

# Foreward

Jennifer L. Turner, Editor

Over the past year, cooperation and dialogue between the United States and China on environmental issues has grown. A delegation from the U.S. National Oceanic and Atmospheric Administration (NOAA) visited China in September 1999, not only to attend working group meetings and workshops, but also to commemorate twenty years of Sino-U.S. scientific cooperation in oceans and atmosphere. The U.S. China Forum on Environment and Development held a third meeting in Hawaii, in January 2000, which has led to new cooperative agreements on renewable energy, atmospheric contaminants, and green chemistry. At this January meeting, the United States/China Water Resources Management Program was also formally established as a working group of the U.S.-China Joint Commission Meeting on Science and Technology. In terms of nongovernmental (NGO) activities, the first NGO Forum on U.S.-China Environmental Cooperation was held in Bethesda, Maryland, in September 1999. As the inventory in this issue of the *China Environment Series* reveals, cooperative environmental activities between U.S. and Chinese nongovernmental organizations have increased over the past year.

This third issue of the *Series* opens with an article by Chris Nielsen, the executive director of the Harvard University Committee on Environment China Project. He argues that the linkage between global and local environmental issues has been highly under-emphasized in the environmental dialogue with China. The environmental studies being undertaken jointly by researchers at Harvard University and various Chinese institutions clearly embody this concern for understanding the local environmental challenges in China and linking them to global concerns. The other four articles in the *Series* explore changes and challenges in the Chinese transportation sector. While vehicle emissions and decisions on land-use for transportation raise local environmental and health concerns in China, they also have regional and global environmental effects. The first of these articles is by Robert E. Paaswell, the Director of the Region II University Transportation Center at the City College in New York. Paaswell highlights some potential lessons from the United States to help China mitigate problems of urban sprawl and traffic congestion. Furthermore, D. Tilly Chang, a Transport Operations Officer with the World Bank, describes the policy evolution of public transport in China. She also provides insights into the institutional and political challenges facing mass transit development in Chinese cities. Michael P. Walsh, a technical consultant specializing in motor vehicle pollution control issues, discusses policy recommendations made in a recent study of vehicular pollution in Chinese cities. Lastly, our authors from Tsinghua University, He Kebin and Chang Cheng, provide an evaluation of current and proposed policies to mitigate vehicular air pollution in China.

The first two issues of the *China Environment Series* featured an inventory of U.S. government and NGO environmental projects and activities taking place in China. In this issue we have broadened the coverage of the inventory to include current and recently completed environmental projects in China undertaken by other countries as well. The inventory also includes a sample of environmental activities funded by multilateral organizations. We will continue to expand the breadth and depth of this inventory and will soon convert it into a searchable database on our Internet site (<http://ecsp.si.edu>). Countless people have contributed to this inventory and I am grateful to all the people in the U.S. government agencies and NGOs who generously gave their time to compile and summarize the information on activities their organizations undertake in China. A large portion of the more recent bilateral and multilateral entries have been made possible by Read Vanderbilt through his work in China as the Project Leader for the Project on Sino-Foreign Environmental Cooperation. Chris Adams and Justin Harris at the U.S. Embassy in Beijing and Jim Stover from EMS were also generous in sharing information for this inventory. Considerable assistance in compiling, formatting, and proofreading this information was done by Clair Twigg (Assistant Editor) and Aaron Sundsmo (Research Assistant) here at the Woodrow Wilson Center. Any updates, corrections, or inquiries regarding the inventory should be directed to me at [chinaenv@erols.com](mailto:chinaenv@erols.com).

Lastly, I would like to thank our funder, the National Oceanic and Atmospheric Administration for their support of the Working Group meetings and this publication. I began my work as Editor of the *China Environment Series* and as Coordinator of the Working Group in September 1999. I wish to thank my colleagues at the Woodrow Wilson Center and the members of the Working Group who have welcomed me with enthusiasm. I also wish to tip my hat to Aaron Frank, the first coordinator of this project, whose energy and creativity produced this dynamic discussion forum and the *China Environment Series* publication.

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# Perspectives on Global and Chinese Environment: Overview of the Harvard University Committee on Environment in China

*by Chris Nielsen*

**I**n many respects, the People's Republic of China (PRC) is following a time-honored, familiar path in its development. The primary goal of the PRC's steady and swift economic growth over the last two decades has been delivering to its people a relative prosperity that is largely defined in immediate material terms. While one may question the success of this material transformation as to its equity across the Chinese population, it is difficult to doubt its success in an aggregate, national sense.

