducted in accordance with a system of accountability. Those failing to carry out their mandated roles properly are responsible for damage that occurs in nature reserves. They should face the legal consequences of their actions.

2. Resource conservation and management inside CNR should be strengthened. Businesses can continue to tender for rights to harvest pine seeds, provided that processes for the granting of permits are standardised and rules tightened regarding the use of technology. For example, tree climbing for purposes of seed collection should not be allowed. The only seeds that should be collected are those that have fallen to the ground. This is important for maintaining the health of the larger ecosystem of which Korean pine forests are a constituent part and for facilitating the self-regeneration of Korean pine forests.

3. The incoherent practice of treating 'hard' and 'soft' targets differentially and disjointedly in forest management in the natural reserves should be corrected. Since fire prevention is considered a 'hard' or clearly-defined policy goal, it is taken very seriously at all levels of the government. It enjoys generous funding and other resources in terms of both personnel and physical facilities. By contrast, since resource conservation is a 'soft', less clearly-defined policy goal, both more ambiguous in terms of evaluation standards and more lax in terms of verification methods, it has largely been marginalized at the level of practice, and assigned to agencies that tend to be poorly funded, understaffed and lacking in necessary equipment. CNR offers a clear example of such an imbalance. To address it, it is first necessary to approach resource conservation and management in the same way that forest fire prevention has been approached, namely by means of instituting a system of responsibility and accountability. Secondly, field station conditions need to be improved. Stations should receive a better share of resource allocation: including personnel, technical equipment

and fringe benefits. Thirdly, any work done in nature reserves should be designed with the aim of promoting harmony between the interests of the reserve ecosystem and local communities. This will involve establishing a model of management and development that emphasizes public participation and community involvement.

4. The ring roads surrounding CNR that were originally built to facilitate patrolling are now useless for this purpose. What is worse, they have helped to make illegal entry into the reserve easier. Allegedly in the name of promoting tourism, it has been suggested recently that these roads be paved over with concrete. But paved roads wreck ecological havoc wherever they go. For example, on the north and western slopes of the Changbaishan Mountain, paved roads have cut off the migratory routes of many animals, which became confined to segregated areas. Obstruction of seasonal migrations jeopardizes genetic exchange among different populations of the same species. Moreover, if the ring roads are paved over, they would sever CNR from the surrounding forests that are not themselves part of the reserve, and this also has adverse consequences for wildlife. This practice should be discontinued. And all the footpaths leading into the reserve that run along the ring roads should be ploughed up to facilitate the restoration of vegetation. Monitoring stations should be set up on the ring roads for fire prevention and resource conservation.

5. Enforce the State Forestry Administration directive that requires the extension of the core area of the Korean pine forests and of the tundra region in CNR. This core should be no less than 70 per cent of the reserve. Ideally, the core should be greater than 70 per cent core, the buffer 10 per cent and the transition (or experimental) zone less than 20 per cent. Tourism and economic development should not be allowed outside the last, and under no circumstance should occur in either the core or the buffer zone.

6. Better training is necessary for both management and employees of nature reserves, as well as for officials at different levels of government. Many of those who work in natural reserves, in some capacity or another, are already forestry veterans. However, their previous experience with forestry has mostly been in either the timber industry or the government. Therefore, they tend to have a fairly narrow understanding of the cause of nature reserves preservation, and tend to think about forest ecosystems in terms of the same economic principles that defined their perspectives and attitudes in their old jobs. Though their jobs have changed, changes in beliefs and ideas necessarily take longer. Therefore, better professional training and continuing education should be mandatory for both management and the employees of nature reserves. Professional licensing should be also be instituted for these jobs.

7. The areas along the highway used by tourists who visit the windthrow forest area should be turned into an environmental education centre. Today, more than half of this highway cuts right through the heart of the windthrow area. Extraordinarily thick old-growth forests have now been replaced by secondary forest, sparse woods and secondary grassland. These damages are a fait accompli, but the mistakes that caused this damage should be clearly understood and not repeated. One way of doing so would be to make use of the location for environmental education in general and for education about forest ecology in particular. In that connection, there have been suggestions to turn some areas inside the former windthrow area and along the tourist highway into educational camps.

8. Changbaishan Mountain was the first nature reserve in China to be included in UNESCO's 'Man and the Biosphere Programme'. It is a complex natural system whose great ecological significance is internationally recognized. The Ministry for Environmental Protection, the State Forestry Administration and the Chinese national committee of 'Man and the Biosphere Programme' should join hands in sponsoring a thorough investigation and assessment of the impact on the CNR ecosystem of twenty years of human disturbances. The investigation should involve different government agencies and experts from different disciplines. Such a study should help provide a sound scientific foundation on which the future reconstruction and conservation of CNR and its resources can be based.

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10
To Save Biodiversity, Protect Cultural Diversity: A case study of the reindeer-herding Ewenki people

Han Nianyong

文化多样性是拯救生物多样性的良方:以使鹿鄂温克为例

In recent years, those concerned with biodiversity protection have taken an increasing interest in the relationship between biodiversity and cultural diversity. In many cases, biodiversity protection efforts have become ineffectual, because they have not taken sufficient account of cultural diversity, or even engaged with cultural diversity struggles. In fact, in some cases, the cause of biodiversity protection has been undermined through conservation policies that contribute to the destruction of cultural diversity. The root cause of this contradictory approach is an entrenched bias that glorifies that which is perceived as modern, while denigrating traditional practices. Some policies informed by this bias seek to forcibly transform traditional cultures into modern ones. The result, more often than not, has been the devastation of both biological diversity in an area and also the cultural integrity of local populations. Protecting biodiversity and protecting cultural diversity go hand in hand. In China, the latter has often been seen as little more than a matter of promoting traditional music, dances and ethnic costumes to tourists. This is, however, fundamentally misguided. It is necessary to ensure that traditional cultures are protected, especially when entire indigenous communities have sometimes been forcibly relocated to make way for ecological reconstruction programmes, which are themselves a key component of the nation's overall efforts to repair a ravaged environment. Protecting cultural diversity in a rapidly modernising China is not a simple task. However it cannot be ignored. In order to conserve both biological and cultural diversity it is necessary to be clear about exactly what kind of development is desirable for different social groups and for society as a whole.

I. A brief introduction to the reindeer-herding Ewenki people

About 300 years ago, a group of reindeer-herding people left the forests of the upper Lena River in Siberia and settled in the forests of the Greater Xing'anling Mountains on the right bank of the Argun-Ergun River in China. They hunted, and used reindeer for transport. They lived in an area of about 20,000 km2. The Ewenki were an extremely small community, with a population of between 100-200 people. Ewenki believed in shamanism, worshipped fire, and the bear was their totem. Harsh as their material conditions were, the group lived in harmony with nature. One sub-group of the Ewenki people were known as the reindeer-herding Ewenki hunters.

After the People's Republic of China was founded in 1949, the cultural traditions of the Ewenki were deemed primitive and backward and were subjected to repeated attempts at reform. These reforms included four resettlement schemes focussed on the Ewenki. The last one, which took place in 2003, involved relocating the hunters to an area close to urban services, but far removed from their home area in the mountains. At the time, the mainstream domestic media lauded this attempt to bring the last tribal hunter community out of mountain forests and into the modern era. However, reindeer are not meant to be stall-fed, so some animals died, and some of the Ewenki hunters ended up returning to the mountain forests for the sake of their animals. However, as they already surrendered their hunting rifles during the resettlement process, they had few choices but to rely on their remaining and dwindling reindeer stock. In the interim, nature reserves had been set up in some of the areas where they used to live. The herders seek to play a part in the management of the reserves, and to be able to live in a way that enables them to practice their traditional hunting lifestyle. Until now however, this has not been possible.

People the world over are now generally agreed that it is important to protect biological diversity. However, deep problems often arise in the implementation of biodiversity protection policies. One major challenge requiring immediate attention is how to protect biological diversity and cultural diversity at the same time.

UNESCO has noted that experience in different countries around the world has shown that biodiversity protection efforts can only be effective when they are combined with efforts to protect cultural diversity (UNESCO, 1997). China's own experience with biodiversity protection also supports this conclusion. The experience of the reindeer-herding Ewenki people provides a powerful illustration of the UNESCO argument.

II. The interdependence of biological diversity and cultural diversity

World biodiversity has been declining precipitously as economies have grown and societies have changed. Only a small (and decreasing) number of biodiversity hotspots have remained intact and been spared the destructive effects of modernising influences. Many of these places have been designated as biodiversity protection zones. They are also prime candidates as locations for nature reserves. In China, 42 per cent of all nature reserves, (or 83 per cent of the total reserve area), are located in the western part of the country. Many of these areas are also where national ethnic minorities or indigenous peoples live and maintain their own local cultural values and practices. This geographical overlap between areas that are biologically diverse and those where local cultures exist and thrive is no mere coincidence. The former is in an important sense attributable to the latter.

Unfortunately, this connection is not as widely recognized or understood as it should be. Biodiversity protection programmes have often been designed or implemented without any consideration for their impacts on the integrity of local cultures. Worse still, in some cases, the very people involved in biodiversity protection are engaged in activities that are either disrespectful or destructive of local cultures. Many nature reserves are plagued by conflicts between managers and local communities. Decision-makers and managers fail to look out for the economic interests of local communities, and are often indifferent to indigenous or local cultures. These behaviours fuel conflicts.

Biological species tend to flourish in areas where supportive local cultures exist, either alone or alongside mainstream cultures. This inevitably raises the question of whether it is wise to attempt to protect biodiversity without initiatives to support cultural diversity, and local cultures.

Today, many geographically remote places are influenced by highly developed urban areas. Local cultures may fit well with local ecological conditions, however, they are often in a steady decline, sometimes even to the point of near collapse. By contrast, the influence of modernity in these places is often ecologically destructive, and harmful to biodiversity. This phenomenon is playing out in dramatic fashion in the Greater Xing'anling Mountains where the reindeer-herding Ewenki hunters have lived. The timber industry has expanded in these areas, as well as distilleries which make use of local wild berries. Meanwhile, local cultures and traditions have continued to wither away. According to some statistics, over the last half a century or so, the forests of the Greater Xing'anling Mountains have retreated at a rate of 5 kilometres per annum due to losses from intensive logging. The Forestry Bureau in Mangui Town alone has nearly 4,000 employees. It has been responsible for harvesting large amounts of timber in recent decades. Meanwhile, the reindeer-herding Ewenki are finding it ever harder to sustain their traditional practices of hunting and extensive animal-herding. In 2003, when the fourth and most recent forced resettlement of the group took place, there were only 24 hunting households, with a total population of 78 people. Of these 78 people, only nine actually owned reindeer. Together, these nine owned fewer than 800 reindeer.

The contrast between the two cultures – the mainstream or 'modern' one and local or 'traditional' ones – is stark from both ecological and the economic points of view. Ecologically, traditional cultures tend to be superior to modern ones. However, while modern culture is generally thought (that is, by mainstream society) to be an economic asset insofar as it has vast commercial potentials, traditional cultures are usually considered an economic liability because they do not fill well with the requirements of the market. Traditional cultures are often perceived as a hindrance to economic growth and believed to be on the verge of extinction (a situation which is often viewed as favourable by many commentators). This belief is dangerous for biodiversity on two different levels. On the one hand, the industrial model of economic development, which is perceived to be superior and sure to prevail, is directly responsible for the extinction of many animal and plant species (thereby reducing biodiversity). On the other hand, cultural homogenisation associated with industrial civilisation dismantles cultural traditions that have for centuries functioned as a protective buffer for biological diversity.

The deeper question that arises from this is: why is it that dominant modern cultures aggravate the very problems – in this case loss of biodiversity – that they have helped to discover and bring to the public's attention? Why have they been so effective in eroding cultural traditions that have proven track records in protecting biodiversity?

III. How is cultural diversity being destroyed?

Cultural diversity and biological diversity are closely linked both conceptually and empirically. By definition, they are both about the existence of difference, pluralism and heterogeneity. The local culture of any place, just like its fauna and flora, is a product of processes of adaptation to local ecological conditions. Protecting biological diversity without respecting cultural diversity is unlikely to be successful. The destruction of cultural diversity is a problem of modernity, because homogeneity is the defining property of modernity. Modernity is fundamentally to blame for the tragic demise of the Ewenki culture. As such it is indirectly responsible for the ecological deterioration of the area where the Ewenki used to live. It is sometimes suggested that the cultural traditions of the reindeer-herding Ewenki hunters are ecologically destructive. However, this is actually far from the case. This is a prejudiced view held by those who equate material productivity with cultural superiority. If modernization signifies homogenization of differences, then it will inevitably threaten diversity in its different forms: biological, cultural and so on. This tendency can be challenged from both a purely utilitarian perspective as well as an existential standpoint that champions the right of different cultural traditions to exist and evolve on their own terms. Both these ways of thinking suggest it is important to think and act respectfully towards local cultures throughout the world.

The dominance of the market system imperils cultural pluralism and diversity because of its dominant value system, which only attaches importance to use and exchange values. In China, as in many countries, transition towards a market economy has put the survival of local cultures at risk. Many people in China are of the opinion that the loss of traditional and local cultures that has gone along with modernisation has been unavoidable, and is basically desirable. This kind of collective false consciousness has been a major factor in processes of cultural annihilation.

After 1949, the Ewenki hunters did briefly – for more than a decade – enjoy deferential treatment from the authorities. But market reforms and rapid economic growth have seen their situation and status decline. Many of them have found it difficult to make sense of these changes. The driving force behind this is an uncritical worship of whatever is perceived as 'modern' and an unthinking rejection of premodern cultures and values. This phenomenon is extremely common in China.

The Ewenki people were eventually resettled as part of a policy to support ecological reconstruction in certain sensitive areas. However, these policies were heavy handed and often ecologically destructive. Ewenki incomes increased in the short term, but cost of living rises eventually eroded any improvements in livelihoods. Ewenki hunters did not adjust well to new ways of living in resettlement areas; many Ewenki missed their former lifestyles and their livelihood systems, and ended up returning to their home areas.

IV. Minimizing the negative cultural impacts of ecological resettlement programmes

Many ecological reconstruction projects are currently underway in China. These are an important part of the government's overall effort to rehabilitate degraded ecosystems. Resettlement of local populations to make way for such projects is labelled 'eco-resettlement'. It can have significant impacts on local cultures. However, this issue is generally overlooked by those responsible for these programmes. This failure to consider the cultural dimensions of ecological programmes actually makes it less likely that such interventions will be successful.

The case of the reindeer-herding Ewenki hunters is a powerful illustration of the problems with ecological resettlement. In 2003, the Ewenki were moved by the local government from Auluguya Town to Genhe City, in Inner Mongolia Autonomous Region, as part of an ecological migration scheme. Many problems followed: reindeer, for example, could not adjust to their new 'homes'. As a result, the Ewenki hunters returned to the regions they had been moved from.

However, as if to add insult to injury, the mountain forests which the Ewenki returned to had changed significantly in their absence. Many more traps for hunting animals that had been laid by outsiders. These traps maimed and killed many of the reindeer owned by the Ewenki. With their hunting rifles confiscated, hunters were deprived of a key instrument for self-defence in the event of bear attacks. This meant they could either live in an unfamiliar urban area without their reindeer and without hunting, or return to a changed hunting lifestyle replete with new risks and dangers for their reindeers and themselves. Having fallen for the false promise offered by the authorities that the eco-resettlement programme would improve their lives (the advertisement jingle had it that the hunters could expect to 'watch well-behaved reindeer roaming contentedly inside breeding pens, while sipping wine without a worry in the world'), the Ewenki ended up losing everything that had defined who and what they were: their reindeer, their rifles, their hunting traditions, their land, and their culture.

The eco-resettlement programme profoundly failed its intended beneficiaries, who were left psychologically devastated by the experience. First the Ewenki were labelled backward and uncivilized, then they were blamed for processes of ecological destruction. This confused them, and of course, made them feel deeply disappointed and disheartened. To date, there has not been a thorough investigation and evaluation of the trauma that the Ewenki hunters experienced. This chapter is an initial attempt to bring attention to the need for 'cultural impact assessment' alongside 'environmental impact assessment' when resettlement programmes (ecological or otherwise) are being considered and designed.

Wure Ertu, an Ewenki scholar and author, has pointed out another problem made visible by the eco-resettlement program, namely the issue of land rights. He notes that Ewenki hunters are descendants of people who lived on the northern slopes of the Greater Xing'anling area more than 400 years ago. Many of the mountain peaks and valleys, rivers and streams were named by these ancestors of the Ewenki. At that time, they were the only inhabitants of the region. However, after the Forestry Bureau was established in the 1950s, the local Ewenki lost control over timber management. In the 1970s, they also lost control over the wildlife in the region, which became

state property. Hunting, an integral part of their way of life for generations, was outlawed. In the late 1970s, more than 300,000 migrants from Jilin and Liaoning Provinces settled in the eastern mountains of Hulun Buir, Inner Mongolia. They began to convert and cultivate large tracts of land. These incomers have now become owners of the land. Some have become rich farming households.

In the 1980s, the Ewenki hunters experienced another blow when it became evident that roads in the region were no longer theirs to use freely either. This greatly compromised their mobility. They were even arrested for cutting down trees to build their traditional conical tents. They also received huge RMB 10,000 (over US$ 1500) fines for each mountain hare they caught. In the last two to three years, ten hunters have been accused of illegally hunting wild hares or chickens and detained or subpoenaed by local forestry or public security authorities. Seven or eight Ewenki hunters have been convicted, and given prison sentences. Fire is a critically important part of the daily life of Ewenki in the mountains. However, use of fires has been prohibited by Forestry Bureau fire regulations focused on prevention of forest fires. Traditional Ewenki practices using fire are now seen as a problem. The Ewenki people have been pushed into a corner. They have been robbed of everything on which their lives have depended for generations. In order to ensure their own survival they have become frequent law-breakers. This situation raises the obvious question of what role the law should play in the protection of the rights of this local ethnic minority population.

Local cultures are the products of evolutionary processes in which material practices adapt to local ecological conditions. Attachment to ancestral land is a key aspect of the cultural identities of indigenous peoples. The reason why some eco-resettlement schemes can be designed and then executed with amazing swiftness is greatly to do with the non-existence of laws to protect ethnic minority populations' rights to their lands. Infringement of these rights by outsiders shows clearly how indigenous cultures have been disrespected. Legislation in this area would be an excellent place to start the hard work of maintaining cultural diversity.

V. Where best to focus efforts to protect cultural diversity?

In many parts of China, the tourism industry is growing rapidly. To facilitate that growth, local governments have been eager to showcase their local cultures. Many cultural festivals and celebrations are organized, and ethnic minority performances are common. Construction of traditional-style buildings is a growth industry in many places. But behind this ethnic minority-themed activity, the substantive welfare of local ethnic minority people is often neglected, if not forgotten altogether. This deserves close attention and remedial action. The reindeer-herding Ewenki hunters have been subject to just such treatment. Local authorities hold annual festivals celebrating reindeer-herding culture. However, these festivals are oblivious to, or even undermine, Ewenki struggles to retain their hunting lifestyle and keep their small reindeer herds. It is of course possible that organizers sincerely believe that these events can promote economic growth and improve the lives of the Ewenki. However, there is no evidence to suggest that these events have brought tangible benefits to Ewenki hunters. If anything, the Ewenki have found them to be offensive. These conflicting perspectives raise questions about the nature of culture, and what is an essential part of a culture, and how relationships between culture, sustainable development and biodiversity should be determined.

These issues can be thought about in the following way. Efforts to preserve local cultures should be carefully tailored to work with cultural aspects that promote ecological coherence with the local environment. This should include a culture's characteristic mode of production and material lifestyle, which relate closely to the ecological niche in which a population lives. By contrast, clothing styles and artistic creations are certainly cultural products, but they are often relatively inessential.

Ornate performances meant to showcase these superficial aspects of local cultures, can contribute to a misrepresentation of the overall culture. This helps to explain why local populations often resent these programmes.

Ethnic minority artistic performances in China are often tacky and superficial. They focus more on economic gain than on a genuine concern for the well-being of the local population. But even if these shows prove profitable sometimes, and manage to improve incomes and living standards among local residents, they do not necessarily contribute to the preservation of local cultures. If essential or fundamental values are overlooked, the culture is bound to eventually disappear. More tragically, when the core of a culture has been destroyed by outside forces, artistic performances become instruments by which those who used to practice the culture are reduced to performers, and objectified and exploited in that role. In this process, people may become alienated from even these inessential (though not unimportant) aspects of their own cultural tradition. As their exploiters are economically enriched, the minority group becomes pauperized as well as culturally deprived.

It is also important to be mindful that maintaining a culture does not mean preventing it from changing or evolving. Cultural conservation should mean that no culture is forcibly reformed against the will of those who practice that culture. However, natural evolution of a culture should be supported. Voluntary changes that come from within the population and which are consistent with the ecological values definitive of the culture should be accepted and even encouraged. It is this kind of change that helps to sustain any culture. After all, genuinely meaningful cultural maintenance should be motivated by a concern for the well-being and autonomy of those who practice the culture, and not by the self-interest or paternalism, benevolent or otherwise, of outsiders. It is only when cultures are maintained by practitioners of the culture that continuation of the ecological benefits of that culture is likely to continue.

Tolerating different cultures means tolerating different value systems and philosophies. Difference cannot be addressed by transfers of money alone. In a rapidly growing and modernizing China many different traditional belief systems are being severely tested. The difference between helping cultures to survive and seeking to eradicate or dilute them reflects a difference between economic growth that results in better and more meaningful lives for people and economic growth that only generates impressive statistics, such as GDP values.

It is the job of government to see to it that a society is guided by the right set of core values. The Chinese government's goals of building 'a harmonious society' helps to define a framework within which to reconfigure the value orientation of Chinese society. Significantly, these goals expressly make room for pluralistic values. Of course, at the local level, many officials still treat a high rate of economic growth as the only worthy object of pursuit, and pay little attention to the kinds of issues discussed in this chapter. This must be corrected if there is to be meaningful and effective government involvement in preservation of minority cultures.

VI. Are modernity and tradition mutually exclusive?

The experience of the Ewenki people shows how modern social and economic organisation can promote an indiscriminate rejection of that which is traditional, including local cultures. The question, now increasingly being asked by many in China, is whether it is necessary to choose between 'modernity' and 'tradition', or if there are other alternatives.

This case study of the reindeer-herding Ewenki hunters reveals that heavy-handed cultural engineering projects can be poorly thought out, or even have dubious motives. Furthermore, project design and implementation has not been cost-effective. The state has had to spend a lot of money to 'maintain' Ewenki people, who are the single costliest ethnic minority group

in terms of per capita subsidy expenditure. This is obviously unsustainable and will soon become a burden that the government will wish to unload, even if it cannot easily do so. To escape from this predicament, a third alternative is necessary. This third way can be seen as attempting to reconcile tradition and modernity.

In what may be a somewhat ironic twist of fate, local cultures have increasingly become an economic asset in themselves. Even as outsiders continue to try to 'bring indigenous people out of their primitive state and into the modern age,' a counter-trend is taking shape, the 'moderns' from the cities, yearn to experience 'pre-modern' forms of life. Local populations and the local government should take advantage of this trend. Local or indigenous cultures are no longer something to be ridiculed, condemned, rejected or reformed.

None of this is to suggest that it will be easy to achieve reconciliation between modernity and tradition in this case. It is bound to be a tall order. As of yet, there are few successful cases, and this makes successful conservation of biodiversity a challenge. The Ewenki case shows that economic development and cultural progress is fundamentally a matter for the members of a cultural population, rather than outsiders. Paternalism, even of the benevolent kind, can often do more harm than good.

VII. Cultural diversity calls for a fundamental change in development outlook

Rapid industrialisation is the main driver of precipitous losses of both biological and cultural diversity, even when development has also yielded vast material benefits for many people. Development needs to deliver the maximum amount of economic and social benefits without being ecologically and culturally destructive.

In the report of the World Commission on Culture and Development, it is argued that 'the time had come to do for "culture and development" what had been achieved for "environment and development"…. [S]o, it was felt, the relationship between culture and development should be clarified and deepened, in practical and constructive ways.' (UNESCO, 1997:8). The Commission report argues against a narrow conception of 'culture' according to which it is 'purely instrumental, not something valuable in itself, but a means to the ends of promoting and sustaining economic progress.' (1997:14). Citing the noted American anthropologist Marshall Sahlins, the Commission report takes the view that culture is 'the total and distinctive way of life of a people or society', and that it is, therefore, 'meaningless to talk of "the relation between culture and the economy", since the economy is part of a people's culture…' (1997:13). The question, after all, is whether culture is 'an aspect of a means of "development", the latter understood as material progress, or if it is the end and aim of "development", the latter understood as the flourishing of human existence in its several forms and as a whole.' (1997:13).

The World Commission on Culture and Development makes it abundantly clear that culture should not be subordinate to the imperative of development. Cultural development is also an important part of development, and cultural development is not the same as cultural modernization or homogenization. Once this is recognised it is possible to understand what went wrong in the Ewenki case, and what should be done differently in the future in other cases to avoid the obliteration of other indigenous cultures.

China has always been both biologically and culturally diverse. To protect either, both must be protected. This requires that interventions are based on the right conception of growth and development. Indefinite expansion of material wealth is a sure and short path to ecological collapse, including extinction of both species and cultures.

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Part Three
Institutions and policies

11
Environmental Rule of Law in China: Why the system isn't working

Wang Jin and Wang Mingyuan

中国的环境法治：现状和思考

I. China's environmental crisis and the need for effective rule of law

China's economy has been growing at phenomenal speed since reform policies where first implemented in the late 1970s. More recently, even in the midst of the global financial crisis, China has managed to maintain overall balance and to continue industrialising and urbanizing apace. Yet spectacular growth rates have also cost the society and the environment dearly. Successful sustainable development in China requires a fundamental recalibration of relations between the economy, society and the environment.

China is home to some of the world's most polluted cities, with Beijing, Shenyang and Taiyuan among the worst. The World Bank has indicated that health and property losses from air pollution can cost the Chinese economy as much as 6 per cent of GDP (World Bank, 1997). Even more alarmingly, a recent study by the Chinese Academy of Sciences suggests that the cost of environmental pollution in China could be as high as 18 per cent of GDP (Niu, 2004). In March 2004, *National Geographic* magazine published a cover story titled 'China's Growing Pains: More Money, More Stuff, More Problems'. In it, the author asks 'whether the Chinese have not so much been creating an economic superpower as committing ecological suicide' (Becker, 2004). The *2004 Report on Studies in Green National Accounting*, jointly published in 2006 by the State Environment Protection Administration (now the Ministry of Environmental Protection) and National Bureau of Statistics (NBS), pointed out that environmental pollution cost the national economy over RMB 500 billion (US$ 75 billion) in 2004, or 3.05 per cent of GDP. The clean-up cost was around RMB 290 billion (US$ 44 billion), or 1.8 per cent of GDP (Wang and Yu, 2009). Repeated incidents involving 'cancer villages' and many lead poisoning cases caused by pollution in recent years are ample evidence that China's environmental problems affect not just property and ecosystem security, but also the lives and the health of Chinese citizens, who are of course the foundation of the economy and society.

How should the environmental crisis that has come along with China's rapid economic growth be understood? The natural environment possesses both economic and ecological values, the former support human development, and the latter sustain human survival. Whilst the economic value of the environment and natural resources can often be determined and realised in tangible forms through market exchange, the same is not true of the inherent ecological value of nature, which is not amenable to market evaluation. The 'invisible hand' of the market is therefore of little use for coordinating efforts to protect nature. This is one of the fundamental reasons why it has been so enormously difficult to solve environmental problems in China, and indeed everywhere else.

We know from the experience of the developed countries in the global North that two basic instruments are essential for tackling environmental problems. These are science and technology and law. These two instruments are necessary but also insufficient on their own, they need to be used together to achieve optimal results. From the legal perspective, environmental laws are designed to protect all dimensions of the environment on which human society depends. They answer to the technological, economic and social needs of society, and are bound by the laws of nature. Their implementation relies on the state exercising its coercive powers to coordinate relations between people and nature. Environmental laws therefore need to define what is required of human activities such that they advance the interests of society without harming the ecosystems which are the foundation of all activity.

II. Obsolete ideas and inadequate legislation: how and why the environmental rule of law has failed in China

Of all the legislation passed by the National People's Congress and its standing committee, environmental legislation (including laws governing natural resources) has enjoyed the dubious distinction of being approved most rapidly and most often. Since 1979, no fewer than 20 major pieces of legislation are connected to the environment. This amounts to about 10 per cent of the total laws passed by the Congress in this period. These include the *Environmental Protection Law*, the *Environmental Impact Assessment Law*, the *Marine Environmental Protection Law*, the *Air Pollution Prevention* and *Control Law*, the *Water Pollution Prevention and Control Law*, the *Noise Pollution Prevention and Control Law*, the *Solid Wastes Pollution Prevention and Control Law*, the *Radiation Pollution Prevention and Control Law*, the *Land Management Law*, the *Water Law*, the *Wildlife Protection Law*, and the *Mineral Resources Law*. At least nominally, a system of legal codes governing environmental protection and resource conservation has emerged in China. However it has many flaws, including an outdated underlying philosophy, inadequate scope, lack of substantive content and poor functionality. More generally, environmental legislation in China still provides inadequate support for the national objective of sustainable development.

1. The failure to protect basic civil rights and uphold the rule of law

In China, the fundamental principle by which the affairs of the state are managed is that the country is to be ruled according to law, and must be a socialist country under the rule of law. Where environmental laws are concerned, this principle has not been closely adhered to. Here is some evidence for this.

First, the founding assumptions of environmental legislation are based on an anthropocentrism which is outdated and inappropriate. It is possible to discern several stages in the history of environmental legislation around the world, from codes governing resource conservation to the distinct new legal field of environmental law that has emerged today. Initially, these laws served the economic interests of the society for resource exploitation for the purpose of human development. Then they began to combine greater concern for protecting the environment with wider concern for human self-interest. In the third and latest shift, environmental laws have increasingly been informed by biocentrism, or a belief that the environment should be protected to support both long-term human survival and development and also for its own sake, for the continuing well-being of the earth's ecosystem as a whole. This gradual transition in basic value orientation and prioritisation of different forms of knowledge has changed the focus of environmental legislation. The progression from anthropocentric to more non-anthropocentric environmental legislation has reflected broader trends in shifting fundamental values.

In China, however, the purpose and basic function of environmental legislation remains overwhelmingly anthropocentric. The 1979 *Environmental Protection Law (Trial)* states that:

> The purpose of the Environmental Protection Law of the PRC is to ensure that natural resources are used rationally in building a socialist and modernised China, that the environment is not polluted or the ecosystem degraded, that the citizenry is provided with a clean and habitable living and working environment, that human health is protected and that economic development continues.

Chinese environmental law scholars agree that the legal interpretation of this statement addresses two issues of basic significance in the *Environmental Protection Law*. One concerns its mission, which is to ensure the rational utilisation of natural resources, environmental protection and ecological preservation, and the existence of a clean and suitable living and working environment for all during the process of national modernisation. The other concerns its purpose, which is to

protect human health and to promote economic development. This purpose was updated in the amended version of the Law passed in 1989 to read:

> This Law serves to protect and improve the living environment of citizens and the country's ecological environment, to prevent pollution and other hazards that threaten the public interest, and to safeguard human health and facilitate the process of socialist modernization.

But this is only a more compact version of the first statement without meaningful improvement in either its mission or purpose.

Compared with other major countries around the world, China has not moved beyond the 1970s in terms of thinking about why environmental laws should exist at all. Chinese lawmakers remain wedded to a traditional human-centred ethic, which is indifferent to the well-being of the earth's ecosystems. Environmental laws are as an instrument to serve the interests of society, and facilitate economic growth. This type of environmental law is an expression of shallow environmentalism. Despite efforts by scholars of environmental law to add token references to modern environmental theories, their efforts belie the reality of environmental practices on the ground. This narrow focus of environmental legislation, even when it is obeyed, yields limited benefits.

Secondly, the preference for generality over specificity compromises the enforceability of environmental legislation. For many years, Chinese legislative organs have favoured use of legal language that is general rather than specific. The idea is that laws should be concise and direct, simple and easy to understand, and they should promulgate basic principles and not elucidate details. Specifics should be left to implementation guidelines, supplementary provisions or to the discretion of law enforcers. This practice has been particularly influential in the area of environmental legislation. Most of the provisions in environmental and natural resource legislation are too abstract, general and vague, and lacking in practical content. As such, they are inadequate for effective rule of law, and the protection of civil and other legal rights of rights-bearing entities.

One consequence of this cluttered coexistence of environmental legislation, implementation guidelines, and supplementary provisions is that detailed legislation sometimes contradicts higher level legislation. Moreover, the vague and general nature of environmental legislation and its limited functionality means that enforcement agencies have practically unbound discretionary power to act in whichever ways they see fit, despite their staff frequently lacking adequate training in either legal enforcement or legal management. This has often resulted in haphazard and incomplete implementation and enforcement of environmental laws. Incompleteness results from various factors. These include contests between administrative agencies responsible for environmental and natural resource management in which participants try to engage only with issues that yield some form of benefit. As a result, many laws are not enforced, or enforcement is too lax, and many violations go unpunished. In other instances, environmental and resource management agencies and their staff deliberately sabotage law enforcement by bending laws to suit their own purposes or even breaking them outright. In other instances, administrative agencies can be handicapped while trying to do their work because legal guidelines are ambiguous, abstract and unenforceable.

The so-called 'single-issue' environmental and resource protection laws have also failed to keep up with emerging problems arising from newer forms of environmental pollution and health hazards. They fail to assign responsibility for protecting the environment (particularly for overseeing environmental impacts and resource use by the private sector) to officials at various levels of government. They also do not support the creation of a legal environment that encourages businesses and corporations to use resources efficiently (and indeed to conserve resources). Legislators have not managed to integrate environmental ideas into the basic laws and institutions of the country. Soft punitive measures for violations of the law do little to encourage compliance.

Thirdly, because public participation in environmental decision-making has traditionally been weak and environmental nongovernmental organizations lack clout, a multilateral and open system of environmental management and control has yet to form. In China, the primary mechanism for implementing and enforcing environmental and resource laws has always been direct administrative control by the government. By comparison, market mechanisms and economic instruments have tended to be relatively weak. Nongovernmental and grassroots organizations are still largely on the fringes of society and public participation in environmental protection, especially through legal means, is haphazard and lacking in institutional support. In addition, many economic activities with devastating environmental consequences are carried out by the government itself, sometimes in partnership with business. Public disclosure of environmental problems, participation in environmental decision-making, and protection of citizen health, life and property are too often jeopardized by unscrupulous and overzealous pursuit of economic growth. This growth often comes directly at the expense of the environment.

2. Sustainable development and the socialist market economy: why current legislative processes are not helping

Environmental legislation in many developed countries has followed a bottom-up development process, in direct response to public demand or as an outcome of environmental dispute resolution. However, in China, environmental legislation always emerges in a top-down fashion. Legislation is unilaterally initiated by the government, or the Party, usually reflecting a concern for social welfare. The advantages of this legislative approach are self-evident. However, weak public participation in China means that it is usually only those working in administrative agencies that in practice have the right to propose laws. This betrays the original intent of the top-down benevolent authority legislative model. Citizens are rarely given a real voice in this mode of environmental governance and their environmental rights are rarely acknowledged or honoured. It is important that improvements are made in this area. Legal scholars with a strong commitment to social justice have an important role to play in addressing this.

The legislative process for environmental laws usually begins within the State Council, where a relevant section will write a draft of the proposed legislation. This draft is then submitted to the legal affairs department, for discussion, negotiation and legislative and technical evaluation before changes are made. A second draft is then submitted to the executive meeting of the State Council. Once approved, the second draft will be forwarded to the National People's Congress or its standing committee for final review and approval. This process is quite cumbersome and complicated because many concerned agencies have their own interests to look after, and the resulting legislation often ends up catering to these more than it does the interests and concerns of citizens. This undermines advancement in environmental legislation, encourages the impunity of law enforcement officers, and threatens people's rights to health, life, and a sound environment. It also increases the risk that laws are hijacked by individual groups and effectively become the laws of a particular department or agency. This jeopardizes not only the internal coherence of a nation's system of laws but their very legitimacy and credibility.

In 1993, the Environment and Resources Protection Committee of the National People's Congress was established. It is entrusted with the authority to initiate the preparation and drafting of bills for direct submission to the National People's Congress or its standing committee for review and final approval. Together with the traditional legislative process described earlier, there are now two legislative models in effect. This is no doubt an improvement on the pre-existing situation. However, the limited resources and capacity of the Environment and Resources Protection Committee often means that it delegates drafting of environmental bills to administrative agencies. At present, there are insufficient mechanisms to check the negative influence of these agencies on environmental legislation.

Most of China's environmental and natural resource laws and regulations were passed in the 1980s, when the economy still relied heavily on government planning. Since the 1990s, more laws and amendments have been passed covering environmental protection and resource conservation. But in terms of legislative priority, the first-generation of so-called 'single-issue' environmental laws has focused overwhelmingly on pollution abatement and clean-up rather than resource conservation. In terms of pollution abatement and clean-up itself, the emphasis is on setting and meeting discharge restrictions, and not on the pollution source itself. This situation is amply reflected in many of the administrative management systems currently in place.

Ineffective enforcement of environmental and resource laws is endemic in China. It results from insufficient public pressure and a lack of incentives to protect the environment or to conserve natural resources. This, in turn, is due to the relatively small role that market mechanisms and economic instruments play in this area, to the pressure of economic growth, and of course, to the absence of formal or legal guidelines on public participation. In addition, lacunae in environmental legislation also help to ensure that Chinese environmental laws still have some way to go before they can fully meet the needs of a socialist market economy and of sustainable development.

Environmental and resource protection laws can be understood as answerable to the interests of three main parties. These are, firstly, the general public, which is the intended beneficiary; secondly, entities subject to environmental regulation; and finally, government administrators and regulators. Each of these parties has its own set of interests and expectations. In China, the subjects of regulation prefer lax government rules, regulations and standards, and try to influence law-making in that direction, often through appeals to the needs of the local economy. For their part, the other two parties can sometimes disagree fiercely over legislation. The public tends to demand accountability and punitive measures the most, whereas government agencies tend to look after their own administrative interests. This has resulted in significant dilution (or even deletion) of key provisions addressing the assignment of responsibilities in many environmental laws. Under such circumstances, there is no-one to stand up and defend the public interest. It is tempting to argue that the National People's Congress and its standing committee could function as a check on legislative abuse, but review of the 20 or so environmental and resource protection laws already enacted shows that they have either not addressed the legal rights of citizens at all or have only done so superficially.

3. How the government management system creates weak environmental laws and ineffective legal mechanisms

Environmental laws in China concern a great variety of subjects and tend to have a very broad scope. This means that they inevitably come up against the entrenched interests of government agencies. It has been a genuine challenge to make different environmental laws work together in a coordinated fashion, rather than at cross-purposes. One reason has to do with the gaps that still exist in China's environmental and resource protection laws. For example, there is still no legislation regulating chemical pollution, protection of nature reserves, biodiversity and biosafety. In the area of 'single-issue' or 'single-topic' legislation, legislation still has to be enacted to protect agricultural lands, wetlands and river basins. In the areas of clean production and energy conservation, two existing laws – the *Clean Production Promotion Law* and *Energy Conservation Law* – are long on abstract and general principles and short on details and specificity. They are currently inoperable and ought to be amended. Moreover, China's *Environmental Protection Law* is now more than 20 years old. During this time, many more sophisticated single-issue or single-topic laws have been passed that have superseded this earlier legislation. This has rendered these laws largely obsolete or redundant. They should be immediately updated.

The fragmented state of environmental legislation is also explained by the absence of basic or overarching laws that coordinate more specific laws. One small step forward on this front is the passage of the *Urban and Rural Planning Law* in 2007. This Law replaced the *Urban Planning*

Law, and its significance lies in formally recognizing the inconsistency in continuing to treat urban and rural areas as distinct in terms of economic and social planning. This is a small step in the right direction, but there is still a very long way to go. The legislative map also lacks an overarching law to adjudicate conflicts between natural resource exploitation and environmental protection. While it is common to think of the 1989 *Environmental Protection Law* as addressing all issues relating to the environment, it is predominantly about pollution abatement, and has little to say about resource conservation and ecosystem preservation. It is a 'basic environmental law' in name only, or perhaps a basic law with respect to the specific issue of environmental pollution. Because of their narrow focus, single-issue environmental laws are by definition unable to address larger issues such as relationships between resource use and environmental protection. In conclusion, a fit-for-purpose basic environmental law is urgently needed.

III. Reasons for poor environmental rule of law in China: local protectionism and a weak monitoring system

Article 16 of the 1989 *Environmental Protection Law* states that: 'Local governments at various levels shall be responsible for the environmental quality of areas under their jurisdiction and take measures to improve it where necessary'. This section looks at what actions local governments have undertaken and what they have achieved.

More than a decade ago, the State Environmental Protection Administration summed up China's environmental problems as 'improving in some places but worsening on the whole and facing a worrisome future'. Over the last decade the state has responded by establishing the Environment and Resources Protection Committee under the National People's Congress; passing or amending over 10 environmental and resource protection laws; and significantly upgrading the State Environmental Protection Administration to full ministerial rank (it is now the Ministry of Environmental Protection). Moreover, government spending on pollution abatement and clean-up jumped from RMB 72 billion (US$ 11 billion) in 1998 to RMB 450 billion (US$ 68 billion) in 2008.

However, over a decade later, China's environmental conditions remain as grim as ever. In January 2010, the *Midterm evaluation report on national environmental protection activities under the Eleventh Five-Year Plan* was discussed and passed in principle at an executive meeting of the State Council. At the meeting, it was noted that: 'while some positive results have been achieved during the period of the Eleventh Five-Year Plan and many of the binding targets for emission reductions have been met, environment pollution as a whole has not been contained, environmental monitoring falls short of what is needed, and the general situation remains grave.'

What factors have led to this situation? Rapid economic growth (including the development model and structure of the economy) create certain problems. However, the main culprits in China's failure to build environmental rule of law are local protectionism and poor monitoring and supervision by local governments. These local level institutional failings have failed to stop damage to public health and property, and to vital ecosystems. They reflect unfair competition and other perversities within the market system.

1. Local government policy: GDP growth first, even if the environment is sacrificed

China in the 1980s fervently pursued economic growth and a higher material standard of living for its people. Central government and national economic policy focused on GDP growth. This was reasonable, but GDP accounting failed to include costs of resource depletion and ecological degradation. Political centralisation, a poorly educated population, and weak rule of law shaped an economy that was resource, energy, and pollution intensive and inefficient. A crude form of economic management prevailed.

Statistical analysis of data from the *Chinese Environmental Quality Bulletin* published annually by the State Environmental Protection Administration since 1994, shows that untreated industrial discharges – the so-called three wastes (solid, air, and water waste) – have been increasing. Natural resource exploitation has been intensifying with each passing year. What happened to the Huaihe River illustrates this well. Home to such prominent historical figures such as Confucius, Mencius, Laozi, Zhuangzi, and Mozi, the Huaihe River is of undisputed cultural and national value. It has also been the site of a pollution clean-up project which started more than a decade ago, and which has cost the government RMB 60 billion (US$ 9 billion). More than a decade later, however, water quality in more than 50 per cent of the river still falls below minimum safety standards. In fact, most of the water in the river has received a Grade V classification, meaning that much of the riverine ecological function has been lost. The quality of water in the tributaries of the Huaihe River is not much better.

The key reason for this is that too many officials in local government, including some party leaders, are all willing to pursue economic growth at all costs, even if it means spoiling the natural environment on which the livelihoods of their constituents depend. Under such circumstance, the state's own role in environmental monitoring and supervision has become an empty shell. Environmental rule of law is dysfunctional.

None of this is lost on local political leaders. Unfortunately, none of them are in a real position to do anything about it either. When faced with the choice between environmental quality and GDP growth, most will feel pressed to choose the latter.

Local government fixation on GDP growth cannot be understood independently of the practice of assessing the job performance of local political leaders on the basis of local economic growth rates. In China, GDP is no longer simply a measure of a country's economic conditions; it has also become a yardstick by which political achievement is gauged. High economic growth rates, whatever their long-term environmental and social implications may be, bring promotions and other political opportunities. Since improvements in environmental conditions don't count towards GDP growth they are, at most, an optional consideration in the performance evaluation of local political leaders. At most, leaders will only pay lip service when doing so serves some political interest.

In China the rule of law is still more of a slogan than a fact. This compounds problems of incentives for local officials. There is no guarantee that the environmental monitoring and supervisory system mandated by China's environmental legislation will be fully honoured by local leaders. This makes it all the more significant that the country has recently embraced a philosophy of economic and social development that is humane, balanced, integrated and sustainable. If job performance evaluation systems for political office-holders could be reformed to make traditionally calculated economic growth rates no longer the primary determinant of official career advancement, there would be enormous benefits for Chinese economy and society.

2. Meeting private capital investment quotas: failure of governmental monitoring and supervision

Clause 2 of Article 13 of *China's Environmental Protection Law* states that:

> Environmental impact assessment, which is required for construction projects, is a document that contains information about how the pollution generated by the project is likely to affect the environment. The document must articulate how pollution from the project is to be minimized, and it must be reviewed by relevant authorities in charge of the project, and then submitted to administrative agencies in charge of environmental protection for their certification. It is only when the document has already been certified that economic planning authorities can grant approval to the project itself.

What this article *does* is to specify the mechanics of environmental impact assessment. But its *underlying rationale* is to ensure that concern for the balance between economic and social developments is institutionalized, such that there is a system in place by which we can try to minimize pollution from new, redeveloped or expanded development projects. To this end, China also enacted a special *Environmental Impact Assessment Law* in 2002.

Similar laws have also been passed at the local level, but most have little bite to them. Most people with any political influence locally are concerned with promoting economic growth. This often involves bringing in outside investment. However, businesses that do come also tend to be resource, energy, and pollution intensive.

With local government approval or stimulus, career politicians at different levels, and especially those in poor areas, have all quickly learned to introduce dirty businesses from other locations to the local area in blatant violation of environmental laws. A 2003 campaign entitled 'Stamp out corporate polluters, Protect public health' was jointly sponsored by six ministries, the State Environmental Protection Administration among them. Fifty-one per cent of the businesses that were disciplined in the campaign had opened only recently.

What explains local environmental agencies' reluctance to exercise their legal authority? Again, the reason lies in the system. Despite explicit legal requirements governing the division and execution of administrative authority, there is at the present time no injunction against the practice of holding joint-appointments in both the Communist Party and administrative bodies at local level. This can impinge on the autonomy of the occupants of these positions. Exercise of power in practice is invariably subject to political influence. Perversely, if local agencies in charge of environmental protection fully discharged their obligations and performed their duties, illegal pollution (and illegal polluters) would be eradicated. But this would adversely affect local economic growth rates, and with it job performance assessments for local cadres.

IV. Judicial remedy as a last resort

In addition to adequate laws, effective administration and law enforcement, the justice system is another means by which the coercive power of the state can advance public interests in relation to the environment. Courts are the last line of legal defence for the public in cases of abuses of environmental rights. When a citizen presses charges and brings an environment-related dispute before a court of law for litigation, the court, as a representative of the state, must act as an arbiter, and ensure its judgments are honoured and implemented.

Judicial practices should directly apply current environmental laws; at least that is the theory. The courts negotiate relations pertaining to the environment, they offer protection for the legal rights of plaintiffs, they monitor and promote general adherence to environmental laws, and they may even provide *ad hoc* remediation for flaws and gaps in existing laws. They also offer lessons and experiences for further improvements in existing laws and their application. Judicial supervision of environmental administration involves making judgements on the legal consequences which result from implementation of environmental protection laws, administrative regulations and government rules by administrative bodies. In a sense, this process is an inspection of the political products that the state put into the society and it emphasises rectification and redress after the event.

Environmental jurisprudence occurs through litigation in individual cases brought before the courts. Examples include losing a lawsuit as a result of illegality in procedures for administrative punishment of an administrative organization, or losing a lawsuit as a result of an administrative organization failing to enforce the law strictly (or carry out its lawful duties).

In reality, a growth-first mentality, flaws within the judiciary system itself, poverty, and inadequate environmental laws, mean that China's judicial system is still incapable of providing robust protection of environmental rights against abuses. When conflicts between the imperative of economic development and environmental protection arise, judicial organs are ineffective at helping the latter prevail. These organs are, therefore, still less able to facilitate the strengthening of law enforcement. Examples which illustrate this include the water pollution disaster in the Huaihe River Basin, and numerous incidents involving 'cancer villages'.

There are two types of environmental litigation cases in China, civil and criminal. Their two outstanding characteristics are that: (1) most plaintiffs are natural persons, and (2) high rates of acquittal. There are several reasons why plaintiffs do not usually win. These include the fact that natural persons are invariably at a decisive disadvantage in terms of various kinds of resources – financial, material and social networks –compared with corporations and other entities. Moreover, litigation is very often chosen only as a last resort, that is, after other means of achieving some desired results have been tried and failed. But the reason they would have failed using other methods is the very same as why they would also lose in a court of law, namely, resource handicap. Ordinary citizens are, therefore, almost set up to fail when they come face to face with corporations in a judicial context. Furthermore, current rules governing the burden of proof in civil cases make little sense. In the general provisions of China's civil law on torts, the basic principle places the burden of proof on those who bring the case. Exceptions are made only in cases that involve conspicuously and indisputably dangerous risk factors such as the presence of hazardous substances, the absence of warning signs near construction zones, the hazardous placement of otherwise innocuous objects and pests.

It was not until the publication of *Several Provisions on Evidence in Civil Procedures* by the Supreme People's Court in December 2001 that it became an official rule that:

> In litigation cases where compensation is sought for damages from environmental pollution, the defendant bears the burden of proof that no causal relationship exists between their conduct and the injury of the plaintiff.

It took another four months or more, however, before the provision went into effect in April 2002. All cases of environmental dispute that were processed prior to that time were subject to the old rule that placed the burden of proof on the plaintiff. Of course, given the technically complex nature of many of these cases, the plaintiff was often unable to offer concrete or conclusive scientific evidence that there were no other explanations for the harm they suffered than the act allegedly perpetrated by the defendant(s). One example is the 2001 case of *Chen Jingcai v. Beijing Municipal Coal Development and Management Company*. Chen, who was the plaintiff, could not prove to the judge beyond reasonable doubt that a coal mining operation was solely to blame for his ailment, or that the corporation had acted in violation of relevant waste treatment laws. In these kinds of cases, strict adherence to the old rule assigning the burden of proof could be the decisive factor in determining who won and who lost. Finally, it does not help that the Chinese legal system is still deeply flawed. And as in non-environmental cases, people as plaintiffs generally stand a very poor chance of winning when faced with other defendants that overwhelmingly tend to be administrative agencies.

Criminal cases involving the environment are another relevant area. Despite the fact that official recognition of the category of 'Crimes Involving the Destruction of Environmental Resources' was created by China's 1997 *Criminal Law*, this category is actually subsumed under the larger one of 'Crimes Involving the Disturbance of Public Order'. This approach differs significantly in character from modern criminal law in western countries, where 'crimes of environmental damage' focus on punishing criminals who threaten or damage the environment, such crimes are not primarily a matter of administrative regulations and rules (as is the case in China). This indicates how far China is behind modern best practice in handling environmental abuses.

Since 1998, there have been fewer than 30 cases nationwide that were officially recognized as 'crimes of serious environmental pollution'. This shows that Chinese criminal laws offer but very inadequate legal protect for both China's environment and its citizens.

With respect to the judicial system, even though Chinese laws grant autonomy to judicial agencies, in practice, the exercise of this independent power is severely constrained, both by the supremacy of the Communist Party (CCP) on the one hand and also by the tension between the Party's supremacy and legal authority at local levels. Obstruction by local governments is common. Pervasive conflicts of interests arise from joint- and cross-appointments in the party bureaucracy and in the administrative bureaucracy. Few who hold legally bestowed judicial powers are free to exercise these powers without having to be constantly mindful of the consequences of their actions either for themselves or for their districts.

V. The long road ahead

Building environmental rule of law in any country is necessarily a large and complex undertaking. For what must be established is an entire system made up of different parts, including the institutions and the mechanisms for legislation, enforcement, jurisdictions and compliance. While each of these components plays a distinct role, just as importantly, they must work together if the system as a whole is to achieve the desired outcome. Of course, since environmental laws do not exist independent of a country's entire system of laws, they are necessarily subject to the same formal constraints which bind all other laws of comparable stature.

In conclusion, there are many flaws in China's current system of environmental rule of law. Their impact on the country is bound to become increasingly evident as economic development continues apace. Indeed, it can be posited that emerging environmental problems could be fatal for China, insofar as they may constitute a threat to the very ecological foundation on which the survival and flourishing of the country depends. Correcting these shortcomings will not be easy, but China has no choice but to tackle them. It is important to remember that the livelihoods, wellbeing, and survival chances of future generations depend on choices that are made today.

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12
Local and Central Government Relations: Impulsive investments and sustainable development

Shen Keting

地方与中央:投资冲动与可持续发展

I. Introduction

In China, the tendency of local governments to pursue their own interests, even when this means failure to comply with central directives is a serious governance problem. Defects in China's fiscal and taxation systems contribute to destructive competition between local governments as well as between local and central governments. The combination of a taxation system where sales taxes play a key role and a government official performance appraisal system that focuses on the economy makes local government revenue highly dependent on GDP. Local governments become extremely sensitive to counter-cyclical policies of the central government. Moreover, deficiencies in the tax collection and administration system exacerbate local protectionism, government-business collusion, and competition to attract outside investments. Weaknesses in the budgetary system and loopholes in the institutional framework for natural resource management also create soft budget constraints for local governments. It is unrealistic to expect local governments that enjoy unchecked power and limited need to pursue fiscal discipline to take the initiative in limiting economic expansion. A new system of public finance is therefore central if economic growth is to be sustainable, and if a more environmentally-friendly industrialization path is to be found.

Since the start of the Sixteenth Chinese People's Congress, China's central government has adopted a development philosophy based on a commitment to sound science, environmental sustainability, and citizen accountability. This philosophy calls for a shift away from a traditional model of economic development that is resource, energy and pollution intensive, towards an ecologically modern one that is less environmentally destructive without compromising economic productivity. However, while local governments are nominally committed to this philosophy and pay lip service to it, their behaviour has not changed in practice. They continue to try to out do each other in how much money they can get from the state, and in how many grandiose projects they can build. This is also reflected in provincial and local government level 11th Five-Year Plans (2006-2010), which have not been as environmentally innovative as has sometimes been claimed.

Between 2004 and 2008, China's central government implemented a series of policies in an effort to cool an overheated economy. However, because many local governments were uncooperative, it greatly reduced the effectiveness of these measures. The result was a higher-than-expected economic growth rate in 2006. In the government work report that Premier Wen Jiabao presented to the National People's Congress in March 2006, the target rate for annual economic growth for the next five years was 8%, and the report stressed the importance of strengthening from the outset the nation's economic preparedness for national and international contingencies so as to avoid fluctuations. However, according to official data the Chinese economy grew by 10.9 per cent in 2006, the highest rate in 12 years (National Bureau of Statistics). The central government's attempts to put a brake on economic expansion largely failed.

In China, it is the responsibility of the state to prevent the economy from overheating, through the use of macroeconomic policy instruments. In recent years, the central government has had to do this many times. However, because the governments at the provincial level and below have an interest in keeping the economy growing briskly at all times, they often act in ways that contradict the aims of the central government. Of course, governments at all levels do not always disagree, and sometimes they share the same economic objectives. For example, in the second half of 2008, soon after the global financial crisis began to spread from the United States, the State Council proposed ten measures to boost domestic consumption, and committed RMB 4,000 billion (US$ 607 billion) for their implementation. This move was quickly followed by local governments that put forward their own spending plans totalling nearly RMB 20 trillion (over US$ 3 billion).

A question that needs to be answered, then, is why local governments are so fixated on economic growth. It is tempting to chalk this up simply to politicians' desire to further their own careers. However, this does not fully explain why local officials sometimes go so far as to defy directives from the central government. Not only can obedience to Beijing generate rewards for local

officials, it is also the case that many local policies designed to attract investments in fact make little fiscal sense if the primary motive for promoting growth is to generate revenue for local government. For example, apparently counter-intuitive practices include giving land away to developers, tax rebates for corporations and reductions in fees. Some governments have even taken on heavy debt burdens just in order to create an investment-friendly environment. Why do local governments do these things? This chapter will make the case that local governments are often driven by forces out of their control, and behave in this way not because they really want to, but because they have to. Understanding what these factors are allows for a better understanding of why local governments are apparently addicted to growth-at-all-cost policies.

II. Destructive competition between local governments

Economic reform in China has essentially been a process of decentralization of various types of power. Early in this process, local governments responded quickly to the opportunity to exercise greater control over local affairs, particularly in the area of economic development. In fact, local governments have played a key role in the growth of the Chinese economy as well as in institutional reform. It is a consensus among Chinese economists that the model of empowering local governments and encouraging competition among them, particularly competition for state money, has been a primary driver of China's economic miracle in recent decades. However, in recent years, competition among local governments has become increasingly vicious and counterproductive.[1] In response, in 2006, five government agencies, including the National Development and Reform Commission (NDRC), issued an *Urgent Notice* (NDRC, 2006) addressing the phenomenon. The *Notice* noted that many new fixed asset investment projects have violated a range of policies, including those regulating industries, procedures for approval and verification of development project proposals, land survey and use procedures, environmental impact assessment, workplace safety and credit borrowing, as well as others. The *Notice* made it clear that these violations must be investigated with appropriate disciplinary and legal actions taken. As had happened in 2004, local governments were asked to tighten land use regulations, development plans, and credit borrowing, to review development projects more thoroughly, and to limit the number of approvals for new projects.

Things did improve somewhat initially. However, by 2010, they had gone full circle, back to where they had been six years earlier. 2009 was a year of ballooning spending by local governments, and in 2010 the central government was once again preoccupied with the task of checking this trend. This is a serious cause for concern. It could potentially lead to economic instability, and contradicts the 'scientific outlook on development'. As usual, politicians in Beijing are quick to criticize local governments for acting in their own self-interests at the expense of the health of the national economy. However, these critics should also reflect on why local government actors behave in the way they do. Why is the 'scientific outlook on development' so difficult to put into action at the provincial and local levels? Are they unwilling to obey the central government's economic plans, or are they unable to afford to do so under given existing institutional configurations? Close examination shows that governments at all levels actually share some responsibility for this problem.

In fact, in trying to understand vicious and counterproductive competition among local governments, the question of *how* they are able to do this is just as important as the question of why they would do this.[2] This chapter argues that severe flaws in China's fiscal and tax systems are largely to blame for lax budget constraints on local government spending. This creates favourable conditions for vicious inter-governmental competition for money at the local level. It is difficult to exaggerate the adverse impact this problem has on the prospects for sustainable development in China.

III. Problems in existing fiscal and tax systems

At the historic Third Plenary Session of the Fourteenth National People's Congress Central Committee, it was made clear that reform of China's fiscal and tax reform was imperative, that a modern public finance system must be established. At the local level, however, reform efforts have been lacklustre since then. In most places, local governments depend on GDP growth for tax revenues, and are therefore extremely sensitive to counter-cyclical macroeconomic policies imposed by Beijing. Tax rules encourage collusion between local government and corporate interests, and foster local protectionism. This not only contributes directly to the fiscal hardship governments at the sub-provincial levels already routinely face, it also hurts them indirectly because tax instruments such as transfer payments, which are designed to compensate for regional inequalities in tax revenues, often fail to work as intended. Greater corruption is one significant negative side-effect of this arrangement.

The country's fiscal and tax policies are, therefore, urgently in need of overhaul if China is to move in the direction of ecological modernization and sustainable development. A rational fiscal system must meet three criteria. First, it must be fair, or equitable, and reduce regional inequalities in financial wherewithal and basic social services. Secondly, it must be efficient, that is, it must help improve the economic efficiency of resource allocation at the local level. Finally, the tax and fiscal system must play a positive role in sustaining the environmental foundations of economic growth over the long term. More specifically, the system should be designed in such a way so as to prevent local governments from pursuing short-term interests at the expense of everything else.

1. How the tax system encourages the overzealous pursuit of economic growth by local governments

In 1994, the central government launched a major reform of the national tax system. One result was the creation of a system where central and local governments would tax revenue. The aim of the reform was to strengthen central government's control over tax revenue (by allowing it a greater cut of the total). The reform, however, did little to improve local tax systems, which remained outdated. In many ways, the antiquated local tax system has proven to be a key hindrance to progress in other areas of reform. The root of the problem is that value-added taxes (VAT) and sales taxes constitute the main sources of local tax revenue. Many local governments go to great lengths, sometimes by engaging in morally and legally objectionable behaviours, to increase their tax receipts.

After the 1994 tax reform, VAT has become a mainstay for central and local governments. One implication of a tax system structured in this way is that the tax revenue of local governments has become tightly linked with GDP. This helps explain the growth obsession of local governments, and their willingness to sacrifice the environment in the pursuit of growth. Apart from VAT, whose receipts they share with the central government, local governments also receive a considerable portion of their tax revenues from sales taxes, especially from real estate, construction, and transportation industries. In recent years, these have become an increasingly important source of tax revenue for many local governments.

Since sales tax receipts by local governments depend on macroeconomic conditions, they are sensitive to macroeconomic policies. Local tax revenues are vulnerable to fluctuations and instability in macroeconomic conditions when they are dependant on sales taxes. It is little wonder then that counter-cyclical macroeconomic policies crafted in Beijing often irk local officials. These and other effects of the local tax system must be taken seriously when state agencies reprimand local governments. Tax items that are particularly sensitive to national economic fluctuations should not be designated as a local tax at all, still less a principal one. If income tax and/or property tax, which are less sensitive to macroeconomic policies and conditions than are sales tax, were the chief source(s) of local tax revenue, local governments would likely assume a more cautious posture in their economic policies, for more industrial activities would not necessarily create more tax revenue.

2. How flaws in the tax system further intensify competition for external investment

One major problem is tax evasion by corporations. According to a report prepared by the National Bureau of Taxation entitled 'A Study of the Distribution of Tax Revenue among Local Governments' (Xu and Wang, 2006), businesses often contrive ways, often through affiliated transactions, to pay VAT where their headquarter is located. The status as a major tax payer confers obvious benefits upon any corporation. However, gaining the status through this dubious manoeuvre violates the so-called 'benefits-received approach' by unfairly hurting the places that have paid most dearly in terms of public services in support of economic production. Moreover, because corporate headquarters tend to be located in wealthy urban areas, this manoeuvre also effectively increases regional income disparities.[1]

A second problem has to do with collection methods. Four rules are particularly notable. First, businesses pay sales tax where they are registered; second, they pay excise tax where their factory plants are located; thirdly, some subsidiaries are allowed to contribute towards their parent company's corporate income tax fund, which means they can avoid paying income tax locally; and fourthly, workers now pay their personal income tax through their employer. All of these rules have the effect of making places of production, sales and consumption pay for the ecological and social costs of economic activities while letting local governments in the areas where corporate headquarters are located reap the tax benefits these activities generate.[2]

It is worth repeating that the current tax system not only does nothing to mitigate income inequality between rich and poor areas, it aggravates the problem by encouraging vicious and counterproductive competitive behaviours in local governments. As was explained earlier, since tax benefits accrue where factory plants are located and where a corporation is registered, strong incentives exist on the part of local governments to make the local policy environment as business-friendly as possible. It stands to reason that if taxation were based on trade and consumption instead of production and corporate registration, local governments would feel less compelled to sacrifice the environment just to please corporate interests, and this would in turn constitute a check on local protectionism.

3. How manipulation of the tax system creates local revenue uncertainty

When the tax reform of 1994 is placed in historical context, it is easy to see why it did little to improve either local tax systems or collection mechanisms. It took place during the early stage of China's transition towards a market economy, when a lot of things unfolded haphazardly, through trial and error. Still, in this reform process, the central government and relevant state agencies also acted in their own interests, making adjustments to tax laws and regulations that would give themselves an advantage.[1]

The stamp duty for securities transactions illustrates this phenomenon well. The growth of the securities market has been driving the growth in stamp duty revenue, it has grown substantially as a percentage of total revenue. In the first half of 2000, during which the securities market boomed, stamp duty revenue from securities transactions accounted for about one quarter of the fiscal revenue for Shanghai. For the year 2000, the national stamp duty revenue from securities transactions reached RMB 48.6 billion (US$ 7.5 billion) which represented 3.83 per cent of total tax revenue, and was 5 times the total stamp duty revenue from securities transactions for the previous 5 years combined. In response to this, the central governments adjusted the distribution schedule for stamp duty revenue. According to the tax sharing system put in place in 1994, stamp duty revenue was to be split evenly between the central and local governments. However, the central government's share grew steadily, to 80 per cent in 1997 and 97 per cent by 2002.

Income tax offers another example of the flaws in the tax system. According to the 1994 tax law, personal income tax was a local tax, while the classification of corporate income tax varied on a case to case basis, depending on the place of registration. In 2002, corporate income tax receipts

reached RMB 212 billion (US$ 32 billion), and personal income tax receipts reached just under RMB 100 billion (US$ 15 billion), which represented increases of 47 per cent and 51 per cent, respectively, from the previous year. With the exclusion of a few special industries such as finance, postal services and railway transportation where tax payments go entirely to Beijing, receipts from both personal and corporate income taxes paid by all other types of businesses are supposed to be shared between central and local governments. Furthermore, the central government must guarantee that local governments can keep no less than the amount of their actual tax revenue for 2001, and would only be required to share with the central government whatever amount is in excess of this baseline. For the year 2002, the central and local governments shared tax receipts equally. For 2003, the central government took 60 per cent, leaving 40 per cent for local governments.

The expansion of the scope of VAT currently being considered by the government is likely to target the real estate, construction and transportation industries. However as VAT receipts are shared between local governments and the state, whereas sales tax is not (it is a local tax), it is all but guaranteed that such an adjustment will adversely affect local tax revenue.

IV. Defects in Government Spending

1. Power disparities: Who controls spending, and who does the work?

One of the most important achievements of the tax reform of 1994 was a clear definition of the fiscal relationship between the state and the provincial governments. In the following two years, the central government called for reform at sub-provincial levels along similar lines, aiming to promote further tax revenue sharing. However, the 1994 reform had not clearly addressed how rights and responsibilities over financial matters and provision of social services should be allocated between different levels of government. The result was that while higher levels of government got more and more money, lower levels of government saw their workload grow and resources dwindle.[1]

The contrast between the highly decentralized nature of public services provision and the increasing concentration of tax revenue in the hands of the highest level of government could not be sharper. In China spending by the central government accounts for 30 per cent of total government spending; this figure is low by international standards. By contrast, fiscal burdens are heaviest for governments at the county level (Institute of Finance and Trade, 2005). They contribute the most towards the provision of social services such as education, healthcare, unemployment insurance and social security. They are also responsible for infrastructure construction and maintenance. Predictably, many county governments are under severe fiscal stress.[2]

The problem is so serious and pervasive, that even wealthy provinces such as Zhejiang have not been spared. For example, Shaoxing county in Zhejiang province is among the top 10 of the 100 richest counties in all of China, but it could barely make ends meet in 2001, and ran budget deficits for the next two years. The county government had little more at their disposal than what was needed to cover salaries for government employees, administrative overheads, social security payments and the cost of other basic social services.

2. Regional Fiscal Inequality

Another problem that the 1994 tax reform did little to help redress was regional fiscal inequality. Through a comparison of statistical data on per capita spending on education, administration and healthcare across different regions, it can be seen that regional inequality in terms of both the quantity and the quality of basic social services has steadily increased in recent years.[1] Trends in the following areas illustrate this:

a *Education.* In 1998, per capita spending on education for the eastern, central, and western regions of China was RMB 178 (US$ 27), RMB 77 (US$ 12), and RMB 90 (US$ 14), respectively.

This means that compared with the wealthy coastal regions in the east, the poorer regions in central and western China were spending RMB 101 (US$ 15) and RMB 88 (US$ 13) less per capita, respectively. While per capita expenditure on education increased for all three regions in 2009, to RMB 1,066 (US$ 162), RMB 633 (US$ 96), and RMB 821 (US$ 125), respectively, the central and the western region still lagged behind the east coast by RMB 433 (US$ 66) and RMB 245 (US$ 37) respectively.

b *Administrative overheads.* In 1998, per capita administrative overhead expenditure for the eastern, central, and western regions of China was RMB 75 (US$ 11), RMB 48 (US$ 7), and RMB 67 (US$ 10), respectively. This means that it was RMB 27 (US$ 4.1) and RMB 8 (US$ 1.2) lower in the central and the western regions, respectively, than it was in the eastern coastal region. By 2006, per capita expenditure in this category grew to RMB 289 (US$ 44), RMB186 (US$ 28), and RMB 242 (US$ 37), for the eastern, central and western regions, respectively, with the centre and the west being RMB 103 (US$ 16) and RMB 47 (US$ 7) per capita, respectively, less than eastern provinces.[1]

c *Basic healthcare.* In 1998, per capita spending on basic healthcare services in eastern, central, and western China was RMB 66 (US$ 10), RMB 24 (US$ 3.6), and 32 (US$ 4.9), respectively, with the latter two lagging behind the first by RMB 42 (US$ 6.4) and RMB 34 (US$ 5.2), respectively. In 2009, per capita spending in this category grew, for all three regions, to RMB 398 (US$ 61), RMB 289 (US$ 44), and RMB 347 (US$ 53), respectively. This meant that even though per capita spending on basic healthcare in western China grew rapidly in absolute terms, it is still significantly lower than the levels in central and eastern regions (State Council Development Research Centre, 2005).

3. Irregularities in the Intra-Governmental Transfer Payment System

Intra-governmental transfer payments from the state to local levels have been growing since the 1994 tax reform. In 2001, 2002 and 2003, the state transferred RMB 600 billion (US$ 91 billion), RMB 735 billion (US$ 112 billion), and RMB 826 billion (US$ 126 billion), respectively, to local governments. These numbers accounted for 51 per cent, 52 per cent, and 53 per cent respectively, of total government outlay, and contributed 46 per cent, 48 per cent and 48 per cent respectively towards local spending for these years. By 2008, transfer payments grew to RMB 2,295 billion (US$ 348 billion), accounting for 62.8 per cent of total government outlay, and 45.9 per cent of total local spending, respectively.[2]

Despite their size, however, these transfers did little to mitigate regional fiscal inequality, which continued to grow. This is to a large degree a consequence of the pervasive irregularities in the transfer payment system. Currently, the different types of transfer payments in China include tax rebates, special-purpose transfer payments, general-purpose transfer payments, subsidies, and many others. However, structural flaws have compromised the usefulness of these transfers for mitigating regional fiscal inequalities. The major types of transfer payment are discussed below.

a *Tax rebates*. In 1994, China's central government transferred RMB 180 billion (US$ 27 billion) to provincial and local governments in the form of tax rebates, representing 75 per cent of the total amount transferred intra-governmentally that year. Since then, the percentage of tax rebates has decreased steadily each year. In 2002, it was RMB 241 billion (US$ 36.6 billion), and accounted for only 33 per cent of the total. In 2009 it was RMB 494 billion (US$ 75 billion), about 17.3 per cent of the total. This considerable proportional drop notwithstanding, tax rebate is still the largest of all categories of transfer payments. However, the amount of tax rebates local governments receive is closely linked to the amount of VAT and sales tax that they pay. And since the latter is contingent on the condition of the local economy, regions that already do better economically also end up receiving more transfer payment in the form of tax rebate than other regions. Therefore, whatever and however benign the intentions behind them may have been,

tax rebates are an ineffective instrument for mitigating regional wealth gaps. If anything, they often exacerbate the problem.

b *Special-purpose transfer payments*. Since the tax reform of 1994, both the scope and the size of special-purpose transfer payments have increased. In addition to natural disaster prevention, towards which this type of transfer has traditionally been directed, agricultural production, infrastructure construction, and funding for economic development of underdeveloped regions and those dominated by minority ethnic groups have all been gradually added to the list of items covered. In 1994, this type of payment amounted to RMB 36 billion (US$ 5.5 billion), representing 15 per cent of the total amount transferred; in 2000, these numbers were RMB 144 billion (US$ 22 billion) and 31 per cent; in 2009, the special-purpose transfer payments grew to RMB 1,236 billion (US$ 188 billion), which accounted for 43.2 per cent of the total transfer amount.

c *General-purpose transfer payments*.[1] According to public records, between 1997 and 2000, general-purpose transfer payments were RMB 5 billion (US$ 760 million), RMB 6.1 billion (US$ 927 million), RMB 7.5 billion (US$ 1.1 billion) and RMB 8.5 billion (US$ 1.3 billion), respectively. In 2002, the central government used all extra revenue made possible by the tax reform towards transfer payments (particularly to the local governments in the central and western regions). Partly as a consequence, the total amount of this type of intra-governmental transfer increased by RMB 13.8 billion (US$ 2 billion) in 2002 and RMB 38 billion (US$ 6 billion) in 2003. Still, even with this increase, this type of transfer amounted to no more than RMB 70 billion (US$ 10 billion), less than 10 per cent of the total. In recent years, general-purpose transfer payments have grown rapidly. In 2009, it was RMB 1132 billion (US$ 172 billion), or 39.6 per cent of the total.