What is familiar to observers of development including observers of now-wealthy nations like the United States is that this transformation is taking place at great cost to China's natural environment. Also familiar are most of the specific forms of China's environmental degradation. The PRC's rivers, reservoirs, and other water resources are largely fouled. Its urban air is laden with harmful particulates, gases, and toxins. Households in rural China are often choked with dangerous cookstove smoke. The PRC's solid and hazardous wastes are often dumped untreated. Serious deforestation and overuse of other natural resources have fueled economic growth, but have also diminished biodiversity and endangered many forms of wildlife.

China has a small environmental protection bureaucracy mounting ambitious policy responses to each of these and other complex challenges, but it clearly suffers from insufficient

human, technological, and budgetary resources for the tasks at hand. More problematical is the fact that its efforts are undermined by a raft of confounding societal, economic, political, and legal factors rooted far afield from mere environmental concerns, with the myriad of transitions taking place across China as a society, economy, and nation as a whole.<sup>1</sup>

While the above environmental problems and many others are severe and harmful to human and/or ecological health, it is fair to observe that nearly all nations went through, or are going through, similar environmental degradation when at economic stages like China's current one. The time-honored course of national development is to pollute at low and medium stages of economic development, and to embrace aggressive environmental protection only when a nation reaches a comparatively high economic status. While we are learning that treating environmental protection as a societal luxury good can be challenged easily on a multitude of counts, it is nevertheless an understandable national response because it approximates the course previously taken by most countries.

Instead of narrowly focusing on the rapid economic development of China and concomitant environmental problems, we should consider expanding our focus to the development of the planetary population and global environmental problems. For example the rise of an anthropogenic environmental risk on the compre-

hensive scale of global climate change. Driven by historical means of meeting the material, agricultural, and energy demands of an ever-larger global population pursuing conventional development, there is no doubt that humankind is fundamentally transforming the planetary biosphere and atmosphere.<sup>2</sup> Legitimate scientific debate continues on the precise risks these transformations will pose to human societies and to ecological systems, but the evidence continues to mount that resulting hazards might reach scales heretofore unforeseen in human history. Humankind is essentially conducting a geophysical experiment with the planet that sustains it. We possess limited means, however, to predict the results of this experiment or even to ensure that conclusive tools of prediction will be developed in time to head off what could be ahistoric human and ecological impacts. The uncertainties inherent in understanding systems as immense and complex as the human interaction with the global biogeosphere themselves counsel, at minimum, precautionary measures.

The United States is by far the leading contributor of anthropogenic gases raising the risks of climate change. China is the fast-rising, second-ranking contributor and is likely to surpass the United States in the coming decades. In raw emission terms, these two nations are linchpins to the global response to the greenhouse effect. Given the drastic economic disparities of the two countries, however, their responsibilities in this strategy are "common but differentiated" in the parlance of the United Nations Framework Convention on Climate Change (UNFCCC). "Accordingly, the developed country parties should take the lead in combating climate change and the adverse effects thereof."<sup>3</sup>

It takes little insight to recognize

that the politics—both international and domestic—of determining the practical nature of such “differentiated” responsibilities are enormous and nearly overwhelming. The Kyoto Protocol of 1997 represents a first, halting step toward defining them. Whether the Protocol will ever enter into force, dependent as it is on a U.S. Senate ratification that currently appears nowhere on the horizon, remains to be seen.

China, for its part, is meeting its lesser UNFCCC commitments and carefully playing a role of self-protection in the ongoing convention negotiating processes. Like all but a handful of developing countries, China is devoting its limited resources to what it sees as more immediate priorities, including some of its domestic environmental woes. On climate change, it is awaiting the leadership of the developed world that was laid out in principle, and subsequently ratified—including by the U.S. Senate—the original Rio agreement.<sup>4</sup>

Surmounting the political barriers to effective, precautionary, global action on climate change is an enormous policy challenge, and its confluence with bilateral Sino-American relations could prove pivotal. The short-term political impediments to the Kyoto Protocol’s entry-into-force, or its replacement with a more viable alternative, are issues that merit serious attention. For observers decrying the current inaction of the United States, the one nation that must lead the way to viable solutions by its own example, to begin with one need not be overly pessimistic. Mounting scientific evidence and pressure from more proactive allies, and perhaps from a citizenry that at least in the abstract framing of public opinion polls expresses pervasive greenhouse concern, may in time alter the American domestic political landscape now

impeding such movement.