Intra-governmental transfers in China have been the subject of continued controversy. Right now, regulations for the system are lax, and lacking in transparency. Local governments are locked in a tug-of-war with one another for state money, and often resort to ethically and even legally questionable practices to achieve their ends. Many officials in charge of reviewing and approving transfer payments have too much discretion which they often do not hesitate to abuse.

Finally, the way the budget is written also creates opportunities for abuse. Incompleteness and omission of details in the budget make verification of where transferred money has gone difficult, if not altogether impossible. For example, the 2005 audit by the State Auditing Administration of 20 provinces, autonomous regions and municipalities found sizable discrepancies between how much tax local governments claimed they received from the central government in rebates and subsidies and how much the central government claimed it paid out. The first number (RMB 345 billion, or US$ 52 billion), was barely 45 per cent of the second (RMB 773 billion, or US$ 117 billion). The difference between the two, RMB 430 billion (US$ 65 billion), could not be accounted for(SAA, 2006). This inconsistency casts further doubt on the effectiveness of the current transfer payment system, as a policy instrument for lessening regional wealth gaps.

V. The perils of fiscal independence

Is competition among local governments for money from the central government a cause for concern? This depends. On one hand, local governments might be able in this way to secure sustainable sources of revenue, but on the other hand, it is also possible for them to end up killing the goose that lays the golden eggs. In other words, by acting on their competitive impulses, local governments could be either a constructive force that fosters the right kind of economic growth or an agent of destruction that wreaks economic havoc for the nation.

In the last ten years or so, many local governments have become involved in frivolous and extravagant spending in the name of 'urban development'. This, however, has been a problematic practice. Because this strategy allegedly brings different kinds of benefits to a city – for its economy, its local revenue, and its image – that it should be particularly attractive for many local governments is to be expected. But the pursuit of this strategy has resulted in unprecedented urban sprawl and loss of farm land, among other undesirable consequences.

Urban sprawl and commercial redesignation of agricultural land generate tax revenue mainly through the sales and income taxes paid by concerned construction and real estate businesses. Almost all of this money goes to the local government. In recent years, these taxes have become a mainstay for some local governments. In some economically advanced provinces and cities on the east coast, revenue generated in these ways has grown by as much as 50 to 100 per cent. In some places, they now account for more than 37 per cent of total local tax revenue. Especially worrying is the fact that land leasing fees have become the main source of extra-budgetary income for many local governments. Between 2001 and 2003, receipts from these fees in some counties and cities in eastern China reached RMB 1-2 billion (US$ 150-300 million), accounting for more than 60 per cent of extra-budgetary government income. The phenomenon exists in central and western China too, albeit to a lesser extent.

There has been no letting up in this trend in recent years. On the contrary, things are getting worse. The rise of the so-called 'land kings' that call the shots at land auctions is increasing the risk of real estate bubbles. While land leasing fees have generated large amounts of cash, they are still far from enough from meeting the developmental needs of the city. To make up the difference, local governments have increasingly relied on land reserves and government mortgages to support spending on infrastructure construction. This has created a precarious fiscal situation in many places, with wild swings between the good and the bad years. The problem has grown so serious that the central government has become very concerned (Shen, 2011).

Land-based fund-raising schemes encourage vanity projects and those designed to score political points for local officials, and they invite land law violations and other forms of corruption. According to the Ministry of Land and Resources, 178,000 cases of land law violations were exposed and documented in 2003, and 5878 hectares of misused land was reclaimed by local governments. There were 4746 cases of land law violations, involving a total of 10,100 hectares of land, which involved local governments and/or government agencies. Of the nine serious cases of land law violation closely watched by the Ministry of Land and Resources that were publicly investigated, eight involved unlawful conduct by government employees and agencies.

When local governments act more like robbers than servants of the people, their long arms reach out to grab much more than land. They also reach for mineral, water and tourism resources. In fact, nothing that has even a hint of commercial potential is spared. By law, these things belong to the state and the people, however, the relevant laws are less clear about who gets to exercise or execute this right. Therefore, at the present time it is almost impossible to effectively regulate local government conduct where these resources are involved (Shen, 2005).

Collusion between local governments and coal mine owners offers yet another case in point. Since the Ministry of Land and Resources began to clean up the coal industry and tighten regulations in 2006, over 70,000 illegal mining cases have been found, investigated and ended in prosecution. Nearly 18,200 mines have been ordered to suspend operation, and more than 5000 government employees have been disciplined for misconduct and transgression.

The enclosure and the sale of land and the capitalization of natural resources are all examples of how local governments opportunistically take advantages of ambiguities and holes in state fiscal regulations. Local governments are endowed by law with a considerable amount of power, and do not hesitate to use it when necessary. Under sustained fiscal pressure, sooner or later they will try to raise quick money by any means possible at their disposal, including those that involve breach of public trust, just to make ends meet. Institutional reform is needed, to check these pernicious tendencies. Only then can environmentally sustainable economic development that genuinely serves the people become a reality.

The central theme of this chapter is that many of the admittedly short-sighted and selfish behaviours of local governments are due to forces over which they have little control. The root of the problem seems to be that the central government has designed and put in place a tax system under which the amount of social services local governments are charged with providing is in inverse proportion to the amount of resources they are given. Therefore, any attempt to change the conduct of local governments would be meaningful and effective only if the country's fiscal and tax systems change first. If local governments can secure the financial resources they need to carry out their duties and responsibilities toward their constituents in legitimate ways, they would have no reason to try to achieve the same end by acting illegitimately (Zheng, 2005). In addition, greater transparency in the budget process and more effective monitoring of spending should also discourage corruption and other forms of official misconduct. As has already been noted, fairness, efficiency and sustainability are the three criteria by which the soundness of a public finance system should be judged. Economic development that is scientifically sound, environmentally sustainable, and meets the needs of the people depends on it.

VI. Conclusion

It is clear from experience that sound management of fiscal affairs is critical to economic development and overall institutional reform for any country. The ill effects of the vicious and destructive competition among local governments that has been taking place across China in recent years illustrate this very clearly. With one hand tied behind their backs, fiscally speaking, by the poorly designed fiscal and tax systems, local governments have been compelled to use their other hand to do whatever is necessary, including things that may be ethically and legal questionable or even wrong, to secure the resources needed to provide basic social services. In fact, this also helps to explain why heavy industries, whose relative importance among all economic sectors had been declining until recently, are actually making a comeback in many places, while light industries are doing the opposite. Indeed, unless the overall fiscal system offers the right kinds of incentives, it would be unreasonable, if not absurd, to expect local governments to behave differently.

China's fiscal and tax systems need to be improved in a number of key respects. First, it is necessary to improve public administration and modernize the roles and functions of the government to suit real societal needs; secondly, division of duties among different levels of government must be clearly defined, and of course, sensible and fair; thirdly, deficiencies in the tax system must be identified and corrected, and collection mechanisms must be established that facilitate sustainable development; fourthly, an equitable transfer payment system must be put in place; fifthly, supervision and monitoring of local budgeting and expenditure processes must be strengthened;

sixthly, natural resource management must be improved, and lastly, there must be greater transparency and public participation in governance.

It would be remiss not to mention that many government agencies have already taken steps in recent years to support the creation of a better public finance system. Passage of the *Supervision Law of PRC*, and improvements made to the classification system for government revenue and outlay, among others, are just some examples of these efforts. But while these are not worthless, they are still only piecemeal measures, and are no substitute for comprehensive reform of the fiscal and tax systems, which are still urgently needed.

1 Some examples are as follows: a) Some local governments not only spend frivolously on wasteful development projects, they also run roughshod over ordinary citizens in the process of land acquisition, housing demolition and resettlement; b) Some local governments try to get around macroeconomic policies set by the central government by means of subterfuge, convinced that it would be in their best interest to do the absolute minimum of what is required and not an iota more; 3) A wide variety of forms of collusion between government and corporations and local protectionism have effectively rendered policies issued by Beijing irrelevant. A powerful example of this is a corruption case involving collusion between governments and illicit mining operations. This was uncovered in 2005. This case was a blatant violation of the central government mantra of sustainable, people-oriented economic development.

2 The following reasons are most often mentioned as factors contributing towards the persistence of fierce competition among local governments for state money: a) a fixation on high GDP growth rates and b) the political ambition of local officials. Of course, the creation of lists naming the '100 richest counties in China' encourages this kind of competition. Ways of tackling current problems include: the implementation of a green accounting system, covering GDP accounting, and inclusion of environmental management, public endorsement and workplace safety in the criteria for job performance evaluation of public officials. However, political self-preservation is not the only explanation for local fixation on growth. Others reasons include the more primordial desire to be bigger and better than others, for the reputation as a capable leader, and vanity. In this sense, the government shares some common features with corporations. The difference is that increases in government revenue are supposed to benefit the citizens by improving social services, although these are not at present directly linked to job performance assessment. Of course this problem of perverse incentives is not unique to China, even if it does seem to be particularly marked in the Chinese case.

3 A related problem is that some businesses evade sales tax and corporate income tax through transactional and bookkeeping practices. Thanks to the many gaping loopholes in Chinese tax laws tax evasion is even more common among international corporations than among domestic ones.

4 Two cases illustrate this well. The first case is the Datong-Qinhuangdao railway. Even though it does not go through Beijing, because the construction firm is registered there, Beijing city government gets to pocket the sales tax the company pays. By contrast, despite having to spend vast amounts of money on everything from land acquisition, resettlement and security once the railway is built, the governments of Datong and Qinhuangdao get little in return through tax collection. The other example is the automobile excise tax. In theory, this tax ought to be levied at the point of retail. However, according to the Chinese tax laws, it is levied at the point of production, which means that excise tax receipts go to where cars are made not where they are sold, used, or maintained.

5 The trend since the tax reform of 1994 has been that the most easily collectible and the fastest growing types of taxes tend to become state tax items, or otherwise have their central government share increase year after year.

6 In 1993, the central government received 22 per cent of total government revenue. By 2000, the percentage rose to 52 per cent. At the provincial level, government revenue did not decline, but grew, from 16.8 per cent in 1993 to 28.8 per cent in 2000 of the aggregate for each year. This means that at or above the provincial level, government revenue grew from 38.8 per cent in 1993 to 81 per cent in 2000, which also meant that governments at sub-provincial levels had had their share of government revenue slashed, going from 61.2 per cent in 1993 to 19 per cent in 2000. The trend has continued beyond 2000. By 2002, the central government's share of total government revenue reached 55 per cent (Tang 2004).

7 In 1995, of the total of 2,159 counties in China, only 132, or about 6.1 per cent, had a budget deficit. Most counties were able to balance their budgets, some even had a mild surplus. In 1999, with the exception of 3 provinces (Jiangsu, Shandong, and Guangdong) and 2 metropolitan areas directly controlled by the central government (Beijing and Tianjin), all the remaining 26 provincial level administrative units had deficits. In 2002, there were 2,860 counties or administrative equivalents in China. Of these, 830 were cities under the direct control of the central government. Of the remaining 2030 counties or equivalents, 1,620, or about 80 per cent, were under fiscal stress: 706 had deficits and 914 relied on subsidies. Finally, many counties do not show a deficit on paper but still have one in practice (Shi, 2005). As the surge in borrowing by local governments received increasing exposure starting the second half of 2009, their debt risks also become a cause for growing concern (Shen, 2011).

8 All of the data in the following three sections are from the National Bureau of Statistics. Data for the western region does not include Tibet. See also State Council Development Research Center (SCDRC, 2005) for similar analysis.

9 For the years after 2007, the National Bureau of Statistics does not include the data administration overhead, but only the aggregate amount of public service spending.

10 All of the data here and in the following four sections come from the Ministry of Finance.

11 The fiscal and tax reforms of 1994 did not result in the establishment of a uniform transfer payment system. It was not until 1995 that a transitional transfer payment system, modelled on international practice, was put in place and began to operate. According to that practice, the amount to be transferred is determined on the basis of reported local revenues. In 2002, a formalized transfer payment system was officially agreed. It has the aim of evening out regional disparities in government income. However, because of the limited scope of the transfers allowed under the programme, its effects have only been limited.

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13
What Role Can Public Expenditure Play in Meeting China's Environmental Protection Targets?

Wu Jian and Ma Zhong

环境投资与环保目标

I. China's environmental protection targets

The environmental protection targets set in the Chinese government's 10th Five-Year National Economic Plan (2001-2005) were mostly missed. Nonetheless, the 11th Five-Year Plan (2006-10) included the ambitious goal of reducing total emissions of major pollutants by 10 per cent from the 2005 level by 2010. It was also the first time the central government set a binding environmental protection target.

II. The importance of environmental protection expenditure

Many factors contributed to China's failure to meet the environmental protection targets in the 10th Five-Year Plan. Among these insufficient financial investment was undoubtedly an important factor. The Chinese government had originally planned to spend RMB 700 billion (US$ 106 billion) on environmental protection, which would have amounted to about 1.3 per cent of projected GDP or 3.6 per cent of projected investment in fixed assets. However, despite the fact that GDP grew by 9.5 per cent, much higher than the 7 per cent that had been forecast, investment in environmental protection was only just over 1 per cent of GDP, and just under 3 per cent of investment in fixed assets during the period. Both figures fell far short of the target.

Data released by the State Environmental Protection Agency (SEPA, now the Ministry for Environmental Protection, MEP) on the progress of environmental protection during the 10th Five-Year Period indicate that by end of 2005, actual reduction in sulphur dioxide emissions missed the target by 30 per cent. The Sulphur Dioxide and Acid Rain Control section of the plan proposed 256 projects; however, only 54 per cent were finished and became operational. Only 65 per cent of the 2,130 pollution treatment projects proposed in the National Environmental Protection 10th Five-Year Plan were completed. This represented an actual investment of RMB 86.4 billion (US$ 13 billion), or 53 per cent of the projected investment amount. By end of 2005, only a fraction of the planned pollution treatment projects for key rivers and lakes had been completed (see Table 1). Support for environmental protection was clearly inadequate.

Table 1 Completion of pollution treatment projects for selected major lakes and rivers during the 10th Five Year Plan period

River or Lake	Completed pollution treatment projects (%)
Huaihe River	70
Haihe River	56
Liaohe River	43
Taihu Lake	86
Chaohu Lake	53
Dianchi Lake	54

The availability of financial resources is one of the most important factors determining whether environmental protection targets can be achieved. While adequate funding does not guarantee achievement, inadequate funding makes failure almost certain. Since the environmental protection target in the 11th Five-Year Plan is binding, it is vital that the financial resources necessary to achieve it are made available.

III. 'Investment in environmental protection': What it means and how it is measured

Official figures for investment in environmental protection in China for the past 20 years show a steep increase. It went from RMB 48 billion (US$ 7.3 billion) in the 7th Five-Year Plan, to RMB 131 billion in the 8th (US$ 20 billion), to RMB 348 billion (US$ 52 billion) in the 9th, and then to RMB 839 billion (US$ 127 billion) in the 10th Five-Year Plan (Wang et al. 2003; SEPA, 1995-2005). In terms of the percentage of GDP, investment in environmental protection increased from 0.68 per cent in the 8th Five-Year Plan to 0.81 per cent in the 9th, and 1.19 per cent in the 10th. During the 10th Five-Year period (2001-2005), official figures indicate that investment in environmental protection grew 6 per cent faster than GDP. Again, official figures show that in 2000, for the first time, investment in environmental protection exceeded 1 per cent of GDP, which marked a watershed. By 2005, according to government statistics, the percentage had grown to 1.3 per cent (and 1.23 per cent, 1.36 per cent, and 1.49 per cent for the three subsequent years: 2006, 2007 and 2008) (SEPA, 2006- 2008).

Impressive as they are, these numbers may be fundamentally misleading insofar as they grossly misrepresent spending on environmental protection in China. Firstly, environmental protection activities that are counted in these calculations are overwhelmingly pollution abatement programmes such as those mandated for buildings and urban infrastructure construction. Spending on ecological preservation programmes has often been left out. Secondly, for many years, the notion of 'investment in environmental protection' has been used to refer only to capital investment (especially towards pollution abatement projects), and not other kinds of spending, such as non-investment government expenditure and spending by the private sector. A third problem is that the current statistics for environmental investments mostly include investment in fixed assets. This actually means that investment in environmental protection as a percentage of total investment in fixed assets would be a better measure of the government's financial commitment to environmental protection than use of the GDP percentage figure.

These two calculation methods yield considerably different results. For example, during the 10th Five-Year Plan, investment in environmental protection grew at an annual rate of just under 16 per cent, reaching RMB 839 billion (US$ 127 billion) by the end of the period. During the same period, the annual growth rate was only 9.5 per cent for GDP, but just under 20 per cent for total investment in fixed assets. Evidently, it makes a large difference which of the latter two figures is used as the base against which financial commitment towards environmental protection is measured. When total investment in fixed assets is used as the base, a slightly declining trend for investment in environmental protection during the 10th Five-Year Plan is observable (the percentages are 2.97, 3.13, 2.93, 2.71, and 2.70 per cent for successive years) (NBS, 2006). Little increase is observable during the first three years of the 11th Five-Year Plan (the percentages are 2.34 per cent for 2006, 2.47 per cent for 2007, and 2.60 per cent for 2008). If investment in fixed assets is used as a measure of the rigor of economic growth, then these numbers show that environmental spending has on the whole been declining at the same time as investment in industrialization and urbanization have increased. In the conflict between the imperative of economic growth and those of resource conservation and environmental protection, the former has decisively prevailed.

IV. Understanding public spending on the environment

1. Government responsibility for environmental protection

Protecting the natural environment is an important government responsibility. Fulfilling it requires fiscal commitment. The Chinese government has attached great importance to environmental protection and declared it a basic national policy. However, it was not until 2007, 30 years after the

Environmental Protection Law of PRC was promulgated in 1979, when spending on environmental protection was finally granted its own line of funding in the government budget. In practice this has meant that there has not been a stable and reliable source of fiscal funding for this policy objective.

While government spending makes up only one part of total expenditure on environmental protection, it has a special status and plays a unique role relative to the other components. First, it is instrumental in establishing a nation's environmental monitoring system, which provides a common mechanism for verifying the environmental conduct of the public sector, the private sector, and individuals. Second, because government spending is often catalytic for investment by the private sector, when and how the government invests can help shape private investment. Third, the government is able to use its spending power to overcome regional fiscal disparities, especially in relation to local expenditure on environmental protection.

2. Misunderstanding the polluter-pays principle

According to the 'polluter-pays principle', corporations whose economic activities generate environmental pollution must pay for their emissions. What role, then, is the government to play in relation to the application of this principle? First, while this principle lays the responsibility for reducing pollution emission or otherwise compensating the public for the adverse impact of pollution discharge at the foot of corporations, it does not mean that the government needs to do nothing. In fact, without rigorous government supervision, the principle will most likely fail in practice. In many cases, corporate polluters are either unable or unwilling to comply with it. The situation is made worse by the fact that sometimes local governments are in cahoots with transgressors of pollution rules and regulations. In short, the 'polluter-pays principle' is sound, but not complete. It requires consistent and effective government engagement to ensure implementation. At the very least, the government must not actively obstruct its implementation.

3. Environmental protection and market mechanisms

The use of market mechanisms in environmental protection can reduce the financial burden for government. However, it is necessary to guard against the temptation to exaggerate the effects of the market. To put a complicated matter in simple terms, market failures need correction by the government, and government failures need correction by the market. Neither type of mechanism can be expected to accomplish the different environmental management tasks on its own. The construction and operation of environmental infrastructure is a good example. When private capital contributes towards the construction of environmental infrastructure, which is typically publicly-owned, the profit motive of the investors does not go way. One thing this means is that private capital tends to go where returns on the investment are highest. This has inevitably resulted in an uneven distribution of pollution treatment capacities, with poorer regions becoming more polluted because they are starved of private funding for environmental infrastructure construction. For example, private investment in sewage treatment facilities in China is much more evident in wealthy cities in the eastern coastal region. But with the upstream sections of major rivers poorly treated, generous investment in wastewater treatment in downstream regions can do little to reverse the trend towards worsening water quality. Here, the government obviously has a role to play in correcting funding imbalances caused by market biases. Without the right kind of government action environmental protection targets stand little chance of being met.

Added to this, the state must be very cautious in privatizing environmental utilities. In this area, the Chinese government should heed many others in recognizing the political sensitivity of this issue. There are certain areas where the market should not play a dominant role, and basic infrastructure for the provision of environmental goods and services should be one of them.

4. Competition within public sectors

As has been noted, environmental protection became a separate funding category in the national budget only as recently as 2007. However, because the Ministry of Environmental Protection has less political clout when compared with other government agencies, its funding needs are often given lower priority if not trumped altogether.

Moreover, funding allocations across different departments or sectors are often decided by short-term factors. This means that funding can dry up for programmes that have fallen out of fashion, and even financial commitments that have already been made can for that reason go unfulfilled. One example was the Sloping Lands Conversion Programme (SLCP), funding for which suffered when the fiscal priority of the central government shifted to rural fiscal reform.

V. Adequate funding to meet protection targets

1. Sustaining the increase in total spending on environmental protection

Since the environmental protection target in the 11th Five-Year Plan was binding, providing sufficient investment is not optional for government. Indeed, against the background of the worsening environmental situation, the growing marginal cost of pollution treatment and increasing demands for environmental goods as people's material standard of living improves, more financial commitment will be necessary.

2. Measuring environmental spending

Because the method currently being used to calculate environmental spending in China makes no distinction between different funding sources – which include the central government, local governments, the private sector and NGOs – reported or official figures of total spending on the environment do not accurately reflect the intensity and the structure of environmental protection efforts in China.

3. Clearly defining the government's financial responsibility for environmental protection

Pollution control responsibilities of enterprises are relatively clear, but strengthening government capacity to undertake environmental monitoring and supervision is essential to ensure that enterprises invest in environmental protection as they grow. The scope and content of the government's responsibility towards environmental protection depends on the nature and magnitude of the problem. Environmental problems that are relatively contained within a certain geographical area coterminous with that of an administrative unit will be the responsibility of the relevant local government. Problems of larger geographical scope should, by the same logic, be the responsibility of central government. Moreover, the central government is charged with adjudicating conflicts between provincial governments as well as between current and future generations. Given large regional disparities in economic development in China, the central and provincial governments should assist local governments (particularly county governments in poor areas) through transfer payments to help them fulfil their responsibility to protect the local environment.

Overall then, it is essential that funding for environmental protection should be stable and sustainable rather than speculative and haphazard in nature (as is the case at present). Economic fluctuations and macro-economic adjustment should not affect the sustainability of national environmental fiscal policies.

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14
Green GDP Accounting Research: Past experience and future prospects

Wang Jinnan, Yu Fang, Jiang Hongqiang and Cao Dong

中国绿色GDP核算研究的历程与展望

Green GDP accounting[1] refers to a national accounting system which takes account of environmental costs and benefits and use of natural resources. Chinese President Hu Jintao has argued that the Scientific Outlook on Development concept should guide macroeconomic policies in China. A green GDP accounting system is an important tool to guide the implementation of scientific development in practice. This article traces the historical development of green GDP accounting in China, it discusses problems to date and makes suggestions for the future.

I. Why is green GDP accounting needed?

1. Flaws in the traditional GDP accounting system

The traditional system for national accounts based on the concept of Gross Domestic Product (GDP) played an important role at a time when resource and environmental problems had not yet affected, or been perceived to affect, people's quality of life and social and economic development. However, under conditions of rapid economic development and population growth, environmental pollution, ecological destruction, resource depletion, food shortages, and other resource and environmental problems have become increasingly evident. These problems not only compromise individual and social welfare; they also threaten human survival. Given these developments, it is unwise to continue using the traditional GDP accounting system to measure the state of economic development. Improvements must be made to the system, and its flaws corrected.

The main flaws with the traditional GDP accounting system are as follows: (1) it only counts created capital as capital and rarely if ever takes into account natural resources or the economic costs associated with environmental problems; (2) the conventional accounting system does not include natural resources in national wealth; (3) it counts investment in environmental abatement measures as an addition to GDP but does not consider losses caused by environmental destruction as a deduction. According to this system, a nation can grow very fast in GDP terms while depleting its natural resources and polluting its environment. This kind of economic growth is environmentally unsustainable. Eventually it will lose momentum, cross important ecological thresholds and give rise to a systemic crisis.

2. The development of green GDP accounting in international context

It has been more than a decade since problems of resource depletion and environmental pollution first gained global attention. Many experts, scholars, government agencies, civil society groups and international organisations are working towards solutions to these problems. These solutions include the establishment of a GDP accounting system which factors the natural environment into its calculations. *Agenda 21*, adopted at the United Nations Conference on Environment and Development in 1992, recommends that:

> The resulting Systems of Integrated Environmental and Economic accounting (IEEA) to be established in all member States at the earliest date should be seen as a complement to, rather than a substitute for, traditional national accounting practices for the foreseeable future. IEEAs would be designed to play an integral part in the national development decision-making process [UN, 2000]

In 1995, the World Bank issued definitions of national wealth and the real savings rate as well as calculation methods for better gauging national wealth and capacity for sustainable development (World Bank, 1997). The European Statistics Bureau established the SERIEE (System for the Collection of Economic Information on the Environment) accounting system, which has an environmental protection expense account as the core component, supplemented with accounts for natural resource use and management, an environmental property recording system, and material flow accounts (European Commission, 2002; UN *et al.*, 2003).

Many countries have also started to research and apply green GDP accounting. Norway, for example, has been using resource and environmental accounting methods since 1978, and implemented the Economic and Environmental Accounting Project (NOREEA) in 1997 (Hass *et al.*, 2002). This project included three elements: firstly, it integrated environmental data into economic data and established a National Accounting Matrix with Environmental Accounts; secondly, it isolated information relevant to the environment that was already included in existing economic data; and thirdly, it evaluated important natural resources. Since that time, similar efforts have been carried out in the Netherlands, Germany and other Scandinavian countries (UNSD, 2006). In the USA and Canada, resource and environmental accounting has received considerable attention. Although green GDP accounting is not officially or systematically used in the USA, the US has established databases on natural resources, pollution prevention, and discharge, and different methods for assessing losses from pollution have been adopted. Developing countries such as Mexico and the Philippines have taken the lead in developing and implementing green economic accounting systems (Peskin and Angeles, 2001). Indonesia, Thailand, Papua New Guinea and other countries have also followed suit.

Green economic accounting has now gained traction and is likely, over time, to become an important basis for formulating and implementing sustainable development strategies in many countries (UNSD and UNEP, 2000; UN, *et al.*, 2003; World Bank, 2002 and 2006). The United Nations Committee on Economic Environmental Accounting was formed in September 2009. China's own efforts to develop green economic accounting will also have great significance for developing countries, and make an invaluable contribution to global efforts towards this same goal.

3. Conditions for implementing a green accounting system in China

China is a developing country that is growing rapidly. It has a huge population, a voracious and growing appetite for raw materials, and is resource stressed. The high rate of economic growth can only be maintained through fierce competition for resources, environmental space, and capital investment. In China these behaviours are labelled the 'three competitions' (*san pin*) and are most clearly seen in overzealous pursuit of GDP growth by local government departments. This dash for growth happens without any regard for the costs to the environment. This practice has had devastating environmental consequences.

To overhaul this traditional model of economic development, the Chinese government has proposed a: 'humanistic, holistic and integrated vision of sustainable development' (*jianchi yi ren wei ben, shuli quanmian, xietiao kechixu fazhanguan*) and a new development strategy of '*wu ge tongchou*' or the 'five syntheses and coordinations'. President Hu Jintao has outlined that:

> We should study green GDP accounting methods, explore an evaluation system that integrates resource consumption, and environmental benefits and losses into the level of economic development in order to maintain a balanced relationship between humans and nature [Hu, 2008].

This requires integrating resource and environmental costs into the economic accounting system, and radically changing how the job performance of party and government leaders is evaluated. It also involves shifting away from the quantitative growth model and towards a qualitative one with smaller ecological footprints. Until then, China will not have truly implemented the scientifically-sound economic development that it now champions.

II. Research on green accounting

Research on green economic accounting and environmental economic accounting in China began relatively late, but it developed fairly fast and there have been considerable achievements. Three developmental stages in this research can be distinguished (Wang *et al.*, 2005).

1. Initial stage (1981 - 1990)

From the early 1980s, Chinese researchers began inquiring into resource and environmental price distortions and reflecting on their irrationality. They proposed to count environmental pollution and ecological destruction as economic costs. They also did basic research on green GDP accounting, on topics that included losses from pollution, environmental cost-benefit analysis, and natural

Table 1 Research Progress on Resource and Environmental Accounting in China (1981 - 1990)

Time	Lead researcher	Main Research Outcome
1981	Yu Guangyuan	Proposed the need to account for the environment, called for the calculation of economic losses from pollution and ecological destruction.
Sixth and Seventh Five-Year Plan Periods	Chinese Research Academy of Environmental Sciences and other groups	Carried out several case studies, including the calculation of economic losses from pollution.
1985	Guo Xiaomin and Zhang Huiqin	Prepared a *Study on Projection and Countermeasures for the Environment in 2000*; which accounted for national economic losses from environmental pollution for the first time.
1987	Li Jinchang	Translated research reports such as *Natural Resource Accounting and Analysis in Norway*.
1988	East-West Centre, USA	Translated *Environment, Natural Systems, and Development: An Economic Valuation Guide* into Chinese.
1988	State Council Development Research Centre, World Resources Institute, USA	Carried out project research on resource accounting and its integration into the GDP system.
1989	State Environmental Protection Administration and WHO	Convened an *International Training Workshop on Environmental Economic Assessment*.
1990	Guo Xiaomin	Carried out research on the accounting of economic losses from environmental pollution and ecological destruction, focusing on economic losses from environmental pollution.
1990	Jin Jianming	Completed research on *Ecological Destruction, Economic Losses and a Calculation Method for Typical Ecological Zones in China*.

resource accounting (Guo and Zhang, 1989; Zhang and Cao, 1998; Xu, 1998; Xi and Zhao, 1995; Wang *et al.*, 2005). Their achievements are listed in Table 1. These included identifying the approximate values of economic losses in different time periods due to various types of pollution. However, because the results cannot easily be used for historical or international comparisons because of the varied range of research and calculation methodologies employed. In general, these research efforts were unable to integrate resources and the environment into GDP accounting, and still less to apply them in practice. In addition to these limitations, not enough attention was paid by relevant government agencies to this research at the time.

2. Exploration Stage (1991 - 2003)

With the rapid growth of the Chinese economy, resource stresses and environmental problems continued to worsen. Partly in response to these worrying trends, more attention was paid to research on resource and environmental accounting and its integration into the GDP accounting system. Many research institutes quickly set up research project teams to conduct research on resource and environmental accounting. They studied various methods for gauging the value of natural resources and the environment, defects in the existing GDP accounting system, as well as how to integrate considerations of natural resources and the environment into the GDP accounting system. A series of practical applications were also carried out. These initial efforts to apply research findings in practice laid a solid foundation for the establishment of a green GDP accounting system in China. Achievements from this stage are shown in Table 2. For instance, Lei Ming and colleagues proposed a green input-output accounting method and constructed related accounting input-output models of physical quantity and value (Lei, 1999). They compiled an input-output table for the Chinese economy for the 1990s, calculated the resource and energy intensity of the economy in various regions in China, and analysed the impact of green taxation on the environment. Their work represented an important theoretical exploration of methods and accounting practices in the field of integrated resource and environmental economic accounting in China.

Table 2 Research Progress on Resource and Environment Accounting in China (1991 - 2003)

Time	Lead researcher	Main Research Achievements
1991	Li Jinchang	Published *An Inquiry into Resource Accounting.*
1994	Li Jinchang	National ecological and environmental cost accounting.
1995	Lei Ming	Calculated the environmental costs generated by the Chinese economy in 1992, which accounted for approx. 4.87 per cent of the GDP of that year.
1996	Chang Yongguan	Air pollution accounting for Chongqing city.
1997	Fu Shouning	Ecological environmental losses from the Three Gorges Project.

Time	Lead researcher	Main Research Achievements
1998	Chang Yongguan	Pilot accounting studies on a true savings rate in Sanming and Yantai cities.
1998	Xia Guang	Published the *Econometric Study of Economic Losses from Environmental Pollution in China.*
1999	Zheng Yisheng	Calculated environmental pollution losses in China in the mid-1990s.
1999	Lei Ming	Carried out a research project on 'Green Accounting for Sustainable Development', including a pilot accounting study in Ningxia Hui Autonomous Region.
1999	Wang Jinnan (CAEP)	Carried out studies on sustainable development and an environmental economic indicator system.
2000	Zhang Shenmin	Conducted a study of evaluation methods for pollution losses in China.
2002	Wang Jinnan (CAEP)	Carried out research on a natural resource availability accounting scheme as part of the GDP accounting system reform.
2003	Cao Dong and Wang Jinnan	Carried out a study on an environmental economic input-output accounting model.
2003	State Statistical Bureau	Set up a new annex account in the *China GDP Accounting System* (2002) – Natural Resource Availability Accounting Table, and compiled a trial national table of land, forest, mineral and water resource availability for 2000.
2003	State Statistical Bureau and Norwegian Central Statistics Bureau	Compiled China's energy production and usage accounts for 1987, 1995 and 1997.
2003	State Statistical Bureau	Carried out accounting pilot studies on expenditure items for forest, water, industrial pollution and environmental protection in Heilongjiang province, Chongqing and Hainan province; compiled a technical summary and work summary report.
2003	Gao Minxue	Translated the UN *Guidebook on Integrated Environmental and Economic Accounting 2003* (SEEA 2003) into Chinese.

3. Practical application stage (2004 - present)

China's central government and its top leaders began to pay increasing attention to the issue of green GDP accounting in 2004, as a result of a confluence of factors, including the government's promulgation of the Scientific Outlook on Development, the unveiling of new job performance evaluation criteria for government employees, and general reform efforts directed at the traditional national economic accounting system. While research in the area continued, application of its results was also becoming more precise and standardized. The international community noted and was favourably impressed by the Chinese efforts in this area during this period.

The four most important tasks undertaken were: (1) the *Integrated Environmental and Economic (Green GDP)* Accounting Study jointly carried out by the Ministry of Environmental Protection and National Bureau of Statistics (NBS); (2) the *National Survey on Green GDP Accounting and Pollution Losses in Selected Provinces and Cities* jointly carried out by the State Environmental Protection Administration (now the Ministry of Environmental Protection) and NBS. The survey is expected to provide a foundation and platform for the first task; (3) a new National Forest Inventory to be jointly conducted by the NBS and the State Forestry Administration (SFA); (4) the water resource accounting project jointly conducted by the NBS and Ministry of Water Resources. These projects are evidence that the Chinese government is now paying considerable attention to the development of a green GDP accounting system. Concrete achievements from this period are shown in Table 3.

Table 3 Research Progress on Resource and Environmental Accounting in China (2004-Present)

Time	Organisations	Main Activities & Achievements
2004	State Environmental Protection Administration, National Bureau of Statistics	*Commenced the Integrated Environmental and Economic (Green GDP) Accounting Study* project
2004	State Environmental Protection Administration and National Bureau of Statistics	Jointly inaugurated the *National Survey on Green GDP Accounting and Environmental Pollution Losses in Pilot Provinces and Cities* project
2004	National Bureau of Statistics and State Forestry Administration	Jointly conducted *China's Forest Resources Accounting Study*
2005	National Bureau of Statistics and the Ministry of Water Resources	Jointly conducted *China's Water Resource Accounting Study* project
2005	World Bank and State Environmental Protection Administration	Jointly carried out the *Study on Establishing China's Green GDP Accounting System* project, completed environmental economic accounting (green GDP accounting) in 2005
2006	State Environmental Protection Administration and National Bureau of Statistics	Jointly issued the first *China's Green GDP Accounting Study Report 2004*
2006	National Bureau of Statistics and Norwegian Central Statistics Bureau	Jointly carried out green GDP accounting research

Time	Organisations	Main Activities & Achievements
2005-2009	Chinese Academy of Environmental Planning under the Ministry of Environmental Protection, Renmin University, Chinese Environmental Monitoring Station	Conducted *China's Environmental Economic Accounting Study* in 2005-2007, completed study reports for these three years
2006-2012	National Bureau of Statistics and Canadian Central Statistics Bureau	Jointly carried out a study on *China's Resource and Environmental Accounting System*
2007	Chinese Academy of Sciences	Conducted *China's Green GDP Accounting Research*
2008	National Bureau of Statistics	Researched and established *China's Resource and Environmental Accounting System*
2008	State Forestry Administration and National Bureau of Statistics	Completed the national accounting of forest resources in 2006
2009	Ministry of Water Resources and National Bureau of Statistics	Established China's water resources and environmental accounting system
2007-2009	Beijing Technology and Business University	Green GDP indicators for 300 cities and provinces in China

The content of the *Integrated Environmental and Economic Accounting (Green GDP) Study*, jointly conducted by SEPA and NBS, mainly included physical quantity accounting, value accounting, and environmentally-adjusted green GDP accounting. At the same time, SEPA and NBS carried out a survey on green GDP accounting and the costs of environmental pollution in more than 10 pilot sites, including metropolitan Beijing, metropolitan Tianjin and Anhui province. After nearly two years of hard work, the two agencies jointly issued *China's Green GDP Accounting Study Report, 2004* in September 2006. This was China's first GDP accounting study report that factored in the costs associated with environmental pollution, and it signified the beginning of a new phase in China's green GDP accounting research.

The report was also the first on green GDP accounting in the world to be issued by a government. The study results showed that the economic losses from environmental pollution in China were RMB 511.8 billion (US$ 77.8 billion) in 2004, or 3.05 per cent of GDP in that year. The virtual abatement cost was RMB 287.4 billion (US$ 43.7 billion), or 1.8 per cent of the annual GDP. This study report generated strong reactions in China and internationally. The media was generally in favour of China's efforts to establish a green GDP accounting system and agreed that it demonstrated the state's willingness to address an important issue. At the same time, Chinese

researchers were also collaborating with colleagues in international research organisations from various countries around the world. As a result, the basic elements and methodology for creating the framework of China's green GDP accounting system were established, most notably the method for counting the economic costs of pollution. Pilot research projects yielded invaluable basic data and experience in the application of these methods. A national report and other reports on trial runs of green accounting practices in 10 provinces or cities were completed. They laid the foundation for the development of green GDP accounting.

Since then, the Chinese Academy for Environmental Planning in the Ministry of Environmental Protection has joined other research organisations to conduct environmental pollution and ecological loss accounting for 2005, 2006 and 2007. Economic losses due to environmental pollution were RMB 578.79 billion (US$ 88 billion) in 2005 and RMB 650.77 billion (US$ 98.9 billion) in 2006, or 2.93 per cent and 2.82 per cent of GDP, respectively. The virtual abatement cost was RMB 284.37 billion (US$ 43.2 billion) in 2005 and RMB 411.26 billion (US$ 62.5 billion) in 2006, representing 2.1 per cent and 2.0 per cent of the total industrial GDP in each of those years, i.e. the GDP pollution reduction index was 2.1 per cent in 2005 and 2.0 per cent in 2006. The cost of environmental degradation as a percentage of GDP remained roughly the same from 2005 to 2006. In absolute terms, however, it did go up by RMB 71.98 billion (US$ 10.9 billion), or 12.4 per cent. Thanks to a decline in pollution emissions in 2006, the pollution reduction index declined by a small a margin.

Professor Shi Minjun of the Chinese Academy of Sciences has been studying integrated green GDP accounting since 2007. He has performed monetary evaluation of resource consumption losses, losses due to ecological degradation losses, and losses due to environmental pollution for 31 provinces, cities and autonomous regions for the year 2005. According to his research, these losses amounted to RMB 2,700 billion (US$ 410.3 billion) in 2005, which represented 13.89 per cent of GDP. Of this total loss, resource consumption accounted for RMB 1,916.996 billion (US$ 291.3 billion), or 70 per cent, environmental pollution for RMB 497.129 billion (US$ 75.6 billion), or 18 per cent, and ecological degradation for RMB 333.693 billion (US$ 50.7 billion), equal to 12 per cent (Shi and Ma, 2009).

After five years of preliminary experience in the practical application of the research methods and techniques developed for environmental pollution loss and environmental economic accounting, the green national economic accounting system can be said to have taken shape in China. A new National Forest Inventory has also been jointly completed by China's State Forestry Administration (SFA) and the National Bureau of Statistics (NBS). All of this signifies that China is making headway in its shift towards a green GDP accounting system. The NBS is also drafting the *Chinese Resource and Environmental Accounting System* in the hope of using it as a focal point for the implementation of a Scientific Outlook on Development.

III. Problems in Research

Green GDP accounting has attracted widespread attention from various groups in Chinese society. It has, however, also generated considerable controversy. Institutions have hindered the process by which results from environmental accounting, forest resources accounting, and water resources accounting are made available to the public. While it should be acknowledged that there are many complicated factors at play in China that affect the institutionalization of green economic accounting, and that this is a new area of research and practice, the following problems in current research and practices of green GDP accounting are identifiable:

1. Imbalanced research work

Research in resource accounting has been undertaken for a considerably longer time than environmental accounting. Many countries have already accumulated a good deal of practical experience in this area. For example, researchers in Canada and Norway have made great strides in the study of forest and mineral resource accounting and how to integrate this with existing accounting practice, through provision of supplements to conventional accounts. However, a larger gap has opened up between resource accounting and environmental accounting in China. There have been many studies on the former, but their results have not been put to practical use. By comparison, research on environmental accounting, and its practical application, has yielded measurable positive outcomes. The *Integrated Environmental and Economic Accounting Research* project and pilot work conducted by the State Environmental Protection Administration (SEPA, now the Ministry of Environmental Protection) and NBS, are also helping the field of pollution accounting to reach maturity. The slow progress in research on resource accounting has slowed the institutionalization of green GDP accounting. Its completion is, therefore, unlikely in the near future.

2. Deficiencies in current accounting methods

There is as yet no unified system of methods for determining environmental and resource values. This renders it nearly impossible to factor in the value of the environment and natural resources into economic accounting. Moreover, there has been no breakthrough in the study of how to combine individual resource and environmental accounts (such as a water resource account) to form a comprehensive account. Nor is it yet possible to accurately express physical quantity and translate it into value. In addition, the merging of resource and environment accounts into economic accounts remains an enormous theoretical and practical challenge.

3. Administrative hindrances

Research on resource and environment accounting, especially pollution accounting, has, as has been noted, yielded considerable theoretical achievements. However, many of the research results are not immediately ready for application. This problem is largely attributable to a disconnection between research entities and the government, as well as existing administrative structures. With respect to the latter, excessive division of labour and functional redundancies within the government greatly compromise overall effectiveness. Moreover, inadequate sharing of resources and poorly-defined boundaries for respective accounting duties for agencies in charge of resource and environmental management and those in charge of economic growth have also obstructed progress in the practical application of results from theoretical studies in green GDP accounting.

4. Uncertainty in applying research outcomes

Conditions are not yet ripe for green GDP accounting practices to be fully systemized and institutionalized in China. Not only is the government insufficiently prepared, but current capacity to implement GDP accounting is still immature. It is therefore not yet possible to integrate green GDP into criteria for job performance evaluation for party and government officials. There are

significant inconsistencies and uncertainties in relation to how to apply research outcomes in government. Nevertheless, there are areas in which research outcomes can be put to ready use. These include environmental cost analysis for local economic development, environmental cost accounting for government agencies and industries, investment planning for environmental protection, environmental taxation policies, and ecological compensation policies. Integrating environmental considerations into these areas has been of great value in moving towards the goal of formulating appropriate development strategies for implementation of the Scientific Outlook on Development.

IV. Outlook for future research

1. Accounting techniques

Green GDP accounting is a complicated subject that relates not only to the economic system but also to elements of the natural environment. Generally speaking, research on green GDP tends to begin in a country with studies of partial accounting that focus on particular resources and environmental problems. Alternatively, it may begin with quantitative measurement of resources. If other countries' experience in this area could be assembled and published, it would be a great source of knowledge and information for researchers working on green GDP accounting in China. The following three things must happen before a coherent and effective green GDP accounting system can be set up in China: (1) further improvements in the theoretical framework; (2) publication of a technical guidebook on natural resource accounting; (3) further improvements in the environmental economic accounting system.

2. Local pilot projects

Green GDP accounting suffers, as is perhaps unavoidable, from a certain degree of incommensurability with the orthodox economic accounting system. In addition, it is handicapped by difficulties in data collection and statistical analysis. Its popularity is bound to be limited given the level of inter-agency coordination it requires and the amount of raw data on which its effectiveness depends. It is, therefore, important for realizing the eventual replacement of the orthodox accounting system by the green GDP accounting system in China that pilot projects on environmental and resource accounting be carried out. This would allow for verification of the scientific soundness of the theoretical framework and accounting methodology that has already been developed.

3. Building a green GDP system

It is necessary to seize on any historic opportunities that emerge to reform the current administrative system, to promote a Scientific Outlook on Development, and to facilitate the establishment of a green GDP accounting system. The building of a green GDP accounting system would involve four aspects: (1) setting up a working platform for green accounting; (2) reforming the existing environmental and resource data system and speeding up the 'greening' of the economic statistics system; (3) accelerating the construction of relevant regulations and standards; (4) linking policy-making, especially in areas such as economic restructuring, environmental taxation, environmental compensation, and job performance appraisal with green GDP accounting.

4. Strengthening international cooperation on green GDP accounting

There has been a resurgence of international interest in green GDP accounting. The United Nations established UN Committee of Experts on Environmental Economic Accounting (UNCEEA) to push green GDP accounting efforts forward at the country level. At present,

the London Group (LG) of the UNCEEA, which is responsible for amending and updating the *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (IEEA) will soon complete this work. Expectations are that a resource and environmental economic accounting system will be formally integrated into the existing GDP accounting system. At the same time, the United Nations, the World Bank, Asian Development Bank, European Union, OECD, Norway, South Korea and Japan have all expressed interest in China's experience with green GDP accounting. China should fully utilise this platform of international cooperation to establish a green GDP accounting system that is consistent with these efforts in the international community.

V. Conclusion

Establishing a green GDP accounting system is an important element in China's overall effort to shift towards an environmentally sustainable and science-based economic development path. In the past 30 years, China has made notable progress in the field of resource and environmental economic accounting. Although problems such as unevenness in research work, immaturity of accounting techniques, and obstacles in administrative structures do exist, the existing research and practices provide a scientific foundation for China to establish its own green GDP accounting system. In the short term, focus should be placed on strengthening research in the development and application of environmental and resource accounting techniques, on the development of local pilot programs that put theories to practice, and on improving international cooperation.

1 In China it has been standard practice when discussing green GDP accounting to refer to the System of Integrated Environmental and Economic Accounting (IEEA) as used by United Nations Statistics Division (UNSD). The term 'environment' is used in a narrow sense in this article, referring to environmental pollution and ecosystem services. It does not include natural resources. This is different from how the IEEA uses the term. Therefore, green GDP accounting system developed in China is not quite the same as the IEEA used by UNSD.

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15
Green GDP Accounting in China: Disputes and progress

Gao Minxue

绿色GDP核算在中国：争议与进展

Green GDP accounting has become an increasingly important issue in China given the great seriousness of the environmental problems that have emerged during prolonged and rapid economic growth. Naturally, wide disagreements have also emerged about whether and how to implement an environmentally-sound national economic accounting system. This paper provides an overview of the key controversies and disputes in this area. It is argued that overstatement and impatience are key factors in many of these disagreements. Some divergences of view reflect the different interests of rival government agencies, and differing assumptions between academic disciplines. The good news, however, is that, these disputes notwithstanding, there is also growing agreement on some core issues relating to green economic accounting. Diversity and pluralism in basic understandings, expectations and methodological approaches exist in relation to green GDP. Nevertheless overall China is moving strongly in the right direction, towards the creation of a system of green accounting.

I. Background

The Chinese economy has been growing at breakneck speeds in recent years, and problems of resource scarcity and environmental pollution continue to worsen. Government macro- and micro-economic policies have historically been based on a national economic accounting system in which Gross Domestic Product (GDP) plays a central role. In recent years, China has begun to follow a development approach known as a 'Scientific Outlook on Development' (*kexue fazhan guan*). Against this background, an integrated environmental economic accounting system, such as that called for by the international community, is urgently needed. The issue can be ideologically charged, yet it is central to prospects for China's future development.

The following three stages are discernable, in relation to the development of this green accounting system. A first stage involved the introduction and initial exploration of relevant international theories and methods. Early research and initial estimations were carried out by experts and scholars on special topics such as natural resources and environmental pollution losses. The main purpose of this work was to attract professional interest and draw public attention to the concept of green GDP accounting and to deficiencies in current national accounting systems. The second stage was characterised by attempts to engage the public in discussion of the issues at hand. Proposals were submitted to the National People's Congress and the Chinese People's Political Consultative Conference at various levels. These appeals built an initial bridge that allowed specialised research on environmental economic accounting and green GDP to be transformed into management tools for government administrative departments. These efforts were instrumental in turning what had begun as a purely academic exercise and theoretical investigation into something of practical value, that is, a set of management tools to be used in government administration. The new tools also stimulated government departments to better integrate environmental concerns in their work.

The third stage was an exploration led by government departments. In 2003, with the technical support of specialists from research institutions, the State Environmental Protection Administration (SEPA, now the Ministry of Environmental Protection) started an environmental economic accounting project targeting the impact of pollution. The State Forestry Administration (SFA) also initiated a project assessing the economic value of the nation's forest resources. The Ministry of Water Resources did the same for China's water resources, and the Ministry of Land and Resources the country's mineral resources. Each of these surveys was conducted in conjunction with the National Bureau of Statistics (NBS). In addition, local governments and research institutions have undertaken their own surveys with similar aspirations and goals.

Many have placed high hopes on green GDP accounting and its rapid application in day-to-day government administration. However, studies and surveys relating to this large and complex subject matter have only been going on for a relatively brief period of time. Of course as green accounting has come under closer scrutiny, new issues have come up which require close analysis. It has not always been possible to come up with clear answers. The upshot of this has been that green GDP accounting has fallen rapidly in and out of favour.

This chapter argues that approaches to use of the green GDP concept have been popular because they are associated with the Scientific Outlook on Development idea (promulgated by President Hu Jintao). The idea also links to GDP, a concept which is of course well-known. Public figures are often expected to take a stance on the issue, as are those who appear to have a professional stake in the matter. Many of these commentators make unrealistic and unfounded claims about green GDP. This has reduced discourse on this serious and important subject to a clash between individuals or groups with vested interests.

Nevertheless green economic accounting is a vitally important subject whose national significance can hardly be exaggerated. It has enormous implications for how the government is run, how the economy is managed, and of course, the relative merits of different statistical methods. There is of course a gap between what people would like to see implemented and what is immediately feasible. It is also not easy to reconcile orthodox economics and sub-fields that deal more specifically with environmental matters, such as resource, environmental, and ecological economics. This has generated frustration with the concept from some and opposition from others.

The remainder of this chapter is organised as follows. In section 2, the main issues relating to green economic accounting are reviewed. In section 3, on-going disputes and controversies surrounding the issue are examined in greater depth. The final section summarises lessons learned to date, and looks at what may happen in the future.

II. The challenges of green GDP accounting

Green GDP accounting is an interdisciplinary subject that brings together economics and the environmental sciences. It has implications for both economic systems and political institutions. As noted, research and practice in this area is still at an exploratory stage. Many definitions and concepts are unclear and empirically untested. Disputes are to be expected and welcomed.

By definition, the concept of 'green GDP' derives from or is based on that of GDP. The core elements of the notion of 'green GDP' are as follows: (1) GDP is central to national economic accounting. It represents the aggregate output of economic activities and has traditionally been used as the primary measure for a society's level of development; (2) the way in which GDP has traditionally been calculated leaves out the economic cost of natural resources and ecological services and functions. As a result it has often exaggerated the real value of a nation's economic output, and this has had the effect of encouraging overzealous pursuit of economic growth; (3) the omission described in (2) must be corrected if the GDP calculus is to yield outcomes that accurately reflect a nation's economic conditions. The idea of green GDP implies an accounting system that takes the environmental cost of all economic activities into consideration.

Despite its conceptual simplicity and elegance, 'green GDP' does not lend itself to facile operationalization. The following section reviews some of the more difficult and contentious issues that attend this process.

1 GDP calculation is important, but is only one aspect of national economic accounting. Its scope is typically confined to economic activities. When resource conservation and environmental sustainability are considered at all in GDP calculations, they are also treated as economic activities.

When natural resources and ecological services and functions are factored into economic accounting, they are no longer treated as free gifts of nature, and the human economy is viewed as if it were materially and energetically independent from the earth's ecosphere. A fundamental question follows from this: is it clear what impact economic activities of different kinds have on resources and on ecological conditions? How do we identify those environmental items that call for economic assessment and whose value should be deducted from aggregate economic output to arrive at green GDP? Unfortunately at present it is not possible to give comprehensive and conclusive answers to these questions.

2 The theoretical underpinning of the entire national economic accounting system, of which GDP calculation is a central component, is traditional economics, especially traditional macro-economics. In conventional economic theory, resources and the environment are not essential production factors in the economic system, or forms of *capital*, and changes in them are treated as exogenous to the economy. Moreover, ecosystem services and functions such as waste recycling, soil regeneration and climate stabilization are not considered economically valuable. And the ecosystem is thought to be invulnerable to anthropogenic functional decline. Breaking from conventional GDP accounting over these basic issues means breaching the conceptual constraints inherent to and definitive of traditional economic theories. This gives rise to the critical question of just what the theoretical basis is for green GDP and integrated environmental economic accounting. Resource and environmental economics implicitly endorse the basic assumptions of traditional economics, and use them for purposes of resource and environmental management. This can be a problem, as these disciplines, as they are currently conceived, provide an inadequate theoretical platform on which to engineer a complete overhaul of the conventional economic accounting system.

3 The national economic accounting system, including the GDP calculus, assumes a market-based economic system. This is a methodological bias. In particular, it gauges the value of everything by reference to prices that are commanded in the market. Until now, however, the market has only been able to do this for economic outputs (intermediate or final), labour power and human-made capital such as machines and buildings. The rules of market exchange have applied fairly straightforwardly in the allocation of these entities. By contrast, environmental resources have not lent themselves easily to the application of the same market rules, so their allocation has typically relied on extra-market mechanisms, such as those based on command and control, and administrative orders. Tax laws are but one example of such an apparatus. It would be a challenge to bring market mechanisms and non-market ones in line with one another. As such, it remains an open question as to whether the market is capable of pricing environmental resources accurately.

4 GDP is a composite indicator that reflects the overall condition of the economy. Its value is determined formulaically by three variables: modes of production, income and expenditure. When this basic model is applied at the national level, a comprehensive assessment of how the national economy is performing can be derived. Therefore, GDP is not a free-standing number, but one that sits at the pinnacle of a pyramid of national economic accounting data. It should, therefore, be interpreted within that context. How it is computed is inextricably linked with how the value of other indicators in the national economic accounting system is determined. According to this logic, the greening of GDP calculations requires careful calibration of the relationship between economic accounting and integrated environmental economic accounting. The crucial question in this connection is whether to green the entire economic accounting system or only the part directly concerned with GDP calculations. Moreover, it is necessary to consider whether the data currently available are adequate for green GDP calculations.

III. Misconceptions about green GDP accounting

The disputes surrounding green GDP accounting are complicated. Both detractors and supporters can suffer from misconceptions of one kind or another about what it is they are supposed to be opposing or supporting. Moreover, all detractors do not share the same reasons for opposing the idea, while all supporters do not share the same reasons for supporting it. I will examine both sides and their internal pluralism in turn.

1. Opposing views

The idea of green GDP accounting has had its share of sceptics and critics since birth. When it was first proposed, the most common objection was that environmental concerns are a luxury that a developing country such as China, which had at the time still a long way to go before eradicating poverty, could ill-afford. On this view, so long as China's per capita income is low, any talk of green GDP accounting is, in both relative and absolute terms, premature. But this view is ill-advised, since it incorrectly assumes that resource and environmental problems are somehow separate or separable from the problem of economic development. In fact, the luxury that China can ill-afford is to follow the example of most developed countries and to 'pollute first, and clean up later'. It is imperative that resource and environmental problems are taken seriously early on and addressed at the same time as the country grows its economy and tries to eradicate poverty. The growing resource stress and pollution woes that have attended the country's rapid economic growth in recent years have left little doubt as to the importance of adopting this general approach.

Another sceptical view takes issue with the assumption that we already have a fairly good idea as to the real state of the Chinese economy as measured according to the conventional GDP calculus. But if this assumption is false, or even questionable, as these sceptics say is the case, it would then be frivolous to talk about greening GDP. Holders of this view are not, strictly speaking, opposed to the idea of green GDP accounting as such. Rather, they doubt whether a key computational precondition for putting the idea to practice has been satisfied. Therefore, their discontent with green GDP might be better interpreted as essentially discontent directed at conventional GDP accounting. This criticism is not without some good reasons, since it is true that much doubt has been cast on China's official GDP figures in recent years. Nevertheless, the need for better conventional GDP calculation is not by itself a good reason for rejecting green GDP accounting. Not only are the two objectives not incompatible, they actually complement each other. Moreover, accepting green GDP accounting does not entail wholesale replacement of conventional GDP accounting, which may well be partially retained for some special purposes and functions. The results of green GDP accounting can be used as a reference for issues involving relations between economic development and resource availability and environmental quality. And having both figures makes it possible to gauge how far the current development path still is from one that is at once environmentally and economically sustainable. For all its shortcomings, conventional GDP accounting is by no means worthless as a way of assessing a nation's economic conditions.

According to a third opposing view, implementation of green GDP accounting in China would be foolhardy when there are no existing international examples of success. These critics tend to highlight critical reactions to the idea from analysts in other countries. But this criticism is of questionable validity. It is true that there are disagreements internationally about the necessity of implementing integrated environmental economic accounting. In particularly, the specific question of whether there is the need for a green GDP has been contentious. If it is true that support for the idea of an environmentally adjusted GDP is only lukewarm in developed countries, the explanation would probably be that these countries tend to face less resource stress and pollution woes than developing countries such as China. Moreover, there may be less government pressure, given their mode of governance, in these countries for the production of such comprehensive economic figures. Lastly, while it is important for China to learn from the

experience of other countries in any area, lack of experience should not prevent action. There is no reason why Chinese researchers should or could not try to do original research and become the international pioneers in this area.

2. Unrealistic expectations cause misconceptions

If many objections to green GDP accounting are based on dubious assumptions, the same seems to be true of support for the concept. Enthusiasm and high hopes for green GDP have led to some misconceptions.

First, there is the naive idea that green GDP accounting will be the panacea for all environmental problems. Nothing, of course, could be further from the truth. Account keeping and statistical analyses generate information that might be used in, but which ought not to be conflated with, the practice of making decisions. To manage and guide the Chinese economy in accordance with the scientific outlook on development, new and scientifically sound statistical indicators (of which green GDP would be only one) are no doubt needed. However, numbers are by themselves inert, they must be put to the right use through concrete human actions for their contribution towards sustainable development to be materialized. The existence of the right numbers is no guarantee for their proper application.

A second misconception induced partly by unrealistic expectations regarding green GDP is that the concept will be rapidly institutionalised as it becomes better known. This optimism is baseless. One problem, for example, is that demand for data on natural resources and environmental pollution and statistical analyses of these data still far outstrips supply. In fact, it took decades for conventional GDP accounting that we now take for granted to be systematized and institutionalized. Theoretical research on the topic began in the 1930s, and it was not until the 1980s and 1990s when the accounting methodology now popularly used became fully developed. Therefore, we should expect the implementation and maturation of green GDP accounting to take some time too. Resolve is also needed, for large hurdles still exist in relation to some of the most basic issues, including the definition, accounting methods and statistical bases for green GDP accounting, and how to account for hitherto extra-market factors such as natural resources and the environmental services. Moreover, determination of the nature, magnitude or geographical reach of the environmental consequences of specific types of economic activities or particular industries remains difficult, so does assignment of monetary values to natural resources and ecological services and functions. Until these theoretical and practical issues are satisfactorily resolved, green GDP accounting will be of an experimental nature and its results should not be used as commanding ultimate authority, or as the basis for performance evaluation of civil servants.

A third misconception is that green GDP is the only indicator that can reflect the state of sustainable development and is, at least for that purpose, irreplaceable. However, while it is important, green GDP is by no means the only measure of sustainability. For example, wealth and its growth rate are also important measures. A more comprehensive picture of how well the country is doing economically emerges when environmentally adjusted GDP is combined with these other figures. Furthermore, because GDP is by definition an aggregate figure, it is necessarily short on detail and specificity. Therefore, it is best used in conjunction with other economic indicators, e.g., the energy and resource intensity of the economy. Until such time when green GDP accounting is fully institutionalized, and consistently practiced, these other indicators can and will serve similar purposes. In a sense, then, the symbolic value of the green GDP figure for defining the nation's overall development strategies might be greater than its substantive informational value for detailed policy-making. It is certainly best used and understood in conjunction with a variety of other economic indicators.

3. Cautious conservatism

Having embraced the idea of green GDP accounting, many in China are now eagerly awaiting environmentally adjusted economic data, and pressing relevant government agencies to produce them. Such strong demands have put these agencies on the defensive. In response, however, these agencies have chosen to proceed slowly, and with abundant caution, taking both the technical difficulties and the inherent uncertainties in green GDP accounting extremely seriously. Many people, however, have accused these agencies of being unnecessarily conservative.

This cautious attitude is consistent with the basic principle these agencies have traditionally adhered to, that is, the importance of ensuring the quality and reliability of the statistical results they publish. Even though the issue of green GDP has received a good deal of attention from the general public, theoretically and technically it is still rather underdeveloped. As such, those whose professional responsibility it is to collect and analyze economic data for the country are right not to rush the implementation of green GDP accounting. Indeed, the results of green economic accounting, such as the value of green GDP, may be of but secondary importance to the methodology and basic development of green GDP accounting practices. It would be difficult to overstate the theoretical significance of these foundational issues. After all, green GDP is but one aspect, albeit a very important one, of green economic accounting. It should be incorporated or integrated with other practices such as resource and environmental economic accounting. If this attitude is conservatism, it is a good kind of conservatism and highly necessary.

However, among statistics professionals, especially those involved in national economic accounting, a significant number are steadfastly resistant to green GDP accounting on account of its alleged inferiority to conventional GDP accounting with respect to scientific soundness and methodological rigor. They probably think that the introduction of environmental factors detracts from the apparent internal coherence and formal elegance of conventional GDP calculus, that is, it makes things messier than conventional economic accounting. Moreover, to these statistics professionals, conventional economic accounting has the apparent advantage of resting on firmly established economic theories, whereas by comparison, green economic accounting is built on shaky theoretical foundation in the form of emerging economic sub-fields such as environmental and ecological economics. Last but not least, for those who have earned their living by doing conventional GDP accounting, it is understandable that they may find the rise of green GDP threatening to their careers. But this attitude is, while understandable, unfortunate and counter-productive. After all, in the larger scheme of things, economic accounting is not an end in itself, but only a means to other ends. Its purpose is to facilitate good governance of national affairs, including sound management of the relationship between society and the natural environment.

Much can be learned from looking at the history of the national economic accounting and GDP calculation. The national economic accounting system was first established in the 1930s and became an important instrument for macro-economic management. The underlying theory was one of the most important achievements in the social sciences of the 20th century. Application of the theory has undergone continuous change and improvement. As times have changed, so have the objectives in macro-economic planning and conceptions of a good development model. National economic accounting must change as well if it is to continue to play a key role in making development sustainable. Some of these changes may seem, at least when they are first proposed, to be threats to the integrity of an 'impeccable' system. However, if we take a moment to remind ourselves of the purposes economic accounting is supposed to serve, we must concede that inelegance brought about by necessary changes is better than elegance based on outdated theories and inadequate data. Innovation will eventually result in an improved accounting system. Moreover, as has been mentioned, instituting integrated environmental economic accounting is not the same as phasing out conventional national economic accounting altogether. The goal for the near future is to only to supplement the latter. There is, therefore, nothing to lose but everything to gain from further research and studies.

IV. Different implementation scenarios of green GDP accounting

Even if the intellectual problems surrounding basic theoretical issues are clarified, disagreements about how best to carry out green GDP accounting persist in practice. Some of these disagreements may be due to differences in perspectives among people from diverse disciplinary backgrounds. But they may also reflect the importance of pragmatism in this matter.

1. Different implementation models

How should green GDP accounting be practiced? Expectations of quick results have now largely been replaced by more modest agendas and a more cautious attitude, reflecting a more reflective understanding of what the task involves. Accounting professionals and policy-makers are now mostly agreed that rather than trying to get all aspects of green GDP calculations right in one shot, which would be unrealistic given various practical constraints in China, a gradualist approach should be adopted. One starting point would be to use environmentally-adjusted economic accounting efforts with limited scope, say, for different economic sectors. Explorative investigations targeting specific issues and areas should also be part of this approach. Indeed, this gradualism has defined China's efforts so far towards green GDP accounting.

Who should be responsible for green GDP accounting? At the beginning, many agencies and organizations were eager to get involved and earn credit by doing so. But now there is more caution and patience: people have realized that this is not something that can be done by collecting a few questionnaires or doing a few simple calculations. The work transcends disciplinary boundaries, especially those that have traditionally separated earth sciences and economics, and it also brings together technical issues and managerial ones. Therefore, optimal results can only be expected if human resources from different fields are brought together to share knowledge and expertise and coordinate efforts.

Government agencies in charge of statistical analyses and economic accounting must be a key part of the gradual implementation of green GDP accounting. Their official status implies that what they do and say carries authority. Moreover, these agencies are not new to the task, as they have historically been responsible for GDP calculations.

The involvement of agencies in charge of resource and environmental management is necessary because they possess technical expertise and are familiar with the specifics of resource and environmental management, including its objectives and mechanisms. Their involvement can help make sure that green GDP accounting practices cohere with and serve the government's macroeconomic goals. Just as important, these agencies already have well-oiled accounting systems and practices whose very function it is to connect economic activities and the environment. These agencies also have a wealth of data that have been accumulated over the years about the condition of the nation's natural resources and environmental pollution. They have, for example, both raw and statistical data on the nation's forest and mineral resources, on changing patterns of land use, on corporate disclosure of pollution discharges and data collected through environmental monitoring. They also have information on the costs of resource depletion and environmental pollution to the economy. All of this, of course, forms the empirical basis for effective implementation of green GDP accounting.

2. The significance of disciplinary perspectives

As has been noted earlier, the GDP-centered national economic accounting system is based on traditional economics and has been constructed to facilitate macro-economic policy making. By contrast, green GDP accounting has been informed by relatively new sub-fields of economics including resource, environmental and ecological economics. While studies in these fields often

yield valuable empirical information in actual accounting practices, it is necesssary to ask if these environmentally-oriented new sub-fields are conceptually of a piece with orthodox economics, as seems to be tacitly assumed. To what extent are the actual experiences of professionals in various fields of environmental management amenable to economic analysis and evaluation? Can data from different fields be readily aggregated? Disagreements exist over all these issues among accounting professionals and other experts working on green GDP accounting.

Consider pollution, a major subject in environmental economics. The basic and most commonly-used approach to its treatment is to subsume the problem under traditional economic theories for analytical purposes, and formulate policy recommendations on the basis of this analysis. The key part of this exercise is determining the monetary value of environmental pollution, either as the cost of negative externalities of economic activities or as savings from pollution prevention or abatement. But it remains to be seen whether this method is adequate for purpose of green economic accounting. On the conceptual level, pollution loss is mainly calculated from the point of view of those who are affected by it. Since changes in environmental quality and/or welfare are typically temporally and spatially removed from the economic activities that have caused them, making specific causal connections can be fraught with difficulties and uncertainties. Therefore, even though, in environmental economic theory, monetary evaluation is considered the preferred method for assessing the problem of pollution, this method is inadequate for purposes of environmental economic accounting. In current accounting practices, the preferred approach is to perform comprehensive monetary evaluation of environmental degradation, with the monetary evaluation of pollution used only as a substitution strategy. But because the latter method produces results that are often insufficiently reliable, it is never the choice method for accounting professionals if other alternatives are available.

Economic or monetary valuation of natural resources faces similar problems. Resource economic accounting and resource management pay special attention to resource valuation assessment, but national economic accounting does not equate resource valuation assessment with resource assessment in resource economic accounting. For example, the economic evaluation of natural resources is usually done as a part of individual projects, and typically it takes into account the economic, ecological and social value of the resource being evaluated. The results of this kind of case-by-case evaluation may not be readily usable in economic accounting at the aggregate level.

3. Ends determine means

Accounting, it is worth repeating, is a means to an end, which is effective management of economic affairs. But how it serves this function is, of course, a large topic in its own right. Different users of accounting products have different needs and expectations, and even the same users may want different things in accounting results at different times.

The basic idea behind green GDP accounting is to deduct the cost of the economy's use of natural resources and ecological functions and services from the value of GDP as it has been computed using conventional methodologies. More precisely it can be said that this essentially amounts to a subtraction. This line of thinking suits government agencies in charge of environmental protection. Under pressure to apply green GDP accounting in their work, these agencies are eager to show the society at large that the nation is actually much less economically robust than the conventional GDP figure would suggest when the environment is factored in. This is shown most effectively using subtraction. In other words, it is in their professional interest to make the number subtracted from the conventional GDP figure as large as possible.

That this subtraction approach can be counterproductive is illustrated by the case of forestry resource accounting. For this particular area, green GDP accounting has been expected to confer two different yet related advantages: (1) to highlight the social, economic and ecological value of forests and (2) to highlight the social and economic importance of forestry. How are these to be

achieved? The basic philosophy of forestry management changed and conservation replaced exploitation through intensive logging to become the new focus. Following this forestry authorities in China have invested generously in forest protection and preservation. They are understandably eager to show their achievements, and to downplay the negative impact of what timber logging that remains. Therefore, from their specific point of view, what best helps them do these is to use an 'additive approach', which essentially involves adding the non-market value of forests to economic values as calculated according to conventional methods. That is to say, forestry authorities prefer to see a green GDP figure that is larger than the conventional one. At a minimum, they would like to see that the contribution by forestry towards GDP has not reduced.

This case reveals the two main sources of disagreement over how best to implement green GDP accounting. One of them concerns the nature of the subject matter and the other the goals, interests and motives of the agencies involved in implementation. So far as the first is concerned, it is important to distinguish between natural resources and environmental pollution. For example, in the case of forests, they may well be the only form of natural resource that is capable of artificial regeneration, and as such a source of increase to the conventional GDP figure. In regard to the second source of disagreement, the forestry example shows that agencies in charge of environmental protection in general and those in charge of forestry management do not always want the same things from green economic accounting. As has been illustrated, where the first wants to highlight how much remains to be done (if only as a way of warning the country about the danger of complacency), the latter may well wish to emphasize how much has already been accomplished (perhaps in order to publicize their own achievements). It is easy to imagine how easy it would be to manipulate the specific mechanisms used in green GDP accounting. One way to keep the impact of these administrative biases and departmental self-interests to a minimum would be to make sure statistical agencies – who are thought to be largely neutral on these issues – are closely involved in green GDP accounting. Such agencies can provide the necessary checks and balances that help ensure the scientific quality of the accounting results.

V. Future trajectories: Composite indicators

In 2006, the Ministry of Environmental Protection and the National Bureau of Statistics published a *Research Report on China's Green GDP Accounting* (MEP and NBS, 2004). The report focused on environmental pollution. It included green GDP-equivalent figures. These figures are not, strictly speaking, GDP figures insofar as they are not 'gross', that is, they did not aggregate across sectors. Instead, they are indexed figures computed on the basis of, and used for comparison with, conventional GDP figures. To date these figures remain the only published official data relating to green GDP accounting. Following this, discussions of the subject began to subside, so much so that many people have concluded that the whole effort has certifiably failed.

This is far from the case. The Ministry of Environmental Protection has continued to carry out green GDP accounting following publication of the 2004 report. Annual reports for subsequent years have also been published. There have been improvements in the accounting methods used. National green GDP accounting is now increasingly being supplemented and used in conjunction with green economic accounting in the broader sense at the regional and even local levels. Green corporate accounting is also being tried in many places. Green resource accounting (such as for the nation's forests and water) is becoming more systematized and institutionalized. Even though the results of these efforts have not all been released, they are often available to relevant government agencies. Far from being over, China's efforts towards green GDP accounting are alive and well. More important, they are bearing fruits.