All does not depend, however, on these eventualities. Many other strides toward politically acceptable policy solutions can and should take place. One essential step is correcting the typical myopia of viewing climate change in isolation from other environmental problems. In the Sino-American context, there is a great tendency to view the pressing domestic environmental priorities of China described at the outset of this article in opposition to the global environmental priorities described in the paragraphs immediately above. Actors on all sides often accept that a key roadblock to greenhouse headway is that there are far more pressing concerns than climate change, including other environmental ones, that face nations like China in the coming decades.

The lost opportunity of simple acceptance of this priority discordance, whether by American actors lamenting a protracted greenhouse stalemate or by Chinese viewing the climate negotiations as an attempted transfer of responsibility for a problem the West created, is gigantic. It is rooted in an overly narrow conceptualization of the issues at hand, or, in academic terms, the hazard of single-issue, single-disciplinary assessment. A refutation of this argument, moreover, does not even depend on demonstrating the prospective impacts of climatic change on China itself, as large and ultimately priority-altering as they may prove to be. This is fortunate, because local and regional impact assessment of climate change is the most imprecise component of the scientific story.

The linkage of global and local environmental issues has been highly under-emphasized in the environmental dialogue with China. One of the most vital components of China’s domestic environmental agenda, as

judged by a comparative health risk assessment, is the need to mitigate local air pollution. Addressing local air pollution can converge powerfully with a well-structured international strategy to mitigate climate change. The predominant cause of both sets of problems is the combustion of fossil and other fuels to meet energy demands. A multitude of solutions to both problems is thus coincident. In the short-run these include incremental but potent and feasible options in improved end-use and combustion energy efficiencies, and the switch to cleaner fossil fuels. In the longer term, these solutions include prospects in large-scale leapfrogging to alternative and renewable energy sources and to modes of sectoral development in which energy demand might diverge from conventional trajectories.

Asserting this confluence of problems and solutions rests on an integration of natural, medical, and applied scientific assessments. While difficult, this is in fact the more straightforward part of the analytical equation. The much tougher challenge is creating international and domestic policy mechanisms informed by this confluence that can be implemented in a cost-effective way. The international context returns one to consideration of UNFCCC processes, such as the evolution of the complex and politically sensitive “flexibility mechanisms” of the Kyoto Protocol. Connecting these to effective domestic policy in places like China is still more challenging, because of the confounding social, economic, political, and legal factors in implementation mentioned earlier in this article. The development of global environmental prescriptions unshaped by central participation of experts and policy actors from China and other developing countries is, in the end, worse than a recipe for ineffectiveness. It is a recipe for polariza-

tion. To address such complex hazards effectively, there is no choice but comprehensive analytical and international inclusion.

Ultimately, a reconciliation of global and Chinese domestic environmental priorities may be more feasible than most realize. Indeed if industrialized countries like the United States better acknowledge the unfamiliar conditions and needs of the developing world, and if nations like China respond carefully but openly, there may be opportunity for most in a well-designed, equitable greenhouse strategy. For China these prospects include real technological, financial, and expert assistance for its own domestic requirements, and avoidance of health and economic damages of the environmental mistakes of other nations. For developed nations like the United States, the opportunities include lowered costs of meeting their own “differentiated” responsibilities on climate. Perhaps most importantly for all countries, of course, the prospects also include lowered risk of direct greenhouse impacts in the future.

THE HARVARD UNIVERSITY  
COMMITTEE ON ENVIRONMENT  
CHINA PROJECT

The need to explore intellectual and policy linkages of global and local environmental degradation motivated Harvard’s university-wide Committee on Environment (UCE) in 1993 to begin building a program of Harvard-China collaborative research, the University Committee on Environment (UCE) China Project. Its central aim is to investigate a reconciliation of rising international concern about climate change with the immediate Chinese domestic concern for worsening urban and rural air pollution. The program has long-term, institutional objectives that are

related to, but distinct from, the specific topical goals described in the introductory section above. It is also driven by two aims of Harvard as a university, one internal and one external, both responding to the limi-

developed its strongest such relationships to institutes and departments of Tsinghua University, Beijing Medical University, the Academy of Social Sciences, the environment committee of the National People’s Congress,

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## The linkage of global and local environmental issues has been highly under-emphasized in the environmental dialogue with China.