At the same time, to meet the needs of macroeconomic policy-making, especially in relation to the goal of adjudicating the relationship between economic growth and resource conservation and

ecological protection, relevant government agencies have developed a number of topic-specific indicators. These include: (1) energy and pollution intensity of the economy as measured in terms of energy consumption or pollution discharge per RMB 10,000 (US$ 1519) of economic output. A target of 20 per cent reduction in energy intensity for the national economy was included in the 11th Five-Year Plan. (2) The National Development and Reform Commission has led various departments in researching and developing a system of indicators for key environmental resources. This will serve as a comprehensive data bank for information on China's environment and economy. The data are to be updated and published regularly. (3) Indicators are being developed to facilitate China's transition towards a circular economy. (4) The National Bureau of Statistics and Ministry of Environmental Protection are also engaged in research and development of guidelines for the compilation of national data and statistics on expenditure for environmental protection. The goal of the project is to construct a database by pooling together the data different agencies and departments already have. In addition, the Ministry of Environmental Protection has already completed a national survey of pollution sources, and the Ministry of Water Resources is preparing to do a national water resource survey. All of these will be instrumental for the eventual establishment of a scientifically sound green GDP accounting system in China.

It can be concluded then that China has entered a new phase in her efforts to establish a green GDP accounting system. In this new phase, scholars, researchers and accounting professionals are at the frontline working on how to put new ideas into practice. These different actors are continually expanding the scope of their work, going beyond the production of a green GDP figure, and working towards the institutionalization of a comprehensive environmentally-sensitive economic accounting system.

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Part Four
Theoretical issues and methodology

16
Ecological Values and Capitalism

Lu Feng

“资本的逻辑”与消费主义

I. How 'the logic of capital' will soon rule in China

According to Hernando de Soto (2000:41), one of the most important insights emerging from Adam Smith's discussion of the concept of capital is Smith's explanation of the tendency for capital to appreciate in value.

This chapter explores this idea and its links to ecological sustainability. The chapter asks what is 'the logic of capital'? The logic of capital can be understood as nothing other than the imperative for capital to grow indefinitely. The growth of capital is possible only through people's conduct, especially their social activities. Money, machines, equipment, factory plants, technology and scientific knowledge can function as instruments for increasing wealth only insofar as they play a role in people's economic activities, in particular, but also their social activities more generally. In any society, 'the logic of capital' does not become its overarching normative principle unless the following two conditions are satisfied:

1 The establishment of sound institutions based on clearly-defined property rights and a reliable system of money and credit;

2 The social dominance of the group of individuals whose main (or highest) purpose in life is to accumulate material wealth.

In general terms, when a particular group (or class) of people occupy a position of dominance in a society two things can be understood. First, if members of the ruling class come from a certain social group, that group will be held in high esteem. Secondly, the lifestyle choices of this group are widely considered to be worthy of emulation. The values of the dominant group command a strong normative force, and both mainstream ideology and social institutions reinforce these norms.

These two conditions in fact hold the key to understanding the mechanism by which capital's inherent potential to grow is realized. Historically, it took a long time for these conditions to be fully satisfied. Indeed, they were only realized with the birth and the maturation of capitalism.

The magic power of capital is fundamentally attributable to the magic power of money. As Davison argues: 'The usefulness of money largely depends on the money supply system' (Davison, 1977). The power of capital has seen its fullest manifestation in capitalist societies. It is only when private property rights are universally respected that capital can actualize its potential to fuel the advancement of society in its various dimensions.

In the west, the development of a system of private property rights coincided with the rise of a highly acquisitive population which became the dominant social group. In fact, it can be said that the two processes are but different aspects of a single historical trend.

The notion that there is nothing money cannot buy has been around from time immemorial. However, only under the conditions of modern society can 'the logic of capital' be an all-encompassing and overarching principle by which all areas of social life are regulated. Both in the west and in the east, people whose main purpose in life is to make money only achieved high social status through a slow process of historical change.

In the west, the establishment of a system of private property rights and the gradual rise of a capitalist class as the dominant social group occurred during the Renaissance, Reformation and Enlightenment periods. By the 21st century, both processes had neared completion, and in societies where this has happened, 'the logic of capital' has come to reign supreme.

In contrast, China has been searching for a path towards prosperity and military prowess since the Opium War. It was a historical event of great moment when, in 1949, the Chinese Communist Party took power. However, 'the primacy of class struggle', a philosophy which still guides all China's decisions in political and economic matters, has also been a highly effective defence

mechanism against the incursion of 'the logic of capital'. The consequence has been the near collapse of the Chinese economy. That China has been able to achieve miraculous growth of the national economy in the years after the reform and opening policies took effect in 1978 was largely due to the massive energy released by the Chinese people's desire for wealth and prosperity, and indeed, to 'the logic of capital'.

Establishing a system of property rights has become an increasingly urgent item on the government's economic reform agenda since 1978. It is generally agreed that the moment at which the Chinese Community Party announced that entrepreneurs would no longer be debarred from joining its ranks marked the emergence of entrepreneurial magnates as a dominant force in Chinese society. At the time of writing, 'the logic of capital' has become such a potent force in China that it is almost the sole compass guiding institution-building efforts in China in many different areas.

The present situation in China is highly complex. Democratic institutions are not yet fully in place, and China lags behind many societies in the west in terms of its system of private property rights. However, the desire of the Chinese people to become a powerful and prosperous nation is strong; everyone from high-ranking government officials to ordinary citizens has eagerly embraced and rallied around Deng Xiaoping's call, famously made during his historic 1992 inspection trip to southern China, that 'development is imperative'. There is a consensus that China should never waver in its pursuit of economic growth.

The world has seen the magic power of the market in spurring economic growth in China since the implementation in 1978 of economic reform and opening policies. As a result, a majority of Chinese have come to welcome not only the institutions but also internalized the values and norms of a market-dominated economy. This popular support among the general public of course constitutes a strong base for further institutional reforms. In addition, a class of entrepreneurial magnates is now pre-eminent in Chinese society. These entrepreneurs are an interest group whose members have benefited immensely from China's institution-building. Insofar as economic growth is a matter of the highest priority, the best way to ensure that it will continue at a brisk pace is to establish institutions and systems that allow the growth potential of capital to be actualized to the fullest extent (Smith, 1999).

Institution building under reform policies has provided a powerful stimulus for economic growth. For example, the growth of financial markets, together with high interest rates – set by the state – have encouraged many citizens to invest and to manage their wealth through new financial instruments. In the minds of the money-wise, only the truly ignorant would keep all their money in the bank. Such an incentive structure in China, in conjunction with the constant and frenzied stoking by the media, has given people the powerful urge to make money and become rich.

Of course, with respect to private property rights, China still lags far behind the developed countries of the west. In China, while the building and development of 'external institutions' has proceeded at a brisk pace, its 'internal institutions' are bound to take much longer to take shape. The serious inconsistency between state ideology and the value imperatives inherent in a market economy, and the mutual reinforcement of political corruption and social corruption, have led to a very serious crisis of trust. This kind of crisis constitutes a serious threat to the future growth of capital.

II. The problem with mainstream economics

When a society is dominated by individuals whose main purpose in life is to acquire money and wealth, its institutions must increasingly obey 'the logic of capital', thereby further reifying its power. In such a society, mainstream economics, which is nothing if not an ideology that openly defends 'the logic of capital', becomes the mainstream ideology. Dispensing with any pretence of subtlety, the ideology teaches that the single-minded pursuit of money is natural, good, and necessary. It claims that material wealth is the only source of individual happiness and social welfare, and promises the possibility of unlimited economic growth. Under the market system, a large swathe of society devotes most of its time and energy to economic activities aimed at accumulating money and material wealth, and succeeds in doing just that.

Mainstream economics legitimises this behaviour by treating it as a moral norm. But when people's basic needs have been adequately met, the imperative for capital (and therefore the economy) to continue to grow, and the need to create demand for what the economy has produced make it necessary to induce 'mass consumption', luxury consumption and 'symbolic consumption'. When a majority of a society's members value the symbolic value of consumer products more highly than they do their use value, a society has become a consumer society, in which consumerism is both the practical manifestation of mainstream economics, and a social norm.

To say that a consumer society induces and encourages people to consume prolifically is essentially to say that this is what the owners of capital in such a society do. Modern consumerism blurs the line separating basic material needs and the need for meaning, encouraging people to try to fulfil the latter by means of an indefinite and insatiable pursuit of the former. Throughout history there have always been those for whom material consumption is only of marginal importance to a happy life. One example is the 19th century American David Henry Thoreau. Throughout his life, Thoreau engaged in a 'life experiment' in which he tried to live as rich a life as possible with as few material resources as possible. Thoreau's was a life of outward simplicity synthesized with, as his writings show, inward richness. Many who are uninformed or unreflective may see this as a great misfortune for Thoreau. This was not his experience however. Thoreau claimed to have lived happily, and without regrets. Indeed, he believed himself to have been among the few human beings to have succeeded in doing so. Thoreau's 'life experiment' proved beyond any doubt that human flourishing is not necessarily correlated with material consumption.

In this day and age, it is not possible for everybody to try to live like Thoreau, but it is necessary to consume with restraint. How, then, should the right amount of consumption be determined? At a bare minimum, it is necessary to consume enough food to maintain health, have enough clothes to be protected from the weather and to be publicly presentable, have enough shelter to be shielded from the elements and for comfortable rest, and enough of whatever else is needed to support social and spiritual life. However, human appetites for material things are influenced as much by nature as by culture, and are extremely plastic. Among the items listed above, food may be the only one for which the minimum can be clearly determined, given what we now know about biology and nutrition. The others – clothes, shelter and social connection and spiritual engagement – are necessarily historically variable and contingent. For clothes and shelter, for instance, levels of need will go beyond practicality once factors such as vanity are taken into consideration. There is no limit to the pursuit of ever more extravagant and bizarre styles and materials. People are bound to become competitive in this pursuit, thereby entering a trap of insatiability. But still, even for clothes and shelter, it is not entirely impossible to arrive at a non-arbitrary estimate of how much – or indeed, how little – is necessary to support a reasonable human existence. Of course, none of this is meant to suggest that people like Yan Hui, a disciple of Confucius known for his self-imposed material austerity, and Thoreau, will not always be in the minority.

Anyone who seeks to independently search for the meaning of life will need to recognize these minimum standards of consumption. It should not be very difficult for somebody who is physically

fit and of sound mind to have these standards met. As Adam Smith claimed, 'the wage of a common labourer is sufficient for providing his basic necessities'.

Most mainstream economists believe that while consumerism and materialism may be crude and crass, they are nonetheless perfectly consistent with human nature, and as such unalterable. In their view, a society governed by 'the logic of capital' is not only inevitable, but good and the best kind of society. Mainstream economics has so far been the economics to furnish the theoretical explication and justification for this logic. Its basic assumption about human nature is that humans are rational beings that seek to maximize their self-interests or individual utility, but their main interests are in material things, and fulfilment of these counts towards their individual utility calculus. It follows from this assumption that it is only natural and good for individuals to pursue material wealth and for societies to pursue unlimited economic growth. The implication of this then is that there is little point in trying to resist capitalism or to contain the 'the logic of capital'.

But is the insatiable desire for ever greater material wealth really intrinsic to human nature? Or is it learned behaviour? Everybody must be born into a social environment, yet nobody gets to choose what kind of social environment they are born into. It is quite possible that culture and society play a more prominent role in shaping our beliefs and desires than other factors, such as genetic make-up. For example, Chinese born after 1980 and in urban areas have been immersed in materialistic culture and a commercial atmosphere since childhood and are ready adopters of consumerist values. However, this does not mean they would have adopted the same perspectives and habits if they had been born and grown up in a different time. It is difficult to imagine that they would not have soaked up revolutionary idealism, utopianism and the zeal for class struggle had they lived in the era of Mao Zedong, much like many of those who actually did live through that time.

Borrowing heavily from Abraham Maslow's humanistic psychology, contemporary economists in the humanistic economics tradition have subjected mainstream economics to serious criticism. Their criticisms of materialism and egoism are particularly noteworthy. Mainstream economists are wont to label economics a (positive) science, which, they claim, seeks only to understand (or describe) facts but do not try to make normative judgments about them. However, contrary to this disingenuous claim to value-neutrality, the 'science' of economics is anything but, as can be seen by the subjective nature of its assumptions about basic human nature. Also the espousal of consumerism and materialism in economic discourse are nothing if not value commitments. By contrast, humanistic economics does not pretend that economics either can or should be value-neutral. Instead, proponents believe that value judgments are impossible to avoid in the social sciences, and that is necessary to avoid making perverse value judgments.

Mainstream economics conflates needs and wants, treating them all as 'personal preferences, to be maximally satisfied and to yield maximum individual utility' (Lutz and Lux, 1979). This is largely due to the fact that mainstream economics arose from utilitarianism, which is noted for its reductionism with respect to happiness and value. Both theories have an inherent tendency towards measuring the diverse phenomena of the world using the same scale. People now live, therefore, in an 'era of dictatorship from numbers'. Of course, this reification of money serves the interests of capital accumulation well insofar as capital is most often measured monetarily. Today, in a world ruled by 'the logic of capital', too many have been misled to believe that happiness depends on nothing but money and material wealth.

But according to humanistic economics, needs and wants are qualitatively different, there are many different types and often they are matters of degree, and must be responded to in different ways. Needs are largely determined by objective factors (for example, nobody can just decide to stop needing food, water, and air) while wants are much more malleable according to subjective factors (luxury goods are so-called precisely because they are optional, and desire for them is such that, with some effort, it can cease). Even if capitalism is credited with having satisfied the basic

needs of most people (which is not an indisputable point), it must be acknowledged that it has also done much to distract people from higher, non-material, pursuits. A society in which a large number of its members are systematically distracted in this way is surely dysfunctional and perverse.

In a society governed by 'the logic of capital', people are encouraged to become experts at making and spending money, but not to become virtuous or to seek enlightenment. Many people may also believe that the more money one has, and the more goods and services one can buy, the more free one will be. But this is not correct. People who live in the so-called 'free world' of modern developed societies are not genuinely free. For 'freedom is a state of being, not a state of possessing. That is to say, freedom is a function of our lifestyle, and not of our standard of living' (Lutz and Lux, 1979). Indeed, many of the nominal winners, laureates and celebrities honoured in this kind of society are not at all paragons of virtue. From the point of view of the advancement of human civilization, a society that holds these figures in the highest esteem and whose norms are defined by their tastes and desires is morbidly and pathologically ill.

Faced with the global ecological crisis, concerns about egoism, consumerism and materialism must go beyond questions about whether they are constitutive of human nature. However these questions are settled, what is certain is that a lifestyle of 'producing prolifically, consuming prolifically and disposing prolifically', if practiced universally, is ecologically unsustainable and as such poses an existential threat to humanity as a whole. Therefore, even if we are unable to use the conceptual scheme of capital to refute individually extravagant lifestyles, from an environmental point of view it is clear that nature has not given anyone the right to live this way! If all cannot live as the richest citizens on the planet do, then it must mean for each who is lucky enough to have managed to do so there are many others who are not so lucky. And among the unlucky ones, many will have so small a share of the earth's ecological space that even their basic needs, such as those discussed earlier, cannot be adequately met.

III. 'Gradual revolution' is the only way to contain the logic of capital

The right to live the lifestyle of one's own choosing has fundamentally to do with how much liberty is granted to individuals under liberalism, the prevailing political philosophy of the modern and the contemporary eras. Liberals believe that the proper aim of the institutions of constitutional democracy and the market economy should be to provide all citizens the space within which to believe what they wish to believe and to practice what they wish to practice without undue interference from authority (but with basic social order maintained through the monopoly force of the state). This is not inherently problematic. Any system that favours a particular religious belief over others is potentially dictatorial. Therefore, not only is an impartial political institutional framework the mark of historic progress in political and cultural terms, but it is thanks to the measurable success of some countries in their experience with this kind of system that people of different faiths have been able to peacefully coexist, to tolerate, and even to cooperate with one another.

How then do egoism, consumerism and materialism fit into this theory of neutrality? In the first instance, they are issues for a country's economic system and not its political system. These three 'isms' inevitably have significant influence over a country's macroeconomic planning and infrastructure-building. A system shaped by these 'isms' is likely to be greatly concerned with encouraging capital accumulation and stimulating material consumption. Its institutions and laws will be designed to serve the interests of the moneyed class, and consequently the issue of the equitable distribution of social resources will likely not receive the attention it deserves. Under such a system, the disenfranchised will easily be abandoned, and all those who for

whatever reasons defy these 'isms' will be subject to ostracism and ridicule. In particular, the voluntarily thrifty will be subject to pressure to conform to the norm of wasteful consumption against their will. Therefore, even if the political institutions of such a society have managed to maintain neutrality among different religions, and between believers and non-believers, economically, they will be in the firm grip of egoism, consumerism and materialism.

As has been noted earlier, mainstream economics assumes that all human beings seek to maximize their self-interests; that all needs and wants are nothing but preferences, and that 'interest' is conceptualized as material desires. It follows from these presuppositions that the 'logic of capital' is consistent with human nature, and that egoism, consumerism and materialism are the most humane values. This in turn means is that if there are good reasons to reject these premises then there are also good reasons for rejecting the conclusions associated with them.

Objecting to the supreme reign of 'the logic of capital' does not mean that the opposite extreme is to be followed, as under a centrally-planned, command-and-control economy. A society severely lacking in economic vitality would not be sustainable because it would not be able to meet the basic needs of its citizens. The only way out of the current ecological crisis is by finding a third way, by building an ecological civilization (Lu, 2009). This entails reigning in 'the logic of capital'.

The only solution is a 'gradual revolution'. This is not, as might be suspected, a contradiction in terms. Not all revolutions need be violent and bloody. One class can upend the social structure and overthrow another by non-violent means. This would begin with changes in prevailing values and beliefs, which often require leadership by intellectual and other social elites, which are then translated gradually into transformations of social institutions, modes of production and lifestyles. This revolution may well take place within the existing democratic institutional framework, yet it will not be accomplished overnight, or even quickly. But it is necessary to remain hopeful, for revolutions or paradigm shifts often take place quietly and unexpectedly, when it is seemingly not possible to discern signs of impending social change. When change arrives, the process by which it was brought about will have run its course.

The success of this revolution hangs, therefore, on whether ecological values can supplant egoism, consumerism and materialism to become the prevailing ideology, the norm. 'Ecological values' refer to such things as benevolence, a commitment to resource conservation and material simplicity, and a desire for higher things than material possession and consumption. The inculcation of these values will require more than efforts by a few intellectual elites to spread the message. The adverse effects of environmental pollution and ecological destruction on human welfare will do just as much to alert people to the dangers inherent in the material culture that currently prevails. When ecological values are no longer marginalized in a society, the Thoreaus and the Yan Huis of the world will no longer be looked upon as misfits, but will become examples to be celebrated and emulated. At that time, institutional reform and construction shall no longer be held hostage to the 'the logic of capital'.

As more people with ecological values become political leaders, a new era will begin in which capital serves the needs of the people, and not the reverse. By that time, the state and the government will have put in place measures designed to limit the influence of 'the logic of capital'. These may include, but need not be limited to: making welfare and tax policies through democratic processes; limiting the role of the market in the provision of healthcare and basic education; promoting philanthropy and other forms of non-profit enterprises; setting preferential policies that encourage the growth of ecological industries (for example, by lowering or even eliminating their tax burden so as to offer them a competitive edge relative to traditional, environmentally more destructive industries); investing in areas such as the study, and the teaching, of ecology; the development of ecologically sound technologies, clean production and renewable sources of energy; and, making the creation of an ecological civilization the goal of science and innovation policies and investments.

IV. Conclusion

Wrenching humanity free of the strictures of egoism, consumerism and materialism requires that people be scientifically literate and informed, especially in the earth and life sciences, and to be willing to think deeply and independently about the meaning of life. Living by ecological values would mean that people care about others, regardless of whether they are near or far either in time or in space, and care about non-human life forms. Individuals in this ecological civilisation would be creative and innovative in expressing their individuality. To achieve this governments must put in place legislation and public policies that encourage limited material consumption. For example, if it is possible to estimate the carrying capacity of a given area, then it is possible to determine, given the area's population, the maximum per capita resource consumption thresholds and waste output allowances. Governments should then make it very difficult to consume and to dispose at levels in excess of the allowed amounts. Those who insist on living more extravagantly must be subject to hefty taxes.

It is safe to say that there will always be those who want little besides vast material wealth and high levels of material consumption. And it is also safe to say that a market-based economy may never completely go away, and perhaps should not either. However, the hope is that as ecological values come to prevail, democratic and market institutions will work together to transform businesses, culture and society. People will acquire environmentally-friendly consumption habits and live by them. It would then not be necessary to abandon either the desire for freedom or the desire for a clean and sustainable environment. Wise, ecologically-sound governance would mean that both aspirations can be realised.

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17
Environmental Resources and Natural Capital: Inefficient allocation and polarized distribution

Zhang Shiqiu[1]

环境资源配置低效率及自然资本“富聚”现象剖析

It is more than thirty years since policies for economic reform and opening-up were launched in China, ushering in a period of rapid economic growth. Today China enjoys the distinction of having the fastest-growing and largest economy on earth. Questions have arisen, however, about what China's growth means for global ecological sustainability. The negative domestic social consequences of increasingly unequal and polarized wealth and natural resource distribution are also becoming more evident.

The Chinese government has made considerable effort to arrest worsening trends in environmental pollution, and has achieved some successes. However, environmental conditions in China remain deeply worrying.[2] The effects of many forms of environmental pollution are cumulative, and new problems are always being added. This means that it is all but certain that in the foreseeable future, the outlook for China's environmental situation will be dire. Evidence of a how the environment has been ravaged will become more widespread and more marked. There will be more frequent environmental disasters and escalating social conflicts. Conflicts between subsistence rights and property rights will be especially salient, and will have environmental impacts. Signs of this are already readily apparent in everyday life. As Chinese society becomes increasingly stratified and hierarchical, these conflicts will become more pronounced. To the extent that the full ecological costs of economic activities are not reflected in the production costs or the market price of economic outputs, opportunities have been created for elite and powerful groups in society to mobilize what resources they control (both economic and political) in order to grab as large a share of natural capital, and social wealth as possible.

Existing environmental regulations are no match for the problems they are intended to help solve (Zhang, 2004). This is because their status is marginal at best. Consequently, to balance environmental protection and economic development, a comprehensive approach is needed that takes into consideration long and short-term concerns and the interests of individuals and society as a whole. China's institutional structure does not allow for proper representation of the interests of citizens in economic, social, and political processes (especially the concerns of small groups). This means these interests are often poorly protected, if they are protected at all. Furthermore, without systematic methodologies for measuring changes in both the quantity and the quality of environmental resources, it can only be expected that the trend towards natural capital depletion will continue for some time to come (Zhang, 2005).

China's most critical environment and development problems are as follows: (1) how to contain unemployment and improve incomes while ensuring the proper balance between economic growth, environmental protection, and social development; (2) how to alleviate poverty and protect the environment at the same time; (3) how to minimize or redress environmental injustices within the context of regional socio-economic disparity; (4) how to avoid becoming an importer of foreign waste (toxic or otherwise), particularly when China enjoys a comparative advantage as an exporter of many kinds of goods and services; (5) how to mitigate social conflicts arising from polarization of incomes and natural resource distribution; (6) how to deal with a situation where new problems arise faster than existing ones can be eliminated; and (7) how to respond to newly emerging global environmental challenges.

Environmental problems in China are no longer simply about resource conservation and environmental protection. They have now become a key driver of social and political tensions that threaten national security. In particular, these problems are manifested as heightened tensions among different social groups.

This chapter addresses inefficiencies in environmental resource allocation, and in particular, how market and institutional failures have allowed a few to commandeer a disproportionately large amount of the nation's natural capital. The existing situation is described and analysed, and suggestions are made about how to deal with environmentally-generated socially conflict.

I. Inefficient environmental resource allocation: Price distortions and market failure

Modern market economies are highly adept at expanding the material productivity and wealth of a society. However they have many flaws that have been widely acknowledged (Hughes, 2001). These include: (1) ambiguity and uncertainty in property rights which render the market incompetent as a provider of public or quasi-public goods, such as environmental protection, education, and national defence; (2) failure of the market to internalize externalities without policy intervention; (3) inadequate provision of services to consumers by government when it is a direct or a principal provider of goods and services and there is insufficient competition (suppliers enjoying natural monopolies tend to be inefficient and charge too highly for goods and services); (4) suboptimal resource allocation due to lack of information, or information asymmetries.

In a market economy price is of pivotal importance for resource allocation. Allocative efficiency hinges on prices, and in particular on whether prices reflect the full social costs of economic activities. This section identifies four different types of efficiency: technical, economic, natural, and social efficiency.

Technical or technological efficiency refers to the amount of material or energy inputs per unit of economic output: a production process is more technically efficient if there is less input per unit of output, or more output per unit of input. However, when more than one factor of production is involved, the marginal productivity of any one factor is contingent on the amount used of each of the others. This means that more than one technologically efficient combination of material and energy inputs may be possible.

So-called **economic efficiency** refers to the financial costs of economic production. The less it costs to produce a certain quantity of goods and services, the more economically efficient a production process is. Assuming zero transaction costs and constant market prices for all inputs, there should be one combination of factor inputs that is more efficient economically than all other possibilities.

The notion of **natural efficiency** refers to the ratio between values for various individual environmental indicators and the overall quality of the environment as a whole. The more stable, harmonious, and integrated the ecosystem, the more naturally efficient it is considered to be. When environmental resources are treated as a free gift from nature to society and undervalued, their overuse necessarily reduces natural efficiency.[3]

Finally, **social efficiency** refers to the ratio between returns to society for a given quantity and quality of output when both input prices and the final price of output reflect social costs of production and consumption.

Studies in economics show that Pareto optimality obtains when all of the following conditions are satisfied:

- Efficient resource allocation. This is when the marginal (M) rate (R) of technological (T) substitution (S) between human-made (M) and natural capital (L) is the same for all of the products (say, w and c) that any producer produces. This is equal to the ratio of the return on investment (P) for the two forms of capital.

$$MRTS_{(m,l)c} = MRTS_{(m,l)w} = P_m / P_l$$

- Efficient consumption. This is when, for each consumer, the marginal (M) rate (R) of substitution (S) between any two kinds of goods/services, w and c, is the same. This is equal to the ratio between the prices (P) of the two.

$$MRS_{(w,c)1} = MRS_{(w,c)2} = P_w / P_c$$

- For all consumers, the marginal (M) rate (R) of substitution (S) between any two kinds of goods/services, w and c, is the same. It is equal to the marginal (M) rate (R) of technological (T) substitution (S) between human-made (M) and natural capital (L), which is the same for these two products, which is in turn equal to the ratio of the return on investment (P) for the two forms of capital (human-made and natural) used in producing these two products.

$$MRS_{(w,c)1} = MRS_{(w,c)2} = MRPS_{(w,c)1} = MRTS_{(w,c)2} = P_w / P_c$$ [4]

Price, as we can see here, is the lever by which resource allocation is controlled. Under conditions of perfect competition, it is by means of the price mechanism that the market adjusts demand and supply, thereby achieving resource allocation efficiency. Therefore, if prices are wrong, as when factor costs do not reflect full costs or relative importance, allocative efficiency is necessarily compromised. Studies show that the efficient price of a resource should reflect its full social cost, that is, it should equal its marginal opportunity cost (MOC) to society. Moreover, the efficient price must reflect not just the market production cost (MPC), but also its marginal environmental cost (MEC) and marginal depletion cost (MDC). Formally, this is represented as $P=MOC=MPC+MEC+MDC$. However, due to epistemological limitations and institutional malfunctioning, societies have more often than not paid either nothing at all or very little for the use of natural resources and the use of the environment as a sink for waste and pollution. Inadequate policies and/or lax enforcement mean that neither the marginal environmental cost (MEC) nor the marginal depletion cost (MDC) of natural resource inputs to production and other ecological functions and services are fully reflected in the market price of outputs. As such, the conditions for Pareto-optimal use of environmental resources in economic production are not satisfied. The following section examines the symptoms of this failure in greater detail.

1. Technological efficiency maximization and economic efficiency maximization: the problem of misalignment

The internal logic of the market economy makes profit the ultimate yardstick by which achievements are measured. Corporations make decisions about the relative quantity and quality of production inputs and modes of production in order to increase economic efficiency. Some forms of input are substitutable, and profit maximization requires that the cheapest inputs be used in favour of costlier ones regardless of whether the latter are superior to the other, technologically or otherwise. Corporations tend, in other words, to be more interested in improving economic efficiency than technological efficiency. Insofar as corporations express any interest in the latter, the interest would typically be derivative of a direct interest in the former. Therefore, market prices that fail to truthfully reflect the full (including social and environmental) costs of economic activities necessarily encourage resource overuse.

The other side of resource overuse in industrial production is overconsumption of the same form(s) of resource by consumers through their consumption of final products. When externalities such as the costs associated with resource depletion are not factored into the price that factories pay for inputs, they tend also not to be factored into the prices consumers pay for the final economic output in the form of goods and services. Products whose prices do reflect the full social and environmental costs of production and consumption are at a competitive disadvantage relative to others because they are typically more costly to consumers. The enthusiasm for cars in China today is a case in point that illustrates well the effect of price (distortion) on consumer behaviour.

This discrepancy between technological and economic efficiency is in fact a reflection of the discordance between natural systems governed by the laws of matter and energy and economic systems governed by laws of exchange and price. As such, there is a fundamental separation between material wealth and economic wealth, and between natural and economic capital.

2. Economic efficiency and natural efficiency

Not unlike the misalignment between technological and economic efficiency, the misalignment between economic efficiency and natural efficiency is caused by a lack of effective government intervention and by a conjunction of epistemological limitations and differences in values within society.[5] Without effective government intervention, the market by itself cannot register the true value of environmental resources for society as a whole, including future generations, through price signals. Epistemological limitations mean that societies are as yet unable to accurately assess the importance, fragility, and vulnerability of various forms of environmental resources and different environmental conditions. While the market may be of some value in accounting for the social costs of economic production and consumption by incorporating them into price, it is unlikely to accurately gauge the relative importance of different forms of environmental resources within and between regions, as well as within and between generations. To sum up, aligning economic and natural efficiency requires not just the right policy with regard to prices, but also more advanced scientific understandings of ecosystems and the value of environmental resources.

3. Linkages between technological, economic, natural and social efficiencies

It is commonly thought that natural systems are something like productive forces. The economic history of different regions and countries shows that something functionally akin to production relations in human society is also discernible within natural systems. In nature as in society, there are organizational structures, in which the forces of different parts impinge on one another. These dynamics inherent to the natural world have enormous implications for humanity, as they constitute the underpinnings for the formation, development, and evolution of social and economic relations. Therefore, the workings of natural systems and the degree to which they are efficient influences productive forces and also shapes social and economic relations. Environmental problems can therefore be seen to be social as well as ecological, because they involve relations between society and nature and also exchanges between people.

Human society is part of nature. The market is currently the dominant mechanism by which resources and benefits are allocated and distributed between different groups. Constant exchanges of materials, energy, and information take place between society and nature. When the volume and intensity of these exchanges exceeds a certain threshold, a host of environmental problems can arise, culminating in ecological crisis. By this logic, it is possible to infer that when discrepancies exist between the first three efficiencies under discussion here, society will be affected. There will be implications for economic growth, social welfare and social and economic structures.

Using this reasoning, it can be argued that only when prices for factors of production and produced goods and services have fully incorporated producer costs, environmental costs and resource depletion costs that technological, economic, and natural efficiencies can be aligned with one another. This alignment is the precondition for harmonious social relations and highly-efficient forces of production. All of this requires, as has been noted already, a proper understanding of the value, and the price, of natural resources and ecosystem services within economic production and consumption. Exchange or trade is the precondition for assignment of a price, and clearly defined and demarcated property ownership is in turn the precondition for the possibility of exchange or trade. Under a market economy, if this last condition is not fulfilled, trade and exchange will fail to properly reflect the true value of different environmental resources. This lies at the heart of the question of how to eliminate price distortions and achieve maximum efficiency levels across the four dimensions of efficiency discussed in this chapter.

II. Government responsibility for inefficient resource use, polarized natural resource distribution and increasing social stratification

Global inequality has attracted significant discussion and analysis. Milanovic (2005) finds that the earnings of the richest five per cent of the global population are 114 times higher than the incomes of the poorest five per cent. The richest one per cent have incomes equivalent to the combined incomes of the poorest 57 per cent of the global population (Milanovic, 2005). Unequal exchange has imposed enormous debt burdens on many developing countries, locking their populations into persistent poverty. Underneath these debt burdens lie deeper environmental crises. China, for example, has made spectacular economic advances in recent decades; however, the benefits are unevenly distributed between regions and social groups. Indeed, some groups have lost out and been harmed. In the 1990s, economic growth in coastal provinces averaged 13 per cent each year, five times the growth rate for the northwest, the slowest-growing region of the country. Under enormous economic pressure, resource extraction and exploitation intensified, fuelling a range of ecological crises. This also reflects global trends. As Amartya Sen comments in the introduction to the UNDP Human and Development Report (2010): 'Twenty years after the appearance of the first Human Development Report, there is much to celebrate in what has been achieved. But we also have to be alive to ways of improving the assessment of old adversities and of recognizing—and responding to—new threats that endanger human well-being and freedom' (UNDP 2010).

1. Polarized allocation of natural resources

A cursory look at the social and economic history of China shows that social, economic and political disenfranchisement is nothing new. There have always been privileged, powerful, elite groups that have used their privilege, power and elite status for purposes of commandeering a disproportionate, and unfair, share of natural resources, and by extension, economic output. In this study, 'polarized distribution of natural resources' occurs when: (1) effective government intervention is absent; (2) a market system is dominant; (3) when inequality in wealth distribution has reached a certain point; (4) and when resources used as inputs for economic production including common property resources and environmental public goods or quasi-public goods are captured by socially and economically powerful groups. This kind of polarized distribution means that the extreme wealth of the rich comes at the expense of further impoverishment of the poor. The richer the rich get, the poorer the poor become.

2. Diagnosis

1. Natural resource exploitation as the basis for economic growth and the pursuit of economic efficiency

The prevailing model of economic growth is based on, and presupposes, the unrestricted exploitation of environmental resources. The fundamental reason for this is that price signals fail to reflect the full social cost of economic activities. As well as this, environmental resources are public goods, and not under private ownership regimes. This public good status makes regulation difficult. The result is management failure, and under-supply of public goods and over-production of public 'bads'. This makes it important to interrogate the nature of growth, and ask whether the improvements in social welfare (for both current and future generations) that follow from economic growth are worth the environmental price tag.

2. Resource allocation on the basis of opportunism as opposed to cost-effectiveness encourages get-rich-quick schemes

In China, an important fallacy has held sway during two decades of economic reform. This is that opportunity, rather than cost or efficiency considerations, should determine resource allocation. A surge in rent-seeking behaviour has gone along with rapid and far-reaching institutional

transformations. Such behaviour is, at root, a pursuit of high (short-term) returns with low (short-term) costs (or in economists' language, capturing of economic rents). Corporations and businesses engage in rent-seeking to gain a competitive advantage in the market. When this behaviour is widespread, some will strike gold and others will fail, since social wealth is not boundless. The difference between them is precisely that the former have somehow managed to lay claim to more resources (environmental as well as virtual, such as opportunities) than was their fair share. At the same time, corporations and businesses which make efforts to increase resource use efficiency frequently lose-out in this opportunistic game. Often, these corporations have no option but to exit rent-seeker dominated markets altogether, in a phenomenon termed 'bad money chasing away good'. The important proposition this raises is about means and ends – that is whether corporations and businesses ought to only be valued in terms of where they have ended up, or whether it is important to consider their starting points, and how fairly they have operated in pursuing their business objectives.

3. Profit-driven market capitalism allocates resources to the most economically efficient sectors, leading to polarization

The most important feature of any market economy is the establishment of a price mechanism for allocating resources. This mechanism should balance supply and demand. Under competitive conditions, resources should flow from less to more efficient businesses in the same economic sector, and also from less to more profitable economic sectors. In addition, the invisible hand of the market should also ensure that resources are put to the most profitable uses. If and when the market price for environmental resources is very low or almost zero, then, following the law of supply and demand, these resources will tend to be over-used. Before long a positive feedback loop should form in which the more profitable a firm becomes through capitalizing on cheap natural resource inputs, the better it will become at grabbing more natural and economic resources. Many examples can be found of this happening in practice.

Developed countries have historically commanded a disproportionate share of the earth's natural resources and ecological space to support their own development. This has resulted in an array of global environmental problems. Similarly, at the regional level, less developed areas often find themselves losing out in order to help sustain growth in more developed areas. This is powerfully manifested in the relationship between urban and rural areas. In China, rapid economic growth in wealthier areas has been achieved at the expense of other areas, which have stagnated. This raises the question of how government might use policy instruments (such as fiscal measures) to encourage internalization of the full social costs of environmental resource use, thereby promoting more equitable income distribution.

4. Unconstrained pursuit of profit intensifies polarization

In his analysis of the social problems generated by capitalism, Karl Marx clearly pointed out that capitalism is defined by the supremacy of the profit motive. The assumption of homo econominus, used in mainstream economics, dictates that any firm will be driven to produce until the marginal return on inputs is zero. It will capture even the slightest opportunity to obtain even the tiniest amount of surplus value. Meanwhile, advances in science and technology continue to augment human capacities to manipulate nature to satisfy ever-evolving human needs. Thanks to institutional inadequacies, it is possible for any form of economic production that involves the utilization of environmental resources to generate profit. Insofar as the mode of production of a society has as its aim the endless pursuit of profit maximization, exploitative and excessive utilization of natural resources is inevitable. Interest groups that have already claimed disproportionately large shares of profit also attract more natural capital, which enables them to secure still more profit. The result is the so-called Matthew Effect, in which the poor become poorer while the rich become richer. The outcome of this generation of extreme inequality in any society is inevitably conflict and insecurity.

5. Short-term individual efficiency gains, but collective losses over the long-term
Short-term efficiency gains for individual firms do not result in benefits for society as a whole, particularly in the longer-term. Resource finitude means that those who are the first to use a resource may easily leave insufficient amounts for other claimants, unless their use is subject to explicit constraints.

Furthermore, in a bureaucratic and administrative managerial system, officials at different levels of government are primarily concerned with properly following rules and procedures, and with the execution of policies made by higher authorities. Within such a bureaucratic hierarchy, occupants on each rung are expected to fulfil a host of requirements and must answer to their direct superiors - their professional performance is evaluated on the basis of how efficiently they do so. These officials are expected to meet many different requirements, and no meaningful distinction is made between those that apply to means or to ends, to individual items or the whole system, to individuals or to the collective. One consequence of this is that many projects with zero marginal return on investment are vigorously and blindly pursued, when they should not have been approved.

Vast amounts of social resources are wasted in this way. For example, even if a particular waste water treatment plant working at full capacity does little to alleviate problems of severe pollution in a river basin, the politicians and officials involved in its construction will still be rewarded for promoting economic activity. In many cases like this, not only are the projects socially useless because they yield zero marginal utility, they also carry a huge opportunity cost because the resources squandered on them could be put to much better uses. Untold numbers of projects like this exist. Tackling the problem is a public sector responsibility. Environmental management agencies should be held accountable for how well they protect public interests, and not rewarded for mechanically fulfilling formal requirements, regardless of outcomes in the real world.

6. Unprotected rights and interests and bad policies
Ultimately, the reason why such inefficiencies and inequities occur is that market forces are highly unlikely to internalize the full social costs of environmental resource use without adequate government intervention.

Polarized distribution of natural resources is an inevitable consequence of market failure. Price signals fails to reflect the full environmental costs of development processes, because institutions fail to safeguard the interests of citizens. Economists such as Marshall and Pigou used concepts of externalities and market failure to address this issue. They explained how price distortions resulted from differences between market prices and relative prices. They did not use property rights theory. However, it is only when property rights are clearly defined that the market price of resources reflects their relative values. Unless there is a market exchange, the issue of price does not arise. Clearly defined property rights are, in turn, a precondition for market exchange, and they are absolutely necessary if optimal allocation of natural resources is to be achieved, and progress is to be made towards mitigating the various social and economic problems and injustices so far discussed (Ma and Lan, 2003).

Despite the impressive statistics associated with ecological reconstruction campaigns, including those to build so-called 'eco-cities', far more effort is needed to reverse nationwide ecological deterioration in China. At the same time as existing problems are being addressed, new challenges continue to emerge. To a large degree, this is unavoidable given the magnitude of resource shortages in China and the degree of waste in production and consumption systems. Meanwhile, it is not clear how to stop local protectionism from undermining rational and comprehensive planning processes. Disenfranchisement of *de facto* owners of land and other natural resources is also likely to occur when projects undertaken under the aegis of ecological reconstruction are over-zealously pursued. There will also be both inefficient and inequitable allocation of resources across regions and between urban and rural areas, as well as wastage of public funds. While it is a

complicated matter, lack of political will is an important part of the problem (Zheng, 2004). Political will is essential if a clear definition of property rights is to be reached in order to support good environmental management (Portney, 1990).

III. Conclusion

Environmental problems are intimately linked with economic and social development. This applies to both how they occur, and how they are to be addressed. Protecting ecosystems has been an enormous challenge for China during its modernisation process. There is now a danger that environmental challenges could become threats to national security. To prevent this, it is vital that the environment is managed differently from in the past. Economic development, poverty alleviation, income inequality mitigation, and urbanization should all be sustainable processes based on full protection of environmental resources. This means that both government and market failure needs to be tackled, and addressed together rather than in isolation.

1 This paper is an updated version of an earlier paper published in Chinese in *Chinese Population, Resources and Environment*, Vol. 17, No. 6, 2007.

2 In January 2010, Premier Wen Jiabao emphasized at a meeting of the standing committee of the State Council that despite some successes the overall state of the environment was a source of deep concern. He said that the environmental monitoring capacity of the country remained woefully limited.

3 While much of what happens in the environment has human causes, nothing ever happens that violates the laws of nature (which includes the laws of chemistry, physics and biology). These laws transcend, and are completely indifferent to, the interests and desires of humanity.

4 Here again MRTS refers to the marginal rate of technological substitution. M represents physical human-made capital including machines and factory buildings; L represents natural capital such as land; C and W represent two forms of goods or service produced by the economy; and, P is price.

5 Contingent Valuation (CV) methods (which essentially involves determining people's willingness to pay – WTP – for some non-market goods or services) are now widely used in environmental economic analysis and policy debates. They are valuable. However, the method suffers from a number of limitations and defects that have been widely discussed in the literature. Technical constraints aside, interpersonal differences in core values constitute a source of difficulty in the application of Contingent Valuation. These differences compromise the credibility of results using CV approaches.

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18
Water Scarcity, Water Transfer and Water Trade in China

Zhang Xiao

中国水资源的短缺，水权利的转让与交易

Water and energy security and their environmental linkages are among the most critical challenges facing humankind. Currently, the world is focussed on greenhouse gas emissions, however, issues relating to water, such as water quality and water supply for agriculture and cities, and as a renewable source of energy (Labatt and White, 2007), may be even more urgent and more critical.

China faces many water resource problems including pollution, flooding, and inefficient and inequitable distribution under conditions of overall scarcity. These three problems have often occurred simultaneously. In China, especially in the north, drought and water scarcity may be the most serious water related problems hampering economic development. Although China ranks number six in the world in terms of aggregate water volume, the per capita useable water availability is only about 25 per cent of the global average (Liu *et al.*, 1998:2). The North China Plain accounts for over 66 per cent of the country's agricultural production (over half is wheat and a third is corn) (Yang and Zehnder, 2001); however, about 80 per cent of water resources lie in the Yangtze River basin in southern China (MWR, 1999-2006). Furthermore, in China, where grain production is highly water-intensive, 80 per cent of the grain is produced on irrigated land (NBSC, 2007). By comparison, the percentages are 20- 60 per cent, respectively, for the United States and India. Water use efficiency is also relatively low in China. It has been estimated that 60 per cent of water is lost in the irrigation process as a result of evaporation. Additionally, demand for water has surged in the country thanks to rapid industrialization and urbanization. For instance, in urban areas, the increase in demand has been around 30 - 40 per cent between 1999 and 2006 (MWR, 1999-2006) .

I. Water scarcity in historical perspective

Life, including human life, evolved under conditions of water abundance. It is, therefore, only natural that most species depend on water for survival. Within human bodies, water functions as a carrier of both nutrients and waste. It serves similar functions within the ecosystem (Griffin, 2006:369).

1. Water resources in China

According to a new study by the Chinese Ministry of Water Resources, water volumes in the Yellow River, Huaihe River, Haihe River and Liao River basins have declined precipitously in recent years (Yao, 2007).

1. Zoning of water resources in northern China

In many areas of the North China Plain, groundwater is the most important form of water resource (MWR, 2000) . Table 1 shows the breakdown of water sources for six northern zones from 1999 to 2005. When these six zones are investigated separately, it is evident that (1) for the Songhua River and the Liao River, from 1999 to 2002, and in 2004, both aggregate water volumes and the volume of groundwater were less than historical averages; (2) the same was true for Haihe River between 1999 and 2005, which accounts for persistent water stress and drought conditions in the Haihe river basin since the end of the 1990s; (3) between 1999 and 2005, with 2003 as the only exception, the Yellow River faced similar problems to the Haihe River with respect to its overall water situation; (4) for the Huaihe River, for the years 1999, 2001, 2002 and 2004, both aggregate water volume and groundwater volume were also lower than historical averages; (5) for the rivers in the Northwest, numbers in all years between 1999 and 2005 except 2004 were greater than historical average. From this it can be seen that most river basins in the six northern water zones have experienced water stress since the 1990s.

2. Water usage

This section focuses on the three main water use sectors in China: namely, agricultural, industrial and municipal or residential water uses.

- **Agriculture**

  Worldwide, agriculture still consumes more water than any other economic sector. With irrigation accounting for about 70 per cent of total water use. By comparison, industrial and residential water uses are much smaller (Al-Attar, 2004: 272-274).

  Table 2 shows the areas of irrigated farmland and reservoir capacities for all of China between 1980 and 2004. Since 1990 both the absolute size of irrigated farmland and the ratio between the sizes of irrigated areas and sown areas have remained constant. Yet, since 1999, agricultural water usage has been dropping every year (see Table 3). Evidently, then, there have been considerable savings in agricultural water use, and this can help fill the gap in industrial and urban water supply for the immediate future (Edmonds, 1994: 118).

  While agricultural water use in China has grown steadily in absolute terms since 1949 (at a little over 100 billion tons in 1949, it grew three times by 1980), in relative terms, it has declined as a percentage of the nation's total water consumption. It was 97.1 per cent in 1949, 88.2 per cent in 1980, 77.3 per cent in 1990, 68.8 per cent in 1999, 63.6 per cent in 2005; see Table 3 for details).

- **Industrial and commercial water consumption and residential water consumption**

  Since 1949, industrial water usage has grown rapidly in China both in absolute and in relative terms. As a percentage of the total, it grew from 2.3 per cent in 1949 to 23 per cent in 2005. Regional comparison shows that industrial water use has grown more slowly in the northern parts of the country than it has in the south. As we can see from Table 4, in 1980, industrial water use in the northern parts of the country was 40.6 per cent of the total. This percentage dropped to 33.7 per cent by 1993, to 28.9 per cent by 2002, and to 26 per cent by 2005. According to Liu and Chen (2001: 11), the main reason for this steady decline is an increase in water use efficiency in the north of China. But additionally, industrial development has grown rapidly in the southern parts of the country since 1980s. Residential water use has also grown in China, as has its relative size as a percentage of aggregate water use. In percentage terms, it accounted for only 1.5 per cent of the total in 1980, for 8.5 per cent in 1990, 10.5 per cent in 2000 and 12 per cent in 2005 (see Table 3). Regional differences exist in this area too. In the northern parts of the country, residential water use grew from 37.7 per cent in 1980 to 43.2 per cent in 1993, while in south it dropped from 62.3 per cent to 56.8 per cent during the same period. From the end of 1990s to the early years of 2000s, the north-south ratio remained largely constant, with the north accounting for 36-38 per cent of the country's total water use and the south for 62-64 per cent.

- **Raising the recycling rate for industrial and residential water use**

  For cities in water stressed parts of the world, it is high time to rethink the prevailing model of urban water consumption. In this model water is brought into the city, discharged as waste water after one use regardless of whether it has been polluted during the process, which it often has not. This flush-and-forget model that dominates urban water systems is unsustainable in the long term, particularly in water-scarce regions (Brown, 2005:115).

2. Water supply damage caused by aridity and drought

Water supply for use by human society comes from two main sources: surface and underground water. Precipitation is the dominant source of surface water, some of which recharges underground water. A crucial part of this component of the water supply is diverted into reservoirs. In many regions and countries, underground supply represents the single largest source of water. In California, for instance, it supplies about 40 per cent of all water used (Coppock *et al*., 1982: 2).

According to estimates from 1980 by the California Department of Water Resources (DWR), about 51.9 per cent of surface water in the region is consumed by society. Of this amount, 85 per cent goes towards agriculture and 15 per cent towards municipal and industrial uses (Coppock *et al*., 1982: 4). By contrast, in China about 24 per cent of surface water was made use of in 2004, with 64.6 per cent used in agriculture and 33.9 per cent in municipal and industrial usages (MWR, 2004) (see tables 1-3).

By comparing the reported figure for the total amount of water resources available for each year with the long-term average , it is possible to determine the direction and magnitude of change from year to year. As is shown in Table 5 the years 2000, 2001, 2003, 2004 and 2005 saw severe water shortages. In 2001 and 2004, the shortage was even more acute than in the other years. During these drought years, total water amounts fell short of the long-term average by 40 to 400 billion m^3. So far as precipitation is concerned, as Table 6 indicates, except for 2002, for each year between 1999 and 2005, average precipitation was less than the long-term average. During these years, convertible precipitation fell short of the long-term average by anywhere between 200 and over 500 billion m^3 (see Table 6).

Table 1 Water resources in the six northern zones, 1999-2005 (100 million m^3)

Zoning		Year							
		1999	2000	2001	2002	2003	2004	2005	Long-term average[a]
Songhua River	Ground water	556.0 [b]	577.78 [b]	558.69 [b]	576.42 [b]	476.8	429.3	474.4	430
	Total Water Resources	1377.1 [b]	1395.05 [b]	1420.32 [b]	1372.98 [b]	1424.0	1189.9	1525.0	1352
Liao River	Ground water	-	-	-	-	172.9	183.2	213.2	194
	Total Water Resources	-	-	-	-	345.2	419.0	549.7	576
Hai River	Ground water	170.9	221.95	174.59	146.09	252.9	237.7	215.4	275
	Total Water Resources	192.5	269.56	200.15	158.99	321.1	299.6	267.1	419
Yellow River	Ground water	393.8	351.56	342.38	334.01	426.3	352.4	405.3	406
	Total Water Resources	625.9	565.85	513.32	473.40	827.3	628.0	756.3	765
Huai River	Ground water	327.4	498.77	313.86	343.66	600.5	391.9	508.1	393
	Total Water Resources	587.4	1232.87	592.08	701.83	1851.7	752.2	1399.6	961
Rivers in North-west	Ground water	1061.5	987.56	1076.98	993.93	893.5	785.7	869.8	862
	Total Water Resources	1564.4	1523.50	1632.17	1457.31	1369.9	1300.4	1453.5	1304
Total	**Ground water**	**8386.7**	**8501.86**	**8390.05**	**8697.18**	**8299.3**	**7436.3**	**8091.1**	**8287.7**
	Total Water Resources	**28195.7**	**27700.81**	**26867.77**	**28261.32**	**27460.2**	**24129.6**	**28053.1**	**28124.4**

[a] Series on China's Natural Resources: Water Resources. Here the long-term average is based on the period of 1956-1979.
[b] The figure is for the Songhua River and the Liao River.
Source: China Water Resource Bulletin 1999-2005, www.mwr.gov.cn; www.waterpub.com.cn.

Table 2 Areas of irrigation and reservoir capacities in China, 1980-2004

Year	Sown Area (1000 Hectares) [1]	Irrigated Area (1000 Hectares) [2]	[2] / [1] (%)	Reservoir Capacities (billion m^3)
1980	146379	44888.1	30.7	-
1985	143626	44035.9	30.7	430.13
1989	146554	44917.2	30.6	461.73
1990	148362	47403.1	32.0	466.0
1991	149586	47822.1	32.0	-
1992	149007	48590.1	32.6	-
1993	147741	48727.9	33.0	-
1994	148241	48759.1	32.9	-
1995	149879	49281.2	32.9	479.67
1996	152381	50381.4	33.1	457.14
1997	153969	51238.5	33.3	458.34
1998	155706	52295.6	33.6	492.42
1999	156373	53158.4	34.0	492.42
2000	156300	53820.3	34.4	518.35
2001	155708	54249.4	34.8	528.13
2002	154636	54354.8	35.2	559.46
2003	152415	54014.2	35.4	565.84
2004	153553	54478.4	35.5	554.20
2005	155488	55029.3	35.4	562.4

Source: Statistical Yearbook of PRC, 1981-2006.

Table 3 Water usage in China by sectors, 1949-2005

Year	Agriculture (%)	Industry (%)	Residential (%)	Ecology (%)	Total Amount (100 million m^3)
1949	97.1	2.3	0.6	-	1031
1959	94.6	4.7	0.7	-	2048
1965	92.7	6.6	0.7	-	2744
1980	88.2	10.3	1.5	-	4437
1985	80.5	11.9	7.5	-	4403
1990	77.3	14.2	8.5	-	4868
1995	72.0	18.5	9.4	-	5305
1999	69.2	20.7	10.1	-	5591
2000	68.8	20.7	10.5	-	5498
2001	68.7	20.5	10.8	-	5567
2002	68.0	20.8	11.2	-	5497
2003	64.5	22.1	11.9	1.5	5320
2004	64.6	22.2	11.7	1.5	5548
2005	63.6	22.8	12.0	1.6	5633

Source: Liu and Chen (2001: 10, Table 0-5) for data of 1949 to 1980, CAS (2007, 20, Figure 2.3) for data of 1985 to 1995, MWR, 1999-2005.

Table 4 Water usage in north and south China-II, 1980-2005

Year	Zone	Each zone as % of total	Each sector as % of the national total		
			Agriculture	Industry	Residential
1980	South	50.7	48.7	59.4	62.3
	North	49.3	51.2	40.6	37.7
1993	South	52.6	48.8	66.3	56.8
	North	47.4	41.2	33.7	43.2
1997	South	53.0	47.5	67.5	63.1
	North	47.0	52.5	32.5	36.9
2000	South	53.8	48.8	66.3	61.9
	North	46.2	51.1	33.7	38.1
2001	South	53.8	48.0	68.6	62.6
	North	46.2	52.0	31.4	37.4
2002	South	53.8	47.0	71.1	62.8
	North	46.2	53.0	28.9	37.2
2003[a]	South	55.7	48.8	72.6	62.1
	North	44.3	51.2	27.4	37.9
2004[a]	South	55.7	48.1	74.2	63.0
	North	44.3	51.9	25.8	37.0
2005[a]	South	55.8	48.1	74.0	63.6
	North	44.2	51.9	26.0	36.4

[a] Total water usage includes ecological water usage.
Source: Data for 1980-1997 come from Liu and Chen (2001:11); data for 2000-2005 come from MWR, 1999-2005.

Table 5 Change in total amount of water resources (TAWR), 1999-2005

Year	TAWR (100 million m^3)	Shift/Down to long-term-average [a]	
		+/- Percentage (%)	+/- Number (100 million m^3)
1999	28196	+0.25	+71.6
2000	27701	-1.51	-423.4
2001	26868	-4.46	-1256.4
2002	28255	+0.46	+130.6
2003	27460	-2.36	-664.4
2004	24130	-14.2	-3994.4
2005	28053.1	-0.25	-71.3

[a] The long-term-average of total amount of water resource (TAWR) is 28124.4 x100 million m^3 (Series on China's Natural Resources: Water Resources, 1996E: 166).
Source: China Water Resource Bulletin 1999-2006, www.mwr.gov.cn.

Table 6 Change in average precipitation (mm), 1999-2005

Year	Average Precipitation (mm)	Convertible Precipitation (100 million m^3)	Shift/Down to long-term-average [a]	
			+/- Percentage (%)	+/- Number (100 million m^3)
1999	629	59702	-3.53	-2187
2000	633	60092	-2.90	-1797
2001	612	58122	-6.09	-3767
2002	660	62610	+1.16	+721
2003	638	60416	-2.38	-1473
2004	601	56876	-8.10	-5013
2005	644.3	61009.6	-1.42	-879.4

Note: [a] The long-term-average of convertible precipitation is 61889 x 100 million m^3 (Series on China's Natural Resources: Water Resources, 1996:166).

II. Water transfer between industrial sectors within China

Researchers from a number of countries have written on the subjects of the water resource input-output model and its application. Chen (2000) constructed an input-output table for Shaanxi province in China, and proposed ways for calculating 'total water input coefficients', 'total waste water emission coefficients' and 'total water imports'. Duarte *et al*. (2002) focused on a particular methodology based on linkage analysis known as the hypothetical extraction method (HEM[1]) and distinguished between the different types of impact water consumption has on different sub-systems within the economy, including 'internal effects', 'mixed linkages', 'net or external backward linkages' and 'net or external forward linkages'. These authors also identified, by means of HEM, key sectors that are either direct or indirect consumers of water. Chen *et al*. (2004) constructed China a Water Conservancy Input-Occupancy-Output Table for the year 1999 and provided effect analysis for investment on water conservation measures. In their study, Xie *et al*. (1991) examined water supply system issues for Beijing, applying their input-output model. Xu (2004) proposed several ways of calculating water use coefficients that can aid in the design of water saving mechanisms. Jiang and Tatano (2005) described six hypothetical scenarios for conditions of reduced water supply and explored the economic impact of water shortage in Japan using a general input-output model with mixed exogenous variables (survey data for non-water sector outputs) and endogenous variables (given final demand in water sector).

1. How to transfer water between sectors through intermediate inputs

Direct water requirements for each sector of the economy can be calculated by dividing the total volume of water use by total output. Comparing the results of this calculation for different sectors allows us to determine which sectors are more or less water-intensive than others. However, the current study focuses on both direct water requirements and indirect water requirements, and in addition, it considers the implications for differential water availability across different economic sectors.

The next section presents three different types of analysis. These are:

1. Inter-sectoral dependence linked to water use
2. Internal effect of water use (WIE)
3. External effect of water use (WEE); including external backward linkage of water use (WEBL) and external forward linkages for water use (WEFL)

Duarte *et al*. (2002) pointed out that distinguishing between these three ways – the internal effect, external backward linkages and external forward linkages – to measure water-intensity of any given economic sector allows for greater precision in understanding key issues. For example, it is possible to determine the amount of water used by more water-intensive sectors that is accounted for by water use linkages between them and other sectors. It is possible to aggregate the internal and the external effects of water use by a sector, the result of which may be greater or smaller than the amount of water it consumes directly (Duarte *et al*., 2002: 76).

2. Key sectors for water use in the economy based on the linkage analysis: water use linkages and intersectoral dependence

Table 7 contains the results of an empirical analysis of water input for all 37 sectors of the Chinese economy for the year 2002.

1. Internal effect of water use (WIE)

The intensity of water use by 37 sectors of the Chinese economy calculated on the basis of external backward linkage is presented in Table 8. The data show that in 2002 the five most water-intensive economic sectors when only the internal effects are considered are agriculture (#01, 190493 million m^3), accommodation and food serving services (#28, 10043 million m^3), electricity (#21, 8652 million m^3), residential and other services (#32, 8006 million m^3), and commerce and trade (#27, 6304 million m^3). Besides agricultural production, electricity production and the supply sector use more water by themselves than any other physical production sector. The five least water-intensive sectors are all productive sectors, namely, sawmills and furniture (#09, 18 million m^3), instruments, metres, cultural and office machinery (#20, 21 million m^3), non-metallic mineral mining (#05, 22 million m^3), metal ore mining (#04, 29 million m^3), as well as extraction of crude oil and natural gas (#03, 34 million m^3).

2. External backward linkages of water use (WEBL)

Table 9 shows the amount of water use by 37 sectors of the Chinese economy as calculated on the basis of external backward linkages. It shows how much of the water attributed to a particular sector is actually used in the production of inputs to this sector by other sectors. A sectors incurs a water debt if its total water use is greater than the amount it uses directly, whereas it earns a credit if the reverse is true, that is, if its direct use of water is greater than the amount it uses when external linkages are factored in.

The data in Table 2-3 show that three classes of sector are water debtors. One includes materials and physical production sectors such as coal mining and washing (#02), non-metallic mineral mining (#05) and gas production and supply (#22). The second class includes food manufacturing and tobacco processing (#06), textile production (#07), and the production of apparel, leather, fur, down and related products (#08), sawmills and furniture (#09) and paper and paper products and printing (#10). The third class of sectors include service sectors such as postal services, communications, information services and software design and production (#26), tourism (#29), residential and other services (#32).

3. External forward linkage of water use (WEFL)

To measure external forward linkages for water use by a sector is to measure, as is known from the definition, how much water it uses in order to produce intermediary outputs that will be inputs for other sectors. As can be seen in Table 10, 12 economic sectors produce nothing but intermediary output. Their consumption of water serves other economic sectors entirely. These sectors can also be divided into three groups. A first group is composed of materials and physical production sectors including coal mining and washing (#02), extraction of crude oil and natural gas (#03), metal ore mining (#04), and non-metallic mineral mining (#05), electricity, steam and hot water production and supply (#21), and water production and supply (#23). A second group is composed of manufacture sectors including petroleum processing, coking and nuclear fuel processing (#11),

chemicals (#12), non-metallic mineral products (#13), metals smelting and pressing (#14), metal products (#15). A third group is composed of the service sector only, including finance and insurance (#30).

The results of this analysis of inter-sectoral dependence with respect to water use show that for many sectors, such as electricity generation (thermal power generation), iron & steel, chemicals, petroleum processing, paper making, and textiles that may seem particularly water-intensive, water intensity is due either to the water intensity of the process by which their input is produced in another sector (examples include food processing, clothing and textiles production), or to the high demand for their output by other economic sectors (examples include electricity generation, chemicals, and iron &steel that are transferred to other sectors).

Table 7 Water use input-output table for China by sector, 2002

Sector No.	Sector	Sector No.	Sector
01#	Agriculture, forestry, animal husbandry & fishery	20#	Instruments, metres, cultural and office machinery
02#	Mining and washing coal	21#	Electricity, steam and hot water production and supply
03#	Extraction of crude oil and natural gas	22#	Gas production and supply
04#	Metal ore mining	23#	Water production and supply
05#	Non-metal minerals mining	24#	Other industry
06#	Manufacture of food products and tobacco processing	25#	Transport equipment
07#	Textiles	26#	Post services, communication, information service and software
08#	Wearing apparel, leather, fur, down and related products	27#	Commerce and trade
09#	Sawmills and furniture	28#	Accommodation and food serving services
10#	Paper and products and printing	29#	Tourism
11#	Petroleum processing, coking and nuclear fuel processing	30#	Finance and insurance
12#	Chemicals	31#	Real estate
13#	Non-metallic mineral products	32#	Residential and other services
14#	Metals smelting and pressing	33#	Health, sport and social welfare
15#	Metal products	34#	Education, culture and art as well as broadcast, movie, television
16#	General and special purpose machinery	35#	Scientific research
17#	Transport and storage	36#	Technological service
18#	Electric equipment and machinery	37#	Administration and other sectors
19#	Electronic and telecommunication equipment		

Source: IOS and ISS, 2006

Table 8 Internal effect of water use (WIE, total) by sector

Sector No.	Sector	Direct Water Use (million m^3) [1]	WIE_j (million m^3) [2]	[2] / [1] (%) [3]
01#	Agriculture, forestry, animal husbandry & fishery	373618.00	190493.32	50.99
02#	Mining and washing coal	846.76	116.20	13.72
03#	Extraction of crude oil and natural gas	635.92	34.61	5.44
04#	Metal ore mining	1060.73	29.71	2.80
05#	Non-metal minerals mining	197.83	22.96	11.60
06#	Manufacture of food products and tobacco processing	2398.94	1596.26	66.54
07#	Textiles	171.05	702.41	59.98
08#	Wearing apparel, leather, fur, down and related products	185.41	165.42	89.22
09#	Sawmills and furniture	61.14	18.55	30.34
10#	Paper and products and printing	2933.77	822.29	28.03
11#	Petroleum processing, coking and nuclear fuel processing	6111.02	359.66	5.89
12#	Chemicals	17941.31	5149.55	28.70
13#	Non-metallic mineral products	907.18	141.30	15.58
14#	Metals smelting and pressing	14965.71	663.88	4.44
15#	Metal products	144.24	47.87	33.19
16#	General and special purpose machinery	444.33	324.13	72.95
17#	Transport and storage	508.44	319.76	62.89
18#	Electric equipment and machinery	203.80	114.38	56.12
19#	Electronic and telecommunication equipment	468.59	605.54	129.23
20#	Instruments, metres, cultural and office machinery	22.24	21.79	97.95
21#	Electricity, steam and hot water production and supply	62006.52	8652.79	13.95
22#	Gas production and supply	235.45	134.81	57.26
23#	Water production and supply	215.69	95.05	44.07
24#	Other industry	569.94	530.58	93.09
25#	Transport equipment	6332.84	1802.54	28.46
26#	Post services, communication, information service and software	1593.79	419.55	26.32

Sector No.	Sector	Direct Water Use (million m^3) [1]	WIE_j (million m^3) [2]	[2] / [1] (%) [3]
27#	Commerce and trade	16582.71	6304.74	38.02
28#	Accommodation and food serving services	19663.79	10043.99	51.08
29#	Tourism	828.22	707.22	85.39
30#	Finance and insurance	1704.84	375.76	22.04
31#	Real estate	625.14	451.79	72.27
32#	Residential and other services	8192.22	8006.76	97.74
33#	Health, sport and social welfare	1158.18	1125.38	97.17
34#	Education, culture and art as well as broadcast, movie, television	1967.77	1851.63	94.10
35#	Scientific research	98.74	81.52	82.56
36#	Technological service	1375.81	936.14	68.04
37#	Administration and other sectors	1749.94	1018.98	58.23
Total		**549728**	**244288.81**	**44.44**

Source: IOS and ISS, 2006; author's analysis of results.

Table 9 External backward linkages for water use (WEBL, total) by sector

Sector No.	Sector	Direct Water Use (million m^3) [1]	$WEBL_j$ (million m^3) [2]	Difference (million m^3) [3] = [1] - [2]
01#	Agriculture, forestry, animal husbandry & fishery	373618.00	7759.44	365858.56
02#	Mining and washing coal	846.76	882.82	-36.06
03#	Extraction of crude oil and natural gas	635.92	178.00	457.92
04#	Metal ore mining	1060.73	84.62	976.11
05#	Non-metal minerals mining	197.83	299.42	-101.58
06#	Manufacture of food products and tobacco processing	2398.94	60639.26	-58240.32
07#	Textiles	171.05	17392.66	-16221.61
08#	Wearing apparel, leather, fur, down and related products	185.41	19129.22	-18943.80
09#	Sawmills and furniture	61.14	3653.31	-3592.18
10#	Paper and products and printing	2933.77	3515.79	-582.03
11#	Petroleum processing, coking and nuclear fuel processing	6111.02	464.96	5646.06
12#	Chemicals	17941.31	9800.58	8140.74
13#	Non-metallic mineral products	907.18	1717.24	-810.06
14#	Metals smelting and pressing	14965.71	974.06	13991.65
15#	Metal products	144.24	4505.41	-4361.17
16#	General and special purpose machinery	444.33	16429.60	-15985.27
17#	Transport and storage	508.44	8174.26	-7665.83
18#	Electric equipment and machinery	203.80	8323.32	-8119.52
19#	Electronic and telecommunication equipment	468.59	15903.04	-15434.44
20#	Instruments, metres, cultural and office machinery	22.24	7275.17	-7252.93
21#	Electricity, steam and hot water production and supply	62006.52	763.55	61242.97
22#	Gas production and supply	235.45	449.75	-214.30
23#	Water production and supply	215.69	588.10	-372.42
24#	Other industry	569.94	87452.30	-86882.36
25#	Transport equipment	6332.84	4653.76	1679.08
26#	Post services, communication, information service and software	1593.79	1824.62	-230.83

Sector No.	Sector	Direct Water Use (million m^3) [1]	$WEBL_j$ (million m^3) [2]	Difference (million m^3) [3] = [1] - [2]
27#	Commerce and trade	16582.71	11117.08	5465.63
28#	Accommodation and food serving services	19663.79	17136.91	2526.88
29#	Tourism	828.22	879.02	-50.80
30#	Finance and insurance	1704.84	1307.90	396.93
31#	Real estate	625.14	3482.41	-2857.27
32#	Residential and other services	8192.22	22163.45	-13971.23
33#	Health, sport and social welfare	1158.18	7532.26	-6374.08
34#	Education, culture and art as well as broadcast, movie, television	1967.77	11248.19	-9280.41
35#	Scientific research	98.74	918.68	-819.94
36#	Technological service	1375.81	1190.96	184.85
37#	Administration and other sectors	1749.94	1413.58	336.36

Source: IOS and ISS, 2006; author's analysis of results

Table 10 External forward linkages for water use (WEFL, total) by sector

Sector No.	Sector	Direct Water Use (million m^3) [1]	$WEFL_j$ (million m^3) [2]	Difference (million m^3) [3] = [1] - [2]
01#	Agriculture, forestry, animal husbandry & fishery	373618.00	193798.33	179819.67
02#	Mining and washing coal	846.76	868.21	-21.46
03#	Extraction of crude oil and natural gas	635.92	1044.64	-408.72
04#	Metal ore mining	1060.73	1897.45	-836.73
05#	Non-metal minerals mining	197.83	233.18	-35.35
06#	Manufacture of food products and tobacco processing	2398.94	816.85	1582.09
07#	Textiles	171.05	756.88	414.17
08#	Wearing apparel, leather, fur, down and related products	185.41	32.16	153.25
09#	Sawmills and furniture	61.14	37.85	23.28
10#	Paper and products and printing	2933.77	2816.97	116.79
11#	Petroleum processing, coking and nuclear fuel processing	6111.02	7668.53	-1557.51
12#	Chemicals	17941.31	21059.87	-3118.56
13#	Non-metallic mineral products	907.18	964.50	-57.33
14#	Metals smelting and pressing	14965.71	20918.09	-5952.38
15#	Metal products	144.24	147.51	-3.26
16#	General and special purpose machinery	444.33	307.25	137.08
17#	Transport and storage	508.44	292.19	216.24
18#	Electric equipment and machinery	203.80	190.37	13.43
19#	Electronic and telecommunication equipment	468.59	275.14	193.45
20#	Instruments, metres, cultural and office machinery	22.24	15.88	6.36
21#	Electricity, steam and hot water production and supply	62006.52	70477.30	-8470.78
22#	Gas production and supply	235.45	142.83	92.62
23#	Water production and supply	215.69	218.40	-2.71
24#	Other industry	569.94	62.74	507.20
25#	Transport equipment	6332.84	5613.17	719.67
26#	Post services, communication, information service and software	1593.79	1435.60	158.19

Sector No.	Sector	Direct Water Use (million m^3) [1]	WEFLj (million m^3) [2]	Difference (million m^3) [3] = [1] - [2]
27#	Commerce and trade	16582.71	13324.90	3257.81
28#	Accommodation and food serving services	19663.79	10880.71	8783.08
29#	Tourism	828.22	136.44	691.79
30#	Finance and insurance	1704.84	1757.99	-53.15
31#	Real estate	625.14	200.12	425.02
32#	Residential and other services	8192.22	953.91	7238.32
33#	Health, sport and social welfare	1158.18	103.28	1054.90
34#	Education, culture and art as well as broadcast, movie, television	1967.77	290.81	1676.96
35#	Scientific research	98.74	26.14	72.60
36#	Technological service	1375.81	593.83	781.98
37#	Administration and other sectors	1749.94	864.69	885.25

Source: IOS and ISS, 2006; author's analysis of results.

III. Water trade between China and other countries

Water researchers have recently formulated the concept of 'virtual water', and the idea of a virtual trade. Allan (1993, 1994, and 1998) defines 'virtual water' as water that is necessary for producing, and therefore embedded in, a final economic output. Allan (1996, 2002, and 2003) has in particular been concerned with the social impact of the virtual water trade on Middle Eastern countries.