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tations of narrow scholarship when assessing real-world environmental choice in an international context.

Recognizing the fundamental multidisciplinary character of environmental degradation and its solutions, the internal aim of the program pursues the mandate of Harvard President Neil Rudenstine to engage the varied schools and departments of the university in internal collaboration on environmental topics. The complex interplay of natural, applied, and medical science, economics, politics, law, culture, and ethics in the reconciliation of climate change and local and regional air pollution abatement are a natural fit for such an interdisciplinary mandate. Given our attention to these issues in a U.S.-China context, the program broadened the mandate for intellectual cross-fertilization beyond the university’s diverse network of environmental scholars, to include members of its equally expansive community of specialists in China studies.

On issues of international import, Harvard University possesses the external aim to foster external, cross-national collaboration. The program is explicitly dedicated to facilitating the confluence of Chinese and American environmental scholarship through exchange and joint research of Harvard and PRC counterparts. The UCE China Project has so far

the State Environmental Protection Administration, the Ministry of Science and Technology, and more recently, the Development Research Center of the State Council.

To date, the research has been conducted in three phases. Phase I tasked participants with taking stock of what was already understood about the general topics of interest. It consisted of exploratory review studies and preliminary analyses, which solicited contributions by open invitation to a range of faculty in the natural, applied, and medical sciences, as well as economics, business, political science, law, cultural anthropology, and history. Contributors came from Harvard, other western universities, and a variety of Chinese institutions. These first studies were published in 1998 in *Energizing China: Reconciling Environmental Protection and Economic Growth*, distributed by Harvard University Press.<sup>5</sup>

Building on these preliminary assessments, Phase II consisted of larger, externally funded, multi-year studies. Some retained a single-disciplinary thrust, strengthened by periodic research reviews by those in other fields. Others were launched with more integrated interdisciplinary aims; the three most ambitious ones were initiated as pilot studies to test their feasibility. The program is now initiating its Phase III, in which most



of the prior projects are concluding pilot or intermediate activities and will embark on new stages of research. A couple of new projects, including two major interdisciplinary ones, are also being launched. Funders of research have included the U.S. and PRC governments, multilateral agencies, and a variety of private foundations, organizations, corporations, and individuals.

Space in this article naturally does not permit full representation of each research initiative and its results. To provide a sampling of the work underway, however, we turn next to brief sketches of a number of the studies, and notes on the topics and status of the others.

#### UNIVERSITY COMMITTEE ON ENVIRONMENT CHINA PROJECT STUDIES

##### *Dynamic Economy-Energy-Environment Model*

A central effort under the program has been the development of a dynamic computable general equilibrium model of the Chinese economy.

In addition to accounting for the effects of population growth, capital accumulation, technological change, and changing patterns of demand, the model also incorporates elements of the dual nature of China's economy in which both plan and market institutions continue to exist side-by-side. The model was developed by a group of Harvard economists, led by Dale Jorgenson, with the collaboration of scholars at China's Academy of Social Sciences and the Development Research Center of the State Council.

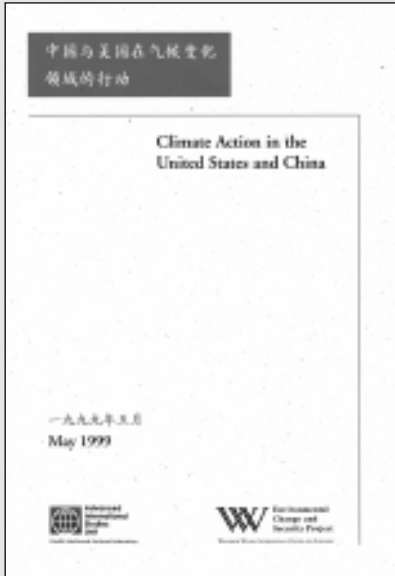
The model has been used for a number of environmental policy and economic analyses. One model explores the possible use of carbon taxes to reduce emissions of carbon dioxide in China.<sup>6</sup> The team conducted policy simulations in which carbon emissions were reduced by five, ten, and fifteen percent from their baseline. These carbon taxes were offset by reductions in enterprise taxes to maintain revenue neutrality. After initial declines, in all simulations the gross domestic product (GDP) and consumption rapidly exceeded baseline levels as the reduced enter-

prise taxes left producers with more retained earnings. Although subject to caveats, the team found evidence of a potential "double dividend," a decrease in emissions of CO<sub>2</sub> along with a long-run increase in GDP and consumption.