The production of almost all forms of goods and services to be consumed by a society requires water inputs at some point or another. When final economic outputs are traded, therefore, the water embedded in them is traded as well (Velázquez, 2007; Novo *et al*., 2009; Ma and Chen, 2006). Some authors have noted that under some circumstances, importation of agricultural products can not only save water but also promote food security for the importing country (Hoekstra and Hung, 2002; Velázquez, 2007; Ma and Chen, 2006; Novo *et al*., 2009). International trade in agricultural products is by far the largest component of the international virtual water trade, accounting for some 80 per cent of the total volume (Horlemann and Neubert, 2007: 19). Between 1990 and 2004, global trade in agricultural products grew from US$ 415 billion to about US$ 783 billion (WTO, 2005). In industrial production, water is mostly used for cooling and washing, and trade in industrial output entails trade in associated virtual water. Kondo (2005) has also pointed out that a useful distinction can be made between 'direct' and 'indirect' water use in economic production. 'Direct use' of water refers to water consumption at the concluding phase of the production process which yields final economic outputs; 'indirect use' of water refers to water consumed at earlier stages in the total production process. For purposes of calculating the total volume of the virtual water trade, the linkage analysis discussed earlier is particularly valuable as it minimizes both omissions and double-counting of water use.

1. Methodology and data

The empirical study of the virtual water trade between China and other countries and regions whose results are reported here is based on data for inputs and outputs for the years 1995, 2002 and 2005. Seventeen industrial sectors are studied (see Table 11). However, water input-output data for China and data on water use by sector are for 2002 only. For 1995 and 2005, estimates are made by means of statistical inference. This has been done for every industrial sector excluding agriculture and service sectors, using data for industrial waste water discharge collected in the *China Statistical Yearbook* (NBSC, 1996, 2003, 2006). The data used here on water use in agriculture come from *China Water Resource Bulletin* (MWR, 1996, 2003, 2006). For service sectors, such as banking and insurance, public utilities and residential services, the data used here are calculated on the basis of water use intensity quota in 2002.

The data on international trade by sectors come from *China Statistical Yearbook of Foreign Trade* and *China Statistical Yearbook of Trade and Foreign Economy*. In the latter, data are organized by product.

2. Findings and discussions

For the years 1995, 2002 and 2005, China transferred a surplus of water to the world either directly or indirectly (see Table 12). Moreover, it is evident that the total volume of the international virtual water trade involving China has been growing. The net volume of virtual water (excluding the transfer volume between sectors) declined slightly and then rose between 1995 and 2005. When inter-sectoral transfers are included, the trend has been a continuous increase in total volume (see Table 12 and Figure 1). The latter grew 2.8 times in ten years, which greatly exceeded the net trade volume (export-import) as a share of GDP. What this means is that China's trade surplus in recent years was sustained by intense water use. The analysis suggests that the trend is unlikely to subside in the near future.

3. Policy implications: relationships between trade patterns and virtual water use

It is well-known that China faces serious water scarcity, and is one of the more water stressed countries in the world. This means that a vast trade surplus in virtual water is of dubious beneficial value to the country. Table 13 shows the world's five largest countries in terms of virtual water trade volume, including both export and import countries. The data reflect only trade in agricultural products, and does not include information on virtual water trade through trade in industrial products. Japan is one country with the distinction of having secured trade benefits in relation to virtual water.

Several policy options are open to China to correct this net loss of water through trade. One is to boost domestic water conservation, especially through increases in efficiency in industrial water use. The other is to make structural adjustments to the Chinese economy, in conjunction with changes to trade patterns relative to the rest of the world. More detailed analyses (including structural decomposition analysis) will certainly be needed to determine the optimal ways of achieving the latter. But just as important, it may also be time to rethink China's strategy for international trade in agricultural products, given their enormous water footprint. China may need to increase its import and reduce exports of these products in order to arrest the trend of net water loss.

Table 11 Input-output table by sector for China

	Sector		
01#	Agriculture	10#	Metal Products
02#	Mining and Quarrying	11#	Machinery and Equipment
03#	Foodstuff	12#	Construction
04#	Textile, Sewing, Leather and Furs Products	13#	Transportation, Post and Telecommunications
05#	Other Manufacturing	14#	Commerce and Catering Trade
06#	Production and Supply of Electric Power, Steam and Hot Water	15#	Public Utilities and Resident Services
07#	Coking, Gas and Petroleum Refining	16#	Banking and Insurance
08#	Chemical Industry	17#	Other Services
09#	Building Materials and Non-metallic Mineral Products		

Note: [a] It is also named as water use 'intensity quota' for each sector.
Source: Website of National Bureau of Statistics of China, http://www.stats.gov.cn.

Table 12 The virtual water trade (water embodied in trade) between China and the world (100 million m3)

	1995	2002	2005
DVWE (China to the World)	193.89	188.75	282.14
DVWI (the World to China)	130.90	137.52	201.76
China to the World Net Direct Virtual Water Embodied in Trade	**62.98**	**51.22**	**80.38**
TVWE (China to the World)	780.26	987.35	1847.60
TVWI (the World to China)	666.72	761.86	1413.93
China to the World Net Total Virtual Water Embodied in Trade	**113.55**	**225.49**	**433.67**

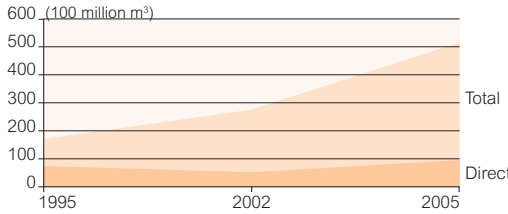
Source: Author's calculation.

Table 13 Top-five virtual water exporting and importing countries (1995-1999)

Ranking	Country	Net imports volume (billion m^3/year)	Country	Net exports volume (billion m^3/year)
1	Japan	59	USA	152
2	Netherlands	30	Canada	55
3	Korea	23	Thailand	47
4	China	20	Argentina	54
5	Indonesia	20	India	32

Source: Hoekstra and Hung, 2005.

Figure 1 Trends in the net (direct and total) virtual water flows from China to the world



1 Here HEM is used to calculate the impact of a hypothetical production shut-down in each sector to determine that sector's economic importance in inter-sectoral flows (Schultz, 1977). HEM is used to capture the total impact of the sectors on water availability, as well as to identify the main inter-sectoral flows with respect to the use of the water resource (Duarte *et al.*, 2002).

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19
Water Rights from a Legal Perspective

Zhao Hongmei and Chen Jie

水权的属性法学的分析

Many Chinese legal scholars tend to view water rights as essentially private property rights, but as private property rights that have features of common property rights. Two main types of water right are officially recognized by Chinese legislation. These are natural rights and legal rights (which are also labelled riparian and regulated riparian rights). Neither of these rights are private rights. This chapter asks if it would be in the public interest if these rights were re-categorised as private rights.

I. Water rights: definition and analysis

Water has both natural and social properties, this means that the exact nature of water rights has always been a contentious issue, especially in relation to water as a common resource and from a justice perspective. Water rights have been a very difficult problem during China's transition toward market economy. Some analysts of water rights overemphasize the ability of the market to allocate water resource efficiently and fairly. The issue of water rights is basically concerned with distributive equity, that is with the proper balance between the interests of water right holders and other stakeholders.

David B. Anderson defines a water right as: 'specifically, a right to take water from a watercourse. Or, to control water in a watercourse' (Anderson, 2007: 485). The definition used in this chapter is that a water right is a right that can be either naturally or legally endowed, for non-owners of water sources to make use of water in both natural and artificial watercourses. It is primarily a water withdrawal right. This definition has four basic elements. First, a water right is a usufruct, or use right, and not an ownership or property right. In this sense, a water right is specifically the right to enter into a direct use relationship – in accordance with the law, in compliance with executive orders or administrative contracts – to water from a source one does not own. In the west, the main type of water right is a riparian right. 'Under the classical formulation of the riparian doctrine, the "natural flow theory", landowners adjacent to water resources have the right to utilize an essentially unlimited amount of water on their land' (Nathan, 2005: 374). Accordingly, the bearer of a riparian right is indisputably the owner of the land on the bank of a river, but she is not entitled to the water that flows by the land. She may use the water, but she does not own it, since it is owned by the public or community as a whole, unless, of course, it has been formally declared to be state property. In China's *Water Law*, for example, it is specifically declared in Clause no. 3, that 'Water resources belong to the state. The State Council represents the state in exercising ownership right over the country's water resources. Water in village ponds and in reservoirs built by villagers belongs to, and ought to be used by, the village collectivity as a whole' (NPC, 1988). Clause no. 6 states that: 'the state encourages organizational entities and individuals to mine and to make use of water resources in accordance with the law, and also to protect them' (NPC, 1988). Such language signifies that water rights holders include organizations engaged in the legal use of water resources (such as businesses with extraction licenses) and individuals (who use water to meet household needs), but exclude local governments even though they are allocated water shares.

The water allocation system is a national scheme enacted by the central government, where total withdrawal amounts and proportions allocated to different levels of government are centrally-determined. Currently, this distribution system is based on the central government deciding, by exercising its administrative and regulatory authority, how the water of major rivers – excluding their tributaries – is to be apportioned. Under this system, local governments' shares confer rights to exclusion. And this also forms the legal basis on which they engage in transfer of use rights.[1] Some legal scholars contend that transferable use water rights are characterised by plurality and equality. Under the overarching system of state ownership of water resources, all participants in the market economy who are also water consumers ought to be eligible to engage in such transactions. According to this view, local governments should be allowed by law to engage in water transactions in the same way businesses and individuals do (Pei, 2007: 46).

The authors of this chapter do not agree with this view, however. Local governments are both administrators of water use and recipients of water shares allocated by the state. While local governments may indeed engage in the transfer of water use rights, and even allow some role for the market in water allocation, their actions should not amount to market exchange of private property holdings. Otherwise it would mean that the government was exercising state responsibilities on the basis of private law. Public governance through private law is in essence a way for the state to manage public affairs by applying laws meant for the private realm. According to Wolff, this is an unusual, and potentially problematic use of private law, since local governments are not independent of the state in the same way that private entities are (Wolff, Bachof and Stober, 2002: 199). But genuine private law 'has as its foundation equality between persons and autonomy, and it defines the legal norms by which interpersonal relations based on these assumptions are constrained' (Larenz, 2003: 1). The relationship between organizations and individuals engaged in the economic development and the use of water resources falls within the realm of private law, and the institutions for adjudicating disputes that are associated with it. China's system of protective equity in water allocation illustrates this well. For example, after the city of Lianyungang paid for water to be diverted to it from the Yangtze River, the government made it available to farmers at very low cost (Huan, 2001: 23). This means that even though the amount of water local governments are entitled to receive through diversion programmes may be fixed by higher authority, and may not be free of charge, the distribution of this water among different local uses and local users can be done through administrative instruments rather than according to the law, especially not on the basis of property law (which is a type of private law). The local government could, for example, use subsidies to avoid passing the costs of imported water to end-users (Wei and Zhou, 2002: 47).

The second of the four basic elements of this definition of water rights is that it places restrictions on the specific modes by which and the specific purposes for which rights to develop and make use of water resources are exercised. The definition discussed here is concerned only with rights to extract, withdraw, or store water; it has nothing to say about uses such as transportation, aquaculture, fisheries or water as a waste receptacle. The third basic element of the definition is that it is concerned with the right to make direct use of water in natural or artificially constructed water bodies. The fourth element of the definition of a water right being proposed here is that it distinguishes between two types of water right that differ from each other in terms of their origin: one being independent of legal conventions and the other being dependent on them. In China, the former is customarily referred to as 'natural water rights' or 'spontaneous water rights', and the latter as 'administrative water rights'.

There are many perplexing theoretical questions surrounding the issue of water rights. The most difficult ones relate to their very nature or essential properties. Just how difficult this question is evident from the following statement concerning water rights in Australia: 'At the outset, it should be noted that the WMA [Water Management Authority] makes no specific reference to the nature of the water rights that it defines. This is in contrast to a number of other Australian jurisdictions' (McKenzie, 2009: 453). The reasoning behind a statement like this is precisely that law-makers deem it prudent to sidestep the intractable issue of the essence of water rights, at least until a fuller theoretical understanding has been achieved. That such a critical question remains unsettled has held back the development of water laws. This is highly relevant to the discussion in this chapter. The nature of water rights is a contested and often unclear issue. A Taiwanese scholar recently made the following insightful observation on this matter: 'Is a water right essentially public or private? How the entire legal system is designed hinges importantly on this question. If a water right is a private property right, then its subject matter is something that can be traded among individuals (free from state intervention and in accordance with contractual obligations). Otherwise, it falls outside the scope of private law altogether' (Lin, 2001: 196).

While some progress has been made in the studies of water rights in the international literature, it is on the whole a relatively under-developed field. There are not many studies in the UK or US legal literatures. The authors of this chapter were only able to find a few English-language articles dealing with water rights. Most studies argue that water rights are essentially private rights, even though the government can interfere in their exercise to protect the public interest. According to one writer: '[B]alancing private elements of water rights against public interest components of water resource allocation allows water rights to be primarily private while ensuring the government the right to intervene when improper transfers or uses endangers public welfare' (Schiller. 2009: 340-341). Others are, however, more sceptical. One has written, for example, that: 'Whether a water market, sustained by (something like) property rights in water, can in fact be effective as one of several mechanisms to deliver an efficient and sustainable water industry remains to be seen' (McKenzie, 2009: 463).

In the continental legal tradition, which also prevails in Japan and Taiwan, this has been a contentious issue. Three broad positions on the issue are observable, namely, that a water right is a private right; that it is a public right; or the compromise view that it is a kind of hybrid right (Kanazawa, 1968; Lin, 2001). In mainland China, which for the most part follows the continental school, some prominent legal scholars have argued that a water right is a private right but with features of public rights. More specifically, a water right is, on this view, regarded as a 'new species of usufruct in civil law' (Pei, 200: 90-101), or, again, within the context of civil law, as 'a quasi-property right' (Cui, 2003a: 37-62). Most scholars seem agreed that, given the unique physical properties of water resources, water rights necessarily exhibit some degree of private-public hybridity. According to this view, as one scholar has written, the system of water rights practically becomes an effective instrument for achieving certain ends for which public law is intended through the application private law (Pei, 2001: 94).

Discussions of water rights by scholars in Japan, Taiwan and the Chinese mainland assume a rigid distinction between public and private rights which reflects a wider separation of private law from public law. Legal scholars in the English and U.S. traditions regard this as not only a basic assumption of continental legal thinking, but also an inherent bias. While scholars in England and the US do acknowledge and frequently make the distinction between private and public rights, they do not tend to equate this distinction with the distinction between private law and public law (Merryman, 1969: 99). The hybrid view, while not absolute, nonetheless suffers from ambiguity, and cannot provide elucidation on the matter. Underneath its appearance of logical soundness, the view – held as noted by some Chinese scholars – that a water right is private but with public features reduces it, for all practical purposes, to the kind of right that is characteristically brought to bear in civil affairs and matters, namely, a private right. As for notions such as 'new' or 'quasi' that have been increasingly used in discussing those features of water resources that are inherently public, they are usually qualifiers for the term 'private right' more than anything else.

McKenzie notes that: 'An analysis of case law and academic writing reveals certain characteristics that point to the existence of a right of property. These characteristics are: excludability, duration, security, quality of title, transferability, and divisibility. The more of these characteristics that attach to particular rights, the more likely that they are to amount to a right of property' (McKenzie, 2009: 452). This means that unless it is first determined which criteria are to be decisive for classifying water rights, with these criteria then applied to particular countries or places, it will not be possible to make a convincing case for the claim that water rights are essentially private rights, with or without predicates such as 'new' and 'quasi'.

In this chapter, the question of the nature of water right is examined by looking specifically at the two types recognized in Chinese law, namely, natural water rights, and administrative water rights. The chapter will also try to compare and contrast these with the so-called 'riparian rights', 'regulated riparian rights' and the 'rule of prior appropriation' that apply in some western countries.

II. The nature of a natural water right, and its comparison with a 'riparian right'

A natural water right is codified in Clause No. 32 of the Chinese Water Law (NPC, 1988). It says that for the purposes of meeting basic household water needs, including the needs of small numbers of livestock, whether free-range or stall-fed, no permit is required for extraction from water sources, and no fees need to be paid. Moreover, the second clause of China's Land Management Law (1999) states that because land is owned by either the state or farmers collectively, the notion of a 'riparian right', which presupposes a system of private ownership of land, is not applicable. As such, the law must define, for residents of pertinent areas, the right by which they are legally entitled to withdraw and use water. This means that the underlying rationale of this right is to satisfy a basic external condition for survival, and is therefore in essence a subsistence right.

When China's natural water rights are compared with riparian rights, it can be seen that the main difference is that a natural water right presupposes public land ownership, and is therefore independent of the issue of who the private owner is. Some scholars contend that a natural water right is tantamount to a kind of legal protection for the right of all and each person living within the same water source region to share that resource. More specifically, the right subject to protect is akin to the exclusive property right of a positive community, that is, a community formed by voluntary agreement, that is, not spontaneously. This right is based on the crude fact that a society is comprised of many different sub-groups, and each is entitled to exclude non-members from entering its territory or becoming a member. Within each sub-group, however, no such exclusivity holds (Wei and Zhou, 2002: 46). But here, the notion of an exclusionary sub-group is still rather vague, for it not only applies to villages and clusters of villages, but also includes any individual living within distances from these places reachable by mechanically unaided human powers. This means that when water is scarce, no settlement or any individual member in the village has the right to prevent those from other settlements from extracting water from water bodies (although the issue can be more complicated when artificially constructed waterbodies are in question) within their territorial boundaries for the purposes of meeting basic household needs, including those related to small-scale free-range or stall-fed livestock production. By contrast, the application of riparian rights presumes that land ownership is in the form of private property. For example, '[i]n riparian states, one need only buy riparian property--land adjacent to a surface water-body or overlying groundwater--to acquire a riparian right' (Grossfield, 1984; Nathan, 2005).

This difference between the two notions is, of course, only superficial. Closer examination would reveal that, appearances to the contrary, China's natural water right and the riparian rights applied in some western countries are really more similar than they are different.

1. Rights to publicly owned resources

'The entity' or 'res' to which the water right attaches is not 'water' but 'running water', i.e., the watercourse (Anderson, 2007: 485). Certainly, insofar as water drawn from a natural waterbody through entitlement rights does not support exclusivity (because of its fluidity), the corresponding right lacks an essential property that makes it a private right. This is why some Japanese legal scholars have called this kind of natural water right 'the (non-private) right to the (private) right to something' (Xu, 1993: 108-9). Indeed, only water in a farmer's bucket is properly considered the subject matter, the 'res', of a private right. As David B. Anderson has noted: 'Upon being diverted from a watercourse, water is no longer part of the watercourse. That water is then no longer the subject matter of the water right but is a substance factually and legally capable of possession and hence of possessory rights' (Anderson, 2007: 485). The source of water is, therefore, common or public property. In Locke's view, '[t]hough the water running in the fountain be every one's, yet who can doubt but that in the pitcher is his only who drew it out?' (Locke, 1997:20). It needs to be noted that the first half of this sentences in fact corroborates the contention made here that water

(re)sources-qua-(re)sources are not private property. The Lockean labour theory of property has it that '[Labour] added something to them more than Nature, the common mother of all, had done, and so they became his private right' (Locke, 1997: 19). But until somebody actually labours to get a particular quantum of water, the benefits of the water *(re)source* as furnished by Mother Nature belongs to all and not just any one individual, and this defines the state of public ownership [of the natural resource] that obtains prior to privatization through labour inputs.

It is commonly believed that '[t]he "riparian right" is the right inherent in the ownership of land adjacent to or traversed by a watercourse (i.e., riparian land) to have the stream of water flow to his land and, while passing' (Hutchins, 1971: 183). This would seem to suggest that water right is derivative of land rights, or, in other words, that it is a particular function enabled by the latter, and as such is private in nature insofar as land tenure is. But this view has its difficulties. 'While the water right is a right of property in the watercourse, it confers no property, no ownership, and no right of possession in the substance of the water itself' (Anderson, 2007: 485). We note that the concept of a riparian right has its origin in the theory of Natural Law, yet it also captures the basic ideas that animate communitarianism. As Weil argued: 'Roman law did not distinguish among the many forms of fresh water in nature: clouds, rain, diffused surface water, stream flow, river underflow, percolating groundwater, vapour, lakes, flood water, seepage, etc. Because of the fugitive and fluctuating character of water in its natural state, Roman law denied the existence of property in water altogether - including running water - and held the use of rivers and lakes to be the common right of everyone, like the sea and the air' (Wiel, 1911:475). David B. Anderson pointed out that: 'Running water belonged to no one; everyone who had access to the resource had a (an un-quantified) right to take from it. Unlike property ownership, whose distinctive features are possession, control, and the right to exclude others, the implicit feature of the public right to running water, being incapable of possession or ownership, was the right not to be obstructed from using it. It was, rather, more like the public right the law recognizes today to use a public street or highway or to use a navigable waterway' (Anderson, 2007: 475).

2. Water extraction to meet basic needs

The second similarity between the concept of a natural water right in Chinese legal thinking and that of a riparian right prevalent in the west is that both restrict the legitimate use of water extracted under them to personal use for purposes of meeting the right holder's basic needs, and disallow or limit other kinds of uses, especially those that involve denying others access, as well as pursuit of profit from the resource.

In China, water obtained through the exercise of natural water rights is used legitimately only when it is used: 'for the purposes of meeting basic household water needs, including for raising small numbers of livestock, free-range or stall-fed'. Above those limits, a license is required, and fees must be paid. Other countries follow a similar approach to China. In Australia, for example, '[u]nder the 1912 Act, NSW land owners retained some limited riparian rights for livestock watering and domestic purposes. For all other extractions of water, a landholder was required to apply for a license' (Water Act 1912; McKenzie, 2009: 446).. Might this be a coincidence? Not at all. In Locke's labour theory of private property, the reason this transformation was not only justified but should have been encouraged during the earlier stages of human society was because 'considering the plenty of natural provisions there was a long time in the world, and the few spenders, and to how small a part of that provision the industry of one man could extend itself and engross it to the prejudice of others, especially keeping within the bounds set by reason of what might serve for his use, there could be then little room for quarrels or contentions about property so established' (Locke, 1997: 19).

However, in today's world, water is extremely scarce in some places and during some periods. Given the large margin by which the benefits to the individual from using water without restraint exceed the costs to the community of their doing so, individual users necessarily have

an overwhelming incentive to do so (or, what is the same, an overwhelming disincentive to refrain from doing so). For they soon discover that while their landholding may be finite, the water that flows through or near their land is apparently not (because it is publicly owned). Moreover, should the entrepreneurially-motivated decide to build storage facilities to supply water to those without direct access to sources of their own, and to charge so much that their profits greatly exceed the cost of building the facilities, they are rightly subject to disapprobation, and such conduct should be legally prohibited. Miano and Crane argue that: 'Regulated riparianism borrows from eastern and western water doctrines and injects an element of command and control regulation into a common law that traditionally was characterized by enforcement of water rights through private judicial action' (Miano and Crane, 2003:14-7). Nathan also notes that: 'Regulated riparian statutes primarily regulate consumptive uses. Non-consumptive uses, or uses that do not require removal or diversion of water from a watercourse, are excluded from the permitting process in most eastern states' (Nathan, 2005: 382).

3. Neither natural water rights nor riparian rights rely on private law for legal protection

It is practically impossible for a natural water right holder to seek legal protection – under private law – by pressing a charge against another individual who is the alleged violator of her right. This is because water resource abuses invariably harm more than one individual, that is, the victim tends to be the public interest, which makes it impossible for any one person to be a sole plaintiff (Field, 2007: 298). Moreover, where single individuals are concerned, it is only when one has been personally, and even physically, harmed or when one's access to water has been deliberately obstructed by another who, say, has damaged one's water-retrieving instruments, that a case against the perpetrator has a legal basis in private law. But then the right violated is not a water right at all but the right to bodily integrity and the property right to one's tools and instruments. Nor is there the need, therefore, to subsume the legal protection that is sought and may be delivered in these cases under the category of protection of a water right.

It has been noted earlier that a natural water right has characteristics of subsistence rights, and subsistence rights are those rights that the people claim against the state. Õsuga Akira has pointed out that the point of subsistence rights is to ensure that people are able to live like people, with dignity (a basic necessity when people live within society, as most do), and claims of these rights are made against the state insofar as their provision and protection are supposed to require positive actions on its part (Akira, 2001: 16). Therefore, when the benefits yielded by the exercise of natural water rights do not materialize due to factors such as resource depletion or pollution, holders of those rights certainly ought to hold the state accountable, and their plea would certainly include concerns over both the quantitative and the qualitative adequacy of water. Moreover, as a kind of shared right within an exclusionary sub-group, a natural water right also has a distinct collective dimension. Therefore, collective actions register much greater impact on the protection of these rights than do individual actions. What we have here, then, is the protection of collective interest, and by derivation, protection of the private interests of which the collective interest is made up. Therefore, for either social groups or individuals in their capacity as representatives of the public interest to act as plaintiffs in water resource abuse cases would seem to be an ideal way to afford legal protection for a natural water right.

Concepts informing the protection of a riparian rights have changed over the years from 'natural flow theory' to the 'principle of reasonable use' and then again to 'the doctrine of a regulated riparian right'. From the procedural point of view, protection has moved from the requirement that remediation and redistribution requests be brought by individuals before the court and subject to litigation, to allowing administrative intervention and public prosecution for the same ends.

Riparian rights have traditionally been regarded as providing a mechanism for balancing the rights of different landowners against one another: 'To make use of the flowing water for reasonable purposes subject to the same correlative rights of the other riparian owners on the stream' (Hutchins, 1971). This is the reason why conflicts of interest involving riparian rights have often be seen as little more than conflicts of interest among landowners qua private property holders. For example, according to one statement, 'since riparian rights are unlimited, a law court provides the only way to adjudicate conflicts between right holders competing over watershed' (Nathan, 2005: 373-374). As such, 'courts replaced the natural flow theory with some form of 'reasonable use' standard. Under the reasonable use standard, riparians may, at any time, make 'reasonable' use of water from an adjacent water source to the extent that this use does not unreasonably interfere with the correlative use of other riparians' (Nathan, 2005: 387).

But even the conjunction of the mechanism afforded by private law on the one hand and the principle of reasonable use on the other still offers but an inadequate (re)solution to conflicts of interests involving riparian rights. Nathan argues that: 'Though an improvement over the natural flow theory, the reasonable use standard is highly subjective and contains no mechanism to protect public resource values. Quantification of a water right can only occur through private judicial action, an expensive and cumbersome process. Even after the entry of judgment, the court's decision is only binding upon the parties to the lawsuit… Because riparian rights may not be easily alienated from the adjacent real property to which they adhere, it may be difficult for states and local governments to reallocate water to more socially or economically productive uses' (Nathan, 2005: 387). This illustrates the way in which the institution of riparian rights evolved from being primarily a legal mechanism for adjudicating conflicts among private parties to being a legal mechanism by which the state intervenes administratively to safeguard the public interest. Such is the genesis of regulated riparian rights or riparian rights by permission (Hamilton, 1994: 947-73). The modern theory of riparian rights also recognizes the role of organizations, or individuals acting on behalf of the public interest, as intervening agents in disputes involving riparian rights. In the view of some scholars, modern riparian rights are 'vindicable not by an individual claiming under private right but by the public prosecutor complaining under the law of public nuisance' (Anderson, 2007: 475). Social groups and individual citizens are also entitled to press charges against abuses and violations of riparian rights under this law (Gates, 2000: 65-97).

Much like holders of riparian rights, holders of natural water rights enjoy the privilege of using the water that flows through an area, and bear the responsibility of adhering to standards of reasonable use while doing so. They do not, however, have property rights over the water source itself. In the case of riparian rights, if somebody is denied access to water in an area because they are denied access to the area itself, they would still be able to get water of comparable quantity and quality from some other places. This cannot be said of a natural water right. Both of these rights refer to the "negative community of interest", [which], as its name implies, was the very antithesis of property' (Anderson, 2007: 475). Therefore, natural water rights and riparian rights should both be classified as **public obligation rights**. They are not private rights at all, even if the latter classification should be qualified by the acknowledgement that these rights carry within them some elements of public obligation.

III. The nature of an administrative water right, and its comparison with a 'regulated riparian right' and 'the rule of prior appropriation'

Rules regarding administrative water rights are codified in Clause No. 32 of the Chinese Water Law (NPC, 1988), which says that: 'organizations and individuals who intend to withdraw water from rivers and streams, lakes and ponds or underground water sources need a license to do so. They must apply to the relevant water management authorities for the license in accordance with relevant rule and regulations, and pay a water resource fee as part of the application.' In our view, to the extent that this right is granted by the government in its administrative capacity and in accordance with the law, it incorporates, by design, direct reference to the public interest, and so is essentially a public right. It would, therefore, be mislabelled as a 'private right with elements of public obligation'.

While scholars of the view that water rights are 'quasi-property rights' do tend to concede that in reality most water rights are of the administrative variety, they nonetheless maintain that the concept of administrative permission and that of 'quasi-property rights' are not comparable; the former makes reference to the genesis of the right while the latter makes reference to its substantive content (or subject matter) (Cui, 2003b: 88). Must water rights born of administrative permission be ultimately reduced to either a usufruct or quasi property right, both of which are of an essentially private nature? We don't believe so. Our view is that whether to classify administrative water rights as private rights should depend on whether conflicts of interest among their holders are of a private nature and amenable to resolution through the application of private law, and not on whether they confer benefits upon their holders. Specifically, it is necessary to consider:

1. Whether the subject matter exhibits excludability because it is scarce

There is one notable difference between an administrative water right and a natural water right, and that is that while the former has quantitative criteria attached to it, the latter does not. Some scholars hold that 'excludability
(or exclusivity) can be unquestionably true only of the use of a certain quantity of water at a particular time and place and by an entity that is a *de facto* water licensee' (Liu, 2005: 257). We are skeptical about this view. When the government allocates water by issuing a quota to users, it is a way for the former to impose restrictions on the latter's appropriation of water. These quota requirements are designed to serve the interests of the public, and it seems ill-advised and poorly motivated for them to be treated as signalling that the user's right is essentially a private one. Since a private right presupposes excludability based on scarcity, things like air and radiation that are both abundantly available and non-excludable can only be classified as common property. So far as water is concerned, excludability-cum-scarcity is true in a particular water basin region (location) and during dry seasons (time) such as the low-water season for the Yellow River. Under these circumstances, the government allocates the finite water resource within the scope allowed by these temporal and spatial restraints through clearly defining the share of water to which each user is entitled. These shares are indeed excludable in the sense that no one can claim that of another no matter how much they may need or want it.

In practice, however, the Chinese system works as follows: first of all, the government takes unilateral charge of water withdrawal management, regardless of the local condition with respect to water availability. A license requirement applies in regions and time periods that are not water-stressed, such as during the high water season in the Yangtze River Basin and the Yellow River Basin.[2] Anybody who qualifies can, by going through the same process, get a permit that gives them the right to withdraw a specific quantum of water.[3] This right, granted under the condition of water abundance, certainly is neither scarce nor excludable. By contrast, when and where the license requirement applies, which it always does, in places and times that are water-

stressed, such as in the Yellow River Basin during low water season, the outcome can be quite different. There and then, the allowance that comes with a license is indeed scarce. However, because the shares are decided by the government on an annual basis, when the water stress intensifies (such as during a serious drought), what cannot be made available to all often is also denied to the few who may really be in dire need.[4] Even key industries that sustain the local economy may be able to do little more than barely subsist with the water allowance they receive. This allocation scheme obviously does not honour the entitlement to private property either. Moreover, lax law enforcement has meant that illegal water extraction – either without a license or in amounts that exceed the legal allowance – is commonplace. As such, it would be quite plausible for water users whose licenses specify the legally permissible level of water withdrawal to argue that a license is not so much a document certifying a right that the government has given as a bill that to be paid as a fee or fine for over-withdrawal! The same phenomenon does occur occasionally in other countries and areas where regulated riparian rights are in effect. As McKenzie notes: 'So, an access license does not provide exclusivity in a strict sense. It only entitles the license holder to a proportion of a shared resource. Other shareholders, including other license holders and those with basic landholder rights or common law native title rights, are also entitled to a proportion of the resource' (McKenzie, 2009: 454).

2. Is the right secure and durable?

Under civil law, property rights, especially the right to permanent assets, must be valid for relatively long periods of time (with ownership rights being valid indefinitely). This relative stability is intended to allow the property title holder to make use of their holding as they see fit. But in China, in practice, an administrative water permit is typically valid for five years, which is a relatively short time (GoC, 2006). Moreover, since government allocates shares on a yearly basis, allowances can fluctuate from year to year. Added to this any licensee risks losing their license if they have not extracted water within two years (GoC, 2006). This, again, is not unheard of in other countries and areas where the system of regulated riparian right is in operation. As Nathan notes: 'However, unlike appropriative permits, most regulated riparian permits are valid only for a certain number of years and are subject to adjustment in the public interest. During times of shortage, permitting agencies may adjust allocations to protect threatened resources. The Model Code suggests that state agencies premise reductions on the social value of each water use so that those uses with the lowest societal value receive the greatest permit reductions. Few states use this approach; instead, during times of shortage they often require unilateral pro rata reductions or reductions based on seniority of use' (Nathan, 2005: 382). In regulated riparian countries, some also follow the principle of 'use it or lose it'. In the view of some scholars, 'according to the use-it-or-lose-it principle, a water right is not something that should be allowed to idle, to be horded, traded, or permanently held. As such, this principle directly contradicts the core idea of a property right' (Wei and Zhou, 2002: 49).

3. Legal protection for water rights

We must also consider the legal protection to be afforded to the right in question. If an administrative water right is essentially a variety of private property right, then it ought to be possible for the right holder to press charges against individuals who have violated their right and to demand compensation and removal of the obstruction. However, if an administrative water right is not properly classified as a private property right, then this should not be possible, and the state would be required to provide compensation. The Chinese system is of the latter variety. If illegal extraction – either without a license or exceeding the allowed amount – depletes water resources to which holders of water right can make legitimate claim, then they must resort to turning to the government for remedy. They do not have the legal option of suing the individual perpetrator(s).[5] The same is true in Australia (McKenzie, 2009: 460).

It can be concluded, therefore, that Chinese law does not yet treat water rights as a genuinely private right (Wei and Zhou, 2002: 46). The door, however, has been open, albeit only slightly, to development in that direction. According to provision no. 27 of the Rules Regarding Water Permits and User Fees: 'For holders of the legal right to extract water, including both organizations and individuals, should they reduce their water consumption through restructuring, product redesign, improvement in production technology or water use technology, then they would be allowed to trade away their savings in exchange for a payment until the time their water extraction permit expires. The same government agency that issues water extraction permits will also be in charge of processing the water trade permit' (GoC, 2006). However, the legitimacy and reasonableness of such a rule should not be exempted from critical analysis.

Some scholars, including Wei and Zhou, believe that a water right really ought to be a private right. They argue that Chinese water rights reform should follow the model for the development of water laws in the American mid-west, where the principle of 'first come first served', or alternatively, the 'principle of priority', used to hold sway (Wei and Zhou, 2002: 46). This principle is indifferent to issues of efficiency or justice. They suggest further that an exclusive system of water rights should be established at the catchment-level, with an associated fixed priority ranking. At the lowest level, individual water right holders may be allowed to share. Moreover, this water right could be traded on the open market (Wei and Zhou, 2002: 48). In the remainder of this chapter, the apparent indifference to issues of ethics and justice that are inherent in the tradable water rights approach is discussed.

A key concern with tradeable water rights is that private individuals' entitlement to exclusionary and tradable water shares would not materialize under conditions of water scarcity. Many people might think this worry unnecessary by claiming that: 'When a natural resource is limited and therefore liable to damage, exhaustion, or destruction by *uncontrolled* exploitation by the public, a statute which prohibits the public from exercising a common law right to exploit the resource and instead confers statutory rights on licensees to exploit the resource to a limited extent confers on those licensees a privilege analogous to a profit a prendre in or over the property of another. A fee paid to obtain such a privilege is analogous to the price of a *profit a prendre*; it is a charge for the acquisition of a right akin to property' (McKenzie, 2009: 450).