In a second analysis, the team also investigated why China's energy use per unit of GDP has fallen so dramatically in recent decades.<sup>7</sup> A long debate has existed in the literature over the relative roles of lower energy use in individual industries versus the sectoral reallocation of total output in this change. At the same time, concerns have been raised about the accuracy of Chinese output data. The team has developed a simple adjustment to produce more plausible output estimates, and has used the most recent input-output data to decompose the overall reduction of energy use into technology and structural changes. Despite finding a serious source of error in the data series definition, the team considers a fair conclusion to be that most of the fall in energy use during 1987-1992 was due to a fall in real energy intensity (at the two-digit industrial classification level) with changes in demand patterns contributing to a small rise in energy use. The changing composition of imports also is playing a role in this fall of energy use. Further research is needed to show if these conclusions also hold at finer levels of industrial classification.

##### *The Future of the Chinese Electric Power Sector: Implications for Emissions of Local and Regional Air Pollution and Carbon Dioxide*

This project explores the most cost-effective investment, technology, and policy choices to meet the increasing demand for electricity in China, and their resulting effects on air pollution and carbon dioxide emissions.<sup>8</sup> The study is centered on



*Climate Action in the United States and China*—Published in May 1999, this thirty-page pamphlet in English and Chinese is designed to provide objective information on climate change projects and policies in the respective countries. A joint publication of the Environmental Change and Security Project and Batelle/Pacific Northwest National Laboratory, over 3,000 copies have been distributed to a broad range of international policymakers and climate experts.

*If you would like a copy, please visit our website at <http://ecsp.si.edu/Climat-brochure> or contact ECSP at [chinaenv@erols.com](mailto:chinaenv@erols.com).*

a nonlinear optimization model that is designed with a user-friendly graphical interface and runs on a desktop or laptop computer so that the model can be readily used as a decision support tool by policymakers. Led by environmental engineer Peter Rogers, the study has incrementally refined and updated the model over several years in collaboration with colleagues at Tsinghua University and the Energy Research Institute.

The model divides China into six regions characterized by their fuel supplies and other energy resources, interregional transport and transmission capacities, current power production, and projected future electricity demands. It calculates the optimal technology mix by minimizing the total cost to meet this assumed demand for each region. The study evaluates sixteen technological options for five-year periods over twenty-five years. The latest version has added several new technologies and alternative energy sources, physical and chemical coal washing, and six new coal categories based on ash and sulfur content. The total cost being minimized includes fuel costs, transportation and transmission costs, fixed and variable operating costs, coal washing costs, and investment costs for new capacity, all discounted to the present. Outputs of the model include emissions of sulfur dioxide and carbon dioxide and deposition of sulfur. The optimization can be run with limits on any or all three of these factors, to explore implications of environmental policies on power sector development.

*The Human Dimensions of Environmental Policy Implementation: Air Quality in Rural China (the "Anqing Project")*

Balancing the macro-scale studies in the program, this ambitiously

comprehensive initiative has as its research focus environmental policy implementation and the health effects of air pollution on the community- and household-level. The study focuses on the largely rural jurisdiction of Anqing, which lies on the Yangzi River in southern Anhui province.

Working with the local Bureau of Public Health, the initiative capitalizes on a pre-existing, large-scale epidemiological survey of Anqing residents' respiratory health, including lung function, asthma, and bronchitis. The centerpiece of the study includes a new household survey of the subjects' knowledge of environmental protection, perceptions of environmental quality, sources of knowledge about the environment, methods of addressing environmental problems, as well as household energy use, economic situation, and demographics. It also adds household-level air pollution monitoring, interviews of local cadres and enterprise managers, and an archival newspaper review for gaining environmental, economic, and political background of the region.

The goal is to learn when and how local citizens become environmentally aware—especially regarding air pollution problems—and to draw appropriate lessons for policy. This roughly includes two broad topics. The first is how people get basic environmental knowledge through schools, the news media, local meetings, or personal experience, with special emphasis on actual air pollution-related respiratory health problems. The second is whether people are able to act on that knowledge through their own behavioral and economic choices or their political and legal options.