But this does not totally solve the problem, as this analogy is disingenuous. 'About half of regulated riparian states require payment of fees in conjunction with permit application or water use registration. Unlike prior-appropriation system fees, regulated riparian fees are intended to partially offset the cost of state oversight and are generally set without regard to the volume of water used' (Nathan, 2005: 383). In China, this fee is in part used by the government to effect policy adjustment and is not determined solely by market forces (GoC, 2006). It does not yet, therefore, reflect the real value of water resources.

It is a necessary consequence of the intrinsic fluidity of water that, unlike land, water does not lend itself to processes whose soundness and justice can be observed and verified by the public such as auctions or bids open to private investors. If private investors beat others in securing water licenses at a cheap price, thereby obtaining the permanent exclusionary right to water resources and augmenting the benefits this right yields indefinitely through trading it in the market, the vast fortune this is likely to generate for the investor will no doubt be accompanied by, and contrast with, the vast misfortune of the public.

It is necessary to realise that: 'the existence of property rights in water was considered a necessary precondition for water trading, which was one of the mechanisms set out in the framework for achieving sustainability. However, affording such protection to private interests in water does not sit as easily with the other mechanisms set out in the framework for achieving sustainability; in particular, those that focus on environmental protection and social welfare' (McKenzie, 2009: 462).

If a water right becomes a private property right, the issue of whether and how its initial distribution can be fair and consistent with the public interest must also be subject to scrutiny.

Indeed, 'where potential participants in a water market are satisfied that the rights have the indicia of property, the market is more likely to be a success' (McKenzie, 2009: 463). However, the value of the market and private property rights in the allocation of water resources should not be exaggerated because of the adverse effects associated with these mechanisms. It is also a problem if the government is relied on too much for micro-planning and management either, as is currently the case. A third way – featuring a prominent role for the public (in the form of, say, greater public participation and legal actions), can facilitate the achievement of the legal objective of fair and reasonable allocation of water resources.

1 For example, on November 24, 2000, Dongyang City and Yiwu City in the Jinhua region of Zhejiang province, signed a contract in which they agreed that the latter would pay the former RMB 200 million (over US$ 30 million) for the right to use, indefinitely, water from the Hengmian reservoir, which has an estimated volume of 50 million m3. Some scholars think this case demonstrates how the market can work to achieve optimal water allocation (Hu and Wang, 2001: 4).

2 According to Rule No. 2 in Rules Regarding Water Permits and User Fees (hereafter Rules), which went into effect in 2006, individuals or organizational entities that wish to extract water from water sources must, except where the conditions specified in Rule No. 4 hold, apply for a permit and pay an application fee.

3 According to Rule No. 16 in Rules, before the government issues a water license, it must consider the nature of the type of business the applicant engages in, the size of the business, and then uses the water requirement standard for that type of business for purpose of verifying the water license application submitted. The tacit operative principle is one that determines supply on the basis of need.

4 According to Rule No. 40 in Rules, the agency in charge of issuing water licenses is also responsible for deciding the water quota for each individual, business and organization for the following year. It does so on the basis of the water use schedule for the following year for the district as a whole and the projected water need for the same period as submitted by individuals, businesses and organizations, and it tries to make that quota schedule is fair, efficient, and sustainable.

5 The typical excused given by violators of others water rights is that it concerns interest of the public, and not the private property right of an individual. Therefore, provision 57 in China's Water Law is unsuitable for adjudicating this type of conflict.

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Part Five
Civil society

20
Breaching Barriers: Chinese environmental NGOs come of age

Fu Tao

在环境危局中突围:中国本土环境NGO的发展

I. Introduction

By the mid 1990's, the profound social impacts of nearly two decades of market reform in China had become very pronounced. As it continued to cede control over the provision of social services to the market, the Chinese government gradually loosened its grip on other aspects of social life. One area in which this was particularly evident was environmental management, where the changing role of the state contributed to the worsening of environmental conditions in China. At the same time, and not coincidentally, a narrow space opened up for citizens to take action to address environmental issues. This space was relatively independent of the government. A cornerstone event in this process was the 4th United Nations Conference on Women and Development held in Beijing in 1995. This event was an inspiration for many of China's future NGO leaders, as it was their first exposure to international NGO advocacy activities on a large scale.

Some far-sighted Chinese intellectuals took the lead in setting up their own NGOs to deal with the country's growing environmental crisis. One of them was the late Professor Liang Congjie, one of the founders of Friends of Nature (FON), China's flagship environmental NGO (ENGO hereafter). The Chinese ENGO movement can in fact be dated to the founding of FON in 1994. This chapter traces the history of the ENGO movement after the creation of FON. It identifies two distinct periods of activity: one before, and one after, the coordinated ENGO campaign in 2003 against the construction of the Nujiang River dam in Yunnan province in southwest China.

During the first phase of the environmental movement, between 1994 and 2003, Chinese grassroots environmental organizations mostly engaged in environmental education and awareness raising. Environmental activism in this period was directed largely at the general public. It was politically neutral and strategically non-confrontational. A key focus was the protection of biodiversity. This kind of environmental education was without historical precedent in China, and it is also significant that it was the ENGOs which initiated this effort before the government made it a priority.

This early activity often consisted of organized tree planting, bird-watching and rubbish collection (activities which are now sometimes jokingly referred as 'same old three things' by NGO veterans). It is easy to think of these endeavours as haphazard and ineffective ways of addressing serious environmental problems. However, they were unprecedented, and important given how sensitive non-governmental activities were at that time. The fact that FON's founding ceremony was held in an obscure park in the western suburbs of Beijing, and organizers used the celebration of Liang Congjie's birthday as a cover for the event, should be evidence enough that any seemingly innocuous gathering was at risk of attracting unwelcome attention from the authorities.

The birth of FON was quickly followed by the creation of many new Chinese ENGOs. These first-generation organizations became an important source of energy for China's environmental movement. In the late 1990s, two high-profile national campaigns were launched, one for the protection of the chiru, or Tibetan antelope, an endangered species native to Qinghai province, and the other for the protection of the snub-nosed monkey native to Yunnan province. These two campaigns showcased the ability of Chinese ENGOs to work as pressure groups and earned them national, and even international, recognition.

After 2003, when Chinese ENGOs entered the second stage of their development, environmental conflicts in China became more frequent and infringements of environmentally-related rights more acute. Environmental education continued to consume much of the organizational energy of ENGOs, which were growing in both scope and depth. However it became evident that education was increasingly limited as a vehicle for addressing the new agenda of environmental crises. ENGO activities began to include lobbying on environmental and social justice issues and promotion of public participation in policymaking. Following this, as China's economy became more globally integrated, Chinese ENGOs also began to turn their attention to environmental issues related to globalization.

The focus in this chapter is on the period after 2003. In section 2, a typology of ENGO activities is offered; in section 3, some principal characteristics of environmental activism in China are discussed; section 4 looks at international influences, particularly against the background of globalization; and finally, section 5 suggests some the reasons for the vibrancy of the Chinese environmental movement.

There are, however, two caveats. First, NGOs that specialize in organic agriculture, rural development, and sustainable development are not covered in this chapter, even though they are also concerned with the environment. They are omitted for reasons of space, and because in practice, cooperation and interaction between these NGOs and ENGOs has been rather limited. International NGOs that operate in China are also not included in this review. While many of these organizations have operated in China for many years and have undergone varying degrees of domestication over time, they are still sufficiently different from home-grown ENGOs to warrant separate treatment.

II. Main areas of ENGO activity

1. Anti-dam campaigns and public hearings on environmental issues

One area in which Chinese ENGOs have become particularly active since 2003 is in campaigning and lobbying against efforts by big hydropower companies to build dams in southwestern China. The objectives of these campaigns have been: to protect and preserve ecosystems and indigenous cultures; to enforce environmental impact assessment and information disclosure requirements; to protect the rights of indigenous people; and, to promote public participation in decision-making. The campaign against the proposed Nujiang Dam is a good example. Participating ENGOs made use of social networks, support from the media, enlightened officials within the government, and help from scholars and experts sympathetic to their cause. They were able to have their dissenting views on the Nujiang dam delivered to top leaders in the central government through institutional channels. As a result, Premier Wen Jiabao issued two suspension orders for the Nujiang River hydroelectric project, one in 2003 and the other in 2009. According to FON's *China Environment Yearbook* (Friends of Nature, 2007), the Nujiang Dam episode became one of the questions in the civil servant recruitment exam – a clear indication of the growing influence of Chinese ENGOs on public policy.

ENGOs also fought fiercely with the hydropower giants over other projects similar to the Nujiang Dam. Those included hydraulic projects at the Yangliuhu Dam above the ancient Dujiangyan water diversion scheme in Sichuan Province, and at Mugecuo Lake in Tibet Autonomous Region. On June 26, 2009, a total of 21 ENGOs issued a joint statement in support of the decision by the State Environmental Protection Administration (SEPA) to stop two hydraulic companies under the Huaneng Group from constructing, without permits, two hydroelectric plants on the Jinshajiang River. Subsequently, Chongqing Green Volunteers Federation brought the case to the central government for administrative review, and filed a public interest suit against the Huaneng Group in a court in Wuhan, a city in Hubei province.

Environmental public hearings potentially provide an institutional mechanism to support public participation in environmental decision-making. ENGOs did much to promote and facilitate them. Moot hearings were held by some ENGOs in partnership with scholars with expertise on the Nujiang Dam. Real hearings, which were attended by ENGOs, finally took place when, in April 2005, Pan Yue, Vice-Minister of the Ministry of Environmental Protection (MEP, formerly the State Environmental Protection Administration), made the momentous decision to hold a public hearing about an incident in which the lake bed of Yuanmingyuan Lake in Beijing was lined with plastic, allegedly to prevent water seepage. This case had generated

intense public interest and raised numerous questions about the lining's potential impact on the lake ecosystem.

Ten ENGO representatives took part in the hearing. These representatives were allowed to present not only evidence they had gathered from their own on-site studies, but also suggestions about remedial measures. The hearing was unprecedented in its openness and participant diversity, and it marked the first time that China's home-grown ENGOs became formally involved in government decisions about environmental issues.

2. Pollution monitoring

Largely in response to drastic increases in pollution levels in river basins and major waterways, many regional ENGOs sprang up around the turn of the millennium. These include the Huaihe River Defenders (established in 2001) and Green Hanjiang River (established in 2002). These organizations have worked with the media and helped to expose environmental misconduct by local governments, which would on occasion consult with them. They have also provided villagers with legal training on how to protect their own rights. Both Huaihe River Defenders and Green Hanjiang River have set up a number of volunteer-operated pollution monitoring stations along their target rivers. This clearly demonstrates their ability to mobilize community support. Huaihe River Defenders even set up a hotline to SEPA for reporting pollution incidents.

ENGOs have also been using the policy of green bank-credit as a way to impose restrictions on initial public offerings (IPO) by companies with poor environmental records. In 2008, six ENGOs sent two signed petition letters to the MEP asking it to delay approval of an IPO application from a paper company that had generated widespread controversy through its involvement in forest destruction and frequent violations of pollution regulations. Significantly, ministerial officials responded by ordering local MEP offices to investigate the charges.

ENGOs have also been very active on the issue of municipal waste management since 2003. As early as 1996, Global Village Beijing launched pilot projects to promote recycling in several communities in Beijing. Unfortunately, these efforts eventually petered out due to a combination of inadequate government rules and regulations, market failures, and technological limitations.

In recent years, ENGOs have also begun to revisit the issue of waste incineration. Growing public concerns about air pollution from these operations have triggered repeated confrontations between citizens and authorities. Friends of Nature, for example, have been involved in the controversy over the Liulitun waste incineration plant. FON has been closely following the planning and construction of the plant, and helped China Central Television (CCTV) ensure that its coverage of the issue incorporated diverse stakeholder views. Four people from FON's small staff now work on the issue of municipal waste.

In addition to facilitating media exposure of environmental misconduct, advocacy and mobilization, ENGOs have also been pushing for environmental information disclosure, and encouraging the utilization of legal instruments to defend people's rights and protecting the public interest. Through these activities and experiences, ENGOs have gradually become a more effective and professional force.

3. Environmental information disclosure

The 'Trial Government Information Disclosure and Environmental Information Disclosure Measures' that went into effect on May 1st 2008 created space for broader and deeper NGO involvement in environmental governance. The following year, the Institute of Public and Environmental Affairs (IPE) and the US-based Natural Resource Defense Council (NRDC) jointly developed a Pollution Information Transparency Index (PITI). They then conducted a preliminary assessment of pollution information transparency for 113 Chinese cities for the previous year (Friends of Nature, 2010: 256).

Before it created PITI, IPE had also developed a China Water Pollution Map (2006) and a China Air Pollution Map (2007). These maps collect, organize, and analyze pollution-related information released by the government. They have become a powerful tool for NGOs, individuals, and the public. To date the maps have recorded 58,000 violations of pollution regulations.

In addition, IPE exerts pressure on corporations and businesses by publishing information about their environmental governance. In March, 2010, just prior to the peak Chinese New Year holiday shopping season, 34 ENGOs jointly launched a 'Green Choice' campaign, as part of which they compiled and published a list of environmentally-unfriendly consumer products. They also urged 21 corporations with large market shares in the products they sell (including both domestic and international brands) to improve their environmental conduct. In April 2010, a newly-released IPE report disclosed environmental violations of companies listed on the Hong Kong Stock Exchange and gave suggestions to the Exchange on how to improve supervision in this area.

IPE was able to do all these activities thanks to its pollution database. As a result, it exposed companies that have begun to yield to this pressure by changing the way they do business. Some corporations in upstream supply chains (many of which are multinational) have also begun to use these maps in making business decisions, and this has generated pressure on downstream companies to become more environmentally responsible. This goes to show how critical access to information is for members of the general public to meaningfully and effectively engage with environmental issues. The maps produced by IPE have been an effective tool to make NGO work more professional.

4. Environmental litigation

Besides facilitating media exposure of corporate breaches of environmental rules and regulations, Chinese ENGOs, and especially those with experience and expertise in the law, have also provided environmentally-related legal services to the public. For example, since its establishment in 1999, the Centre for Legal Assistance to Pollution Victims (CLAPV), affiliated to the Chinese University of Politics and Law, has tried to push for legislative and policy reform in the areas of environmental information disclosure and rights protection through its representation of pollution victims. In another example, in 2009, the All-China Environment Federation (ACEF) filed two public interest suits in two local courts and eventually prevailed in both. The defendant in one of the two cases was the local Bureau of Land and Resources, and the case was heard before a court in Guiyang, the capital of Guizhou province. The defendant in the other case was a company that violated pollution regulations. This case was heard before a court in Wuxi, Jiangsu province. Both cases were handled promptly, lasting only two months from the time of filing in July 2009 to the final ruling in September 2009. The two cases marked a milestone for public interest litigation in China. They were the products of experiments with environmental courts by certain local governments, and could not have happened without removal of restrictions against NGOs acting as plaintiffs.

But of course, not all cases were as successful as these two examples. For example, the case brought by Chongqing Green Volunteers League (CGVL) in August 2009 in a court in Wuhan, Hubei province, to halt the construction of two hydroelectric plants has yet to be heard.

According to Zhang Jingjing, deputy director of the China programme at the Public Interest Law Institute (PILI), the outcome of a case can depend as much on the identities of the plaintiff and the defendant as on its substantive content. ACEF's success in the two cases it filed may be attributable to the plaintiff's status as a quasi-governmental organization as well as the relatively straightforward nature of the cases, which did not impinge on powerful local interests. The organization faced little obstruction from government authorities. By contrast, the CGVL case, involves a major power corporation, and is more challenging both legally and politically, and therefore has stood considerably less chance of success. However, relatively favourable circumstances notwithstanding, the symbolic significance of the ACEF successes should not be downplayed.

Whereas existing laws are often poorly enforced, laws that are only under consideration are of even less help to NGOs that try to promote public interest litigation. It has been five years since Liang Congjie submitted a proposal about public interest litigation to the Chinese People's Political Consultative Conference, or CPPCC, yet little discernible progress has been made. However, in a sign that all hope may not be lost, Wan Exiang, Vice-President of the Supreme People's Court, submitted a similar proposal to the National People's Congress earlier this year.

5. Environmental education: Energy conservation and climate change

Environmental education has continued to be an important component of ENGO work. In fact, ENGO involvement in other areas, such as those described above, is both supplementary and complementary to education work.

In recent years, China has become the largest carbon emitter. International calls for China to become more pro-active in fighting global warming have also increased. But external pressure notwithstanding, China has also badly needed to find internal impetus to conserve energy and reduce greenhouse gas emissions. Chinese ENGOs played an important role in mobilizing the public on this issue. For example, in June 2004, a number of ENGOs initiated a campaign encouraging people to set their air conditioners to 26 degrees or above during the summer. Similar energy-saving campaigns have taken place across the nation, organized by Chinese ENGOs, sometimes working jointly with international NGOs operating in China. These campaigns became an integral part of the country's overall effort to reduce carbon emissions per unit of GDP by 20 per cent by 2010, a target included in the 11th Five Year Plan.

The growing prominence of climate change as an environmental issue also precipitated the emergence of three home-grown ENGO networks in 2007. These are the China Climate Action Network (CCAN), the Chinese Civil Society on Climate Change Programme, and the China Youth Climate Change Network (CYCAN). All are the products of deep international influence, and are primarily learning networks whose main goal is to keep people informed about international discourse and negotiations on climate change.

Of the three networks, CCAN focuses more on the technical details of international negotiations over climate change responses. It has close contacts with CAN, a global network on climate change, with whom it already shares some members. CCAN sent a number of observers to the Copenhagen climate change conference.

For its part, the Chinese Civil Society on Climate Change Programme was the product of joint efforts by both home-grown ENGOs and international NGOs with operations inside China. Its membership is inclusive of people from both ENGOs and NGOs working on economic and social development. Its areas of concern include not only global climate justice but also local adaptation. On behalf of Chinese civil society (albeit informally), the organization delivered, first in Bali in 2008, then again in Copenhagen last year, a position statement on climate change and climate change responses. The third organisation, CYCAN, is comprised mostly of university students already involved in environmental organizations and activism.

These three organizations are all similar in that international influences played a role in their formation. They began with the initial intent of studying the international politics of climate change, but have all had to learn how to integrate these topics with domestic concerns.

III. Characteristics of the Chinese environmental movement and ENGOs

1. Advocacy and lobbying

Over the years, Chinese ENGOs have honed their skills in exerting pressure on government and corporations in whatever ways were permissible with, and tolerated by, the institutional status quo. Their strategy of choice has been to be as politically-neutral and tactically non-confrontational as possible. They try to act jointly as opposed to going it alone, to trigger inter-agency check-and-balance mechanisms within the government, to seek out and elicit support from enlightened and sympathetic government officials, to facilitate media exposure of corporate misconduct, and to communicate with national leaders through the National People's Congress and the Chinese People's Consultative Conference. They also recruit scholars, experts and other professionals who are sympathetic to their cause and willing to help where they can.

2. Working with struggling communities

In some countries in Southeast Asia, such as Thailand and the Philippines, it is common for NGOs to work closely with local communities in facilitating grassroots social movements. As these movements work on achieving their immediate goals, such as defending the right of citizens against transgressions, the NGOs provide the financial, media, information, and intellectual support needed to encourage their social movement partners to look beyond short-term objectives. This kind of collaboration has enriched some local movements with globally-related perspectives on local struggles.

Despite geographical proximity to Southeast Asia, a similar pattern has not been evident in China. Chinese ENGOs have had to operate within the confines of tight institutional spaces and under close government surveillance. They have, therefore, mostly maintained a safe distance from grassroots social movements inside China. Even when and where they have opted to get involved, they have typically done so strictly in the name of protecting the environment, as opposed to defending people.

For example, in 2007, a petition signed by 105 Chinese People's Consultative Conference members was lodged with the Conference opposing a plan to build a PX chemical factory in Xiamen, a city in Fujian province. On June 1st, using the tactic of 'taking a stroll' (a popular Chinese pastime) thousands of Xiamen residents took to the streets to make their opposition to the factory known. During these events, local ENGOs chose to remain neutral and largely refrained from participation.

In another example, FON has chosen to be involved in the Liulitun waste incineration project, located on the outskirts of Beijing. FON has used promotion of the principle of the 3R's – recycling, reuse and reduction – in a local community that might be affected by the plant. FON has defined its own role as a kind of 'third party' or go-between for the government and the citizens.

There are a few exceptions, of course. One is Yunnan based Green Watershed, which has done more than most other organizations of its kind to defend the rights of citizens adversely affected by environmentally dubious projects. It provides legal training to farmers who face the prospect of forced resettlement as a result of dam construction on the Nujiang and Jinshajiang Rivers. Green Watershed organized trips for these farmers to prior resettlement locations so they could witness the impact of dam construction on the lives of people. These activities had the objective of empowering farmers by boosting their morale and strengthening their assertiveness and capacity for self-expression. For these efforts, however, Green Watershed came under pressure from both the local government and hydroelectric corporations.

For its part, Green Anhui has been providing various forms of material support to locals in their fight against corporate polluters since 2005. The group has, among other things, helped train

village leaders, but has otherwise not become directly involved in oppositional activities, which resulted in three chemical factories being shut down by the local government.

Compared with NGOs based in Beijing, which tend to enjoy greater access to information and financial resources, NGOs headquartered in other places have typically had to rely heavily on local communities, whose trust and volunteer reserves are absolutely necessary for their operation. This has also allowed them to respond more rapidly to the needs of local communities than might otherwise have been the case.

Currently, collaboration between elite ENGOs and local communities remains a highly sensitive issue. Each ENGO must find the right strategy for what it wants to do in this regard. Most have chosen to do what is politically safe, focusing on environmental education and advocacy for institutional reform. These have continued to be bread-and-butter activities for Chinese ENGOs.

3. Addressing the underlying causes of environmental problems

As it becomes increasingly evident that environmental issues are inextricably linked with issues of social justice and individual rights, many ENGOs have expanded their environmental focus to engage with rights issues. The campaigns described earlier, and numerous ones not mentioned here, including some that helped secure clean drinking water for communities, illustrate ENGOs' growing awareness of the links between their work and justice and rights issues. For example, Green Camel Bell, in northwestern Gansu province, originally focused on environmental protection. But as desertification became an agent of impoverishment in the area, the group became a kind of hybrid, acting as an ENGO and also an NGO working on development issues. The same was true of the group Green Cross, based in Hubei province. It also broadened the scope of its work to include support for social development.

Green Watershed also carried out a pilot project that helped empower local residents to participate in river management and water resource development. The social impact assessment report that Green Watershed prepared in 2005 on the Manwan hydroelectric power plant, to be built on the Lancang River (the upper Mekong River within Yunnan province), focused directly on protecting the rights of resettled villagers. In another example, some of the projects developed by a local NGO, the Global Environment Institute (GEI), have integrated environmental protection and community development. GEI has worked to promote organic farming and renewable energy sources, and helped to equip farmers with self-help skills and strategies.

Green Earth Volunteers (GEV) has specialized in ecotourism since its establishment but has also increasingly incorporated social development elements into its work. For example, it has provided financial and other kinds of support to schools in the Nujiang River basin. Most recently, Wang Yongchen, the group's founder, has repeatedly and emphatically stated that the rights of people are the primary concern for her group and that ecological conservation is of secondary importance. Shan Shui Water Conservation Centre, a local NGO established by Lu Zhi, former Country Director for Conservation International in China and a biologist with expertise in giant panda and forest conservation, worked with local residents in forest protection on a project that diverts water from ecologically sound areas to water-stressed communities in Yunnan province.

In recent years, many Chinese ENGOs have also deepened their understandings of the complex nature of China's environmental challenges. Their intellectual maturity is reflected in the increased variety of projects they are willing to take on. One area that has enjoyed increasing ENGO involvement is the protection of cultural diversity. For example, some groups have worked on grassland ecosystem preservation by preserving the cultural heritage of nomadic pastoralists. Indigenous Tibetan culture has been the subject of similar attention, again for its ecological significance. Beijing-based Global Village incorporated education about the environment and classical Chinese philosophy into community development plans for a community reconstruction project in earthquake-stricken Sichuan province.

This trend towards diversification and increased intellectual and organizational ties with those working on social problems is consistent with the experience of international ENGOs over the last 30 years. 'Most humanitarian relief and development NGOs have come to emphasize environmental protection as a necessary condition for human development. Meanwhile, many NGOs that started off as "pure" environmental NGOs have come to see human development as a necessary condition for environmental protection' (Young, 2004).

4. Domestication of international ENGOs

Many international ENGOs working in China have undergone domestication: they have evolved Chinese characteristics, willingly or otherwise. Many of those organizations have worked for years in China and have developed unique approaches for getting things done. Their basic premise is to work with, not against, the government. Increasingly, international and home-grown ENGOs are partnering with one another on large projects, including energy conservation advocacy, formulation of a quasi-official civil society stance on climate change, the compilation and publication of pollution maps, and a push for environmental information disclosure. In all these collaboration efforts, international ENGOs are no longer just the source of funding. Increasingly, they work with home-grown ENGOs on everything from project design to project execution. It is also worth noting that, locally-based foreign staff members of international, and in particular western, NGOs are not always in full agreement with their home office colleagues on global environmental issues, such as climate change, in which China has a high stake. On these issues it seems to be true that where one sits influences where one stands.

IV. Chinese ENGOs in a global context: from recipient to partner

1. International NGO influence

The environment has been the dominant issue for international NGOs working in China. Home-grown NGOs, that focus on the environment have received most international attention, and were the first to establish working and other relations with their international counterparts. If the 1995 UN Conference on Women and Development held in Beijing inspired the first generation of Chinese NGO leaders, the 2002 World Summit on Sustainable Development (WSSD) offered Chinese NGOs, still then in their infancy, their first real exposure to a massive international gathering. Exchange between international and home-grown ENGOs has been growing apace, a process that got a boost from China's entry into the WTO and increasing globalization of civil society. As many foreign NGOs working inside China become domesticated, their relationship to China's home-grown NGOs has also evolved to become more like a partnership and less that of manager and implementer. International NGOs working in or with China are particularly concerned with the social and environmental impact of China's growing overseas investments, as well as with issues of desertification, sandstorms, trans-boundary water resource development projects, and climate change.

In April 2003, a Canadian NGO, Forest Action Network, came to Beijing and appealed to Chinese ENGOs and the media to help stop Chinese companies from importing timber products harvested in the Great Bear Rain Forest in British Columbia, Canada. The massive extraction of lumber by these companies was threatening the forest ecosystem. Five years before this, Professor Liang Congjie, the co-founder of FON, wrote a letter to former British Prime Minister Tony Blair asking for help to stop international trade in Tibetan antelope products. While the two events may not appear to have much in common, they signalled a subtle change in the relationship between international and China's home-grown NGOs as described above. In general, local challenges still

remain the priority for Chinese ENGOs. There is still a long way to go before they are ready to take on global issues more systematically (see Box 1).

Box 1 Increasing global focus of Chinese ENGOs

- In 2008, a Chinese ENGO network led by Green Watershed initiated a campaign to promote the adoption of a green credit policy by Chinese banks. The network designed an indicator system to evaluate the performance of banks operating in China. Its model was Bank Track, an international NGO pioneer in this area, although it made necessary adjustments to the latter's practice to suit the Chinese context. So far, the evaluation system has only focussed on the domestic performance of Chinese banks, largely due to difficulties in data collection. But this is likely to change in the future. Chinese banks will in time be scrutinized for their international as well as their domestic conduct.
- Several years ago, Green Watershed collaborated with the Mekong River Commission, an intergovernmental agency that aims to promote regional cooperation in water resource development in the Mekong River basin, jointly producing a newsletter to promote communication and exchange between China and downstream countries.
- In its production of pollution maps, the Institute for Public Environment (IPE) focuses mostly on China's own pollution problems, even though it relies a great deal on techniques and strategies that have been developed within a western context. Moreover, IPE also recruits western NGOs to exert pressure from overseas on corporate polluters with operations inside China. The reach of its activities, in other words, has become international.
- China Waste Information Network (CWIN), a small Chinese network based in Anhui province, is a project supported by the Global Anti-Incineration Alliance (GAIA). CWIN has managed to blend an idea of non-Chinese origin with specific circumstances within China to produce a set of methodologies that is particularly suited to addressing China's own waste disposal and treatment problems.
- The Global Environment Institute (GEI) has also developed a global focus. It developed, in partnership with government agencies, a set of 'Guidelines for Chinese Forestry Enterprise Operating Overseas'. As part of its pilot project to 'strengthen ties between the Chinese government, Chinese timber corporations and the governments of southeast Asian countries in promoting sustainable management of forests', it has established an office in Vientiane in Laos. GEI are exploring ways to help build the Lao government's capacity to manage and utilize land resources sustainably.

2. Regional NGOs in Southern countries

Groups based in the Global North were the first international NGOs to work with China's home-grown ones. As China has emerged as a leader of the global South and with a growing voice on the international stage, international NGOs from many countries in Asia and Africa have recently increased their presence in China, often with the expectation that Chinese NGOs might also become leaders of an NGO movement, especially in relation to issues such as the WTO, globalization, and climate change.

Driven by a strong concern for social justice, many of these regional NGOs (and the social movements they either help lead or are a part of) are politically and ideologically left-leaning. Third World Network (TWN) and Focus on the Global South are just two of the better known among them. Such groups focus on climate justice, globalization, and the WTO. While working on these issues with Chinese NGOs, regional NGOs have also tried to share their basic social and political philosophy. Earth Rights International, for example, an NGO based in the US and Thailand, has devoted itself to promoting the rights of people living along the Mekong River

and to protecting the Mekong riparian environment. It has set up training programmes in Chiang Mai, Thailand, for NGO activists and pubic interest lawyers, and the organization is on track to develop more ties with Chinese NGOs working on similar issues.

To sum up, Chinese ENGOs are now working in a global context. Some of the local issues will of course have more global impact than others, while their handling of local issues will no doubt increasingly show the influence of their global perspective.

3. Where to go from here?

International influence on China's home-grown ENGOs is anything but homogeneous. International NGOs are sharply divided both in terms of ideology and choice of tactical approaches. For example, a fissure over climate change within the NGO community was already apparent at the Copenhagen climate summit in 2009. According to Dorothy Guerrdo, China Programme Director for Focus on the Global South: 'A visible split happened between the traditional NGOs such as Climate Action Network, World Wide Fund for Nature, Conservation International, Greenpeace, and the more radical bottom-up climate justice social movement that is strongly against market mechanisms like carbon trading'. What distinguishes the climate justice social movement from the traditional environmental movement is that the former is animated by the principle of 'change the system, not the climate', the motto of the climate justice movement.

Even though China's home-grown ENGOs have often been involved in exposing corporate misconduct and criticizing government inaction in these cases, they are market-economy friendly in their basic philosophical orientation. Indeed, some Chinese ENGOs have opted to take advantage of the market as an instrument for achieving their objectives. Resource constraints and capacity limitations have much to do with this preference, for under these conditions, working with the market rather than against it is simply more practical for many NGOs. This has made them seem less concerned with issues of institutional reform than might have been expected. Influence from their counterparts in other countries of the global South may change this.

NGOs have had to negotiate trade-offs between economic development and environmental protection. Now they are encountering new dilemmas around the ideal of cosmopolitanism, as sometimes expressed through the notion of 'global citizenship', and the reality of national interests. One recent manifestation of this conflict came in 2010 when severe drought affected the entire Mekong River basin, including parts of Yunnan province. This prompted downstream countries to oppose China's plan to build a series of dams on the upper Mekong (known as the Lancang River within China). Cross-border resource and environmental disputes such as this will increasingly demand involvement from Chinese NGOs. But because such matters are inevitably complicated by diplomatic considerations, and subject to much tighter control by the government than other environmental issues, these disputes will be more challenging to handle, as well as less pressing, for Chinese NGOs.

V. Some factors animating environmental activism in China

1. Sharing the same goals as the government

One important reason Chinese ENGOs have been able to do as much as they have within the limited institutional space that government has given them is that they share the latter's basic objectives with respect to the environment. Indeed, the government needs ENGOs to help it achieve some of its own objectives. ENGOs not only help raise public awareness and support for the government's environmental policies, they also function as a kind of watchdog over corporations, something that the government welcomes.

Compared with other policy areas in China, environmental protection has enjoyed more public participation in decision-making. ENGOs made a strategic choice to be non-confrontational and politically neutral, and have stuck to this over the years. This has made them more acceptable to the government than they might otherwise have been. However, they have also become a formidable force, and the government can no longer afford to ignore them completely. Pan Yue, Vice-Minister of the Ministry of Environmental Protection (formerly SEPA), has remarked that 'environmental protection is the testing ground for China's political and social reform' (CYOL, 2006). The nature of environmental protection as a matter of public interest tends to support consensus-building that unites different parties rather than dividing them.

As one might expect, however, the Chinese government has not been completely at ease with the growing influence of ENGOs, especially given an increasing ENGO focus on issues relating to the rights of citizens. The government remains wary of the long-term political impact of environmental activism as a potential challenge to its authority. But in this respect, ENGOs are little different from NGOs working in other areas, which often face some of the very same problems of legitimacy. Indeed, the government has 'imposed tough restrictions on NGOs taking collective action and acting on behalf of interested groups' (Kang, 2002).

2. Inter-agency checks-and-balances within the government

Notionally there has been a balance of power between agencies in charge of environmental protection and those in charge of economic development within the hierarchical structure of the government. However, the authority of the former has typically been trumped by that of the latter. This, however, has also created an opportunity for ENGOs to become an ally for politically marginalized government agencies. ENGOs often need to turn to the central government for help in their work, especially in promoting information disclosure and public participation. These are areas in which support from progressive government officials has been especially valuable, and interdependence and mutual support between ENGOs and these agencies has increased.

Government-affiliated NGOs, paradoxically known as 'governmental non-governmental organizations' (or GONGOs) have also had positive effects on NGOs. For example, the China Environmental Culture Promotion Association (CECPA), a GONGO headed by Pan Yue, the outspoken Vice-Minister of the Ministry of Environmental Protection, and the All China Environment Federation (ACEF), a GONGO co-founded by a group of retired senior SEPA officials, have both been very active in promoting ENGOs. These organizations help raise the profile and publicize the work of ENGOs by inviting the latter to their annual meetings and to award ceremonies for people who have made outstanding contribution towards environmental causes, and by organizing workshops for NGO leaders and staff. All these events and activities, together with media coverage of them, have helped confer legitimacy on NGOs. For NGOs that have often found themselves mired in a tug of war with local authorities, this is particularly meaningful and valuable.

3. Non-governmentalization of the media and academia

A key advocacy strategy for Chinese ENGOs is to problematize important issues. They typically do this by generating media interest in an issue, promoting public debates and collecting expert opinions on a problem. For example, Green Earth Volunteers runs a monthly forum for reporters and journalists to meet 'non-mainstream' scholars and experts to discuss various environmental issues. The Internet has also provided a venue for NGOs to publicize their work and achievements. Many ENGOs have managed to have their activities broadcast live by partnering with public interest Internet channels on corporate websites. Increasingly, and especially after the coordinated campaign against the planned Nujiang River Dam in 2003, many social interest groups that have not traditionally been associated with the environmental movement have begun to adopt NGO-style approaches and tactics.

4. International support

Environmental protection has been one of the most important areas for international involvement in China's social and political transformation during recent decades. Indeed, Chinese ENGOs have also been expected to promote the construction of democratic institutions in the country through their work. Since their earliest days, Chinese ENGOs have climbed a steep learning curve, and as they continue to mature, they will become less dependent on international assistance, financial or otherwise, and rely more on domestic moral and material support. Of course, being Chinese NGOs, domestic issues will, perhaps rightly, always remain their priority.

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China's economic transformation over three decades has lifted hundreds of millions of people out of poverty. But impressive economic growth rates in the world's largest country have come with heavy environmental costs. The air in many of China's largest cities is the most polluted in the world, the water in many major rivers is unfit even for irrigation, and soils in key agricultural regions are contaminated by heavy metals. Scarce arable land and water resources and important biodiversity are being lost at alarming rates. Added to this, China's carbon and nitrous oxide emissions are having serious impacts both in China and worldwide.

China urgently needs to shift to a more sustainable economic model. Future growth will need to delivers jobs and additional poverty reduction without further undermining ecosystems and the natural resource base. This means rethinking links between energy and climate change and land and water use. But changing institutions, policy and practice to support this is far from easy. This book, which brings together writings from China's leading thinkers on sustainable development, reflects on experiences to date, such as experiments with Green GDP accounting, and implementation of Green for Grain, the world's biggest reforestation programme, as well as China's role in climate negotiations. Clear ideas are presented on what needs to change in China (and elsewhere), in order to deliver economic development with better social and environmental outcomes.

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