The multidisciplinary team (including public health officials, air pollution epidemiologists, political scientists, legal scholars, cultural an-

thropologists, and an economist) has completed a pilot study and is currently drafting its initial papers.<sup>9</sup> The team initiated the first full wave of field research in summer of 1999, although completion of the field research has been delayed by Yangzi flooding in the district. Under consideration for the future of the study is a comparative extension of a part of the research strategy to a more economically vibrant and urban locality in coastal China.

*The Harvard-Tsinghua Joint Working Group on the Clean Development Mechanism of the Kyoto Protocol*

The Kyoto Protocol's primary transnational policy instrument to limit greenhouse gas emissions in developing countries is the "Clean Development Mechanism" (CDM).<sup>10</sup> The CDM takes advantage of the fact that a ton of greenhouse gas (GHG) abated in China, for instance, has the same climate benefit as one saved in the United States, because the greenhouse effect takes place in the global atmospheric commons. It also seeks to capitalize on projected lower marginal costs of GHG abatement in developing economies. The structure of the CDM is not specified in the Protocol and is the subject of ongoing debate, but it is designed in principle to create incentives for firms in developed nations to invest in GHG-abating activities in developing ones. In return, through still-to-be-devised systems, abatement credits would be transferred and counted toward attainment of the firm's home country GHG commitments under the Protocol.

Bringing CDM into practical application, however, depends on overcoming a score of imposing analytical and political challenges. To date, the vast majority of CDM studies have been limited to broad theoretical surveys of issues, with little

## PECS NEWS

A tri-annual newsletter on issues of population, environmental change, and security published by the Environmental Change and Security Project.



### Featured in Issue 1:

Meeting reports: Demographic, environmental, and food security conditions in West Africa

Migration and the environment in Mexico's Calakmul Biosphere Reserve

World population trends after reaching six billion

Book review: Water and Population Dynamics: Case Studies and Policy Implications

From the Field: Details of the University of Michigan Population Fellows Programs

Project News: Information on new publications, website features, and staff activities

Each issue of the newsletter features summaries of recent meetings; a book review on a recently released publication looking at population, environment, and/or security issues; Project news items; and "lessons from the field," a section dedicated to sharing field reports from the University of Michigan Population Fellows Programs.

### Early feedback on the first issue of the *PECS News*:

"You have really put together a first-rate piece. The layout is crisp, clean, highly readable... You have a fine assortment of articles, all at just the right length for all-in-one-sitting readability. I loved the book review you solicited... it was refreshing to read a true critique, with both positive and constructive comments... I also especially liked the report highlights and project news sections—they really give the reader a sense of the breadth of your work at a glance."

*Issue 2 of PECS News was published in May 2000. If you are interested in receiving a copy, please contact the Project at [ecspwwic@wwic.si.edu](mailto:ecspwwic@wwic.si.edu) or by telephone at 202-691-4130. All issues of the newsletter are available online at <http://ecsp.si.edu/PECS-News>.*

consideration of real project conditions and site data. Following a set of preliminary papers,<sup>11</sup> an interdisciplinary Harvard-Tsinghua Joint Working Group on CDM is focusing on one cross-cutting requirement of such investments: the viability of determining acceptable emission baselines.

Baselines are the linchpin of the concept, as they are the necessary reference case against which the abatement benefits of a project are measured.<sup>12</sup> Calculating baselines, however, even on the most bounded, project-level basis, is neither a straightforward task nor one likely to yield strictly accu-

rate results. The main analytical challenge is that the baseline is generally hypothetical in nature, and some uncertainty is unavoidable. Emission reductions are intended to be additional to those that would occur in the entire economy in the absence of the project. A vexing challenge un-



der the environmental “additionality” requirement is to assess indirect emission effects of a specific CDM investment, i.e., those emissions occurring outside of the process targeted in the project.

The team, led on the Harvard side by environmental engineer Peter Rogers and international law scholar Abram Chayes, and by a diverse faculty group at Tsinghua led by Vice President He Jiankun and energy system scholar Liu Deshun, is now conducting a series of case studies of Chinese CDM opportunities. These emphasize actual field assessments in applications as diverse as electric power,<sup>13</sup> coke-making,<sup>14</sup> district heating, vehicle stocks, and renewable energy. From the completed case studies, the team’s integrative objective is to draw a neutral comparative analysis of the practical viability of baseline determination for CDM. A mid-term version of this assessment has now been drafted in support of an initiative of the Asian Development Bank.

### *Valuation of the Health Damages of Air Pollution in China*

A newer multidisciplinary project is growing out of the economic, atmospheric, and epidemiological research of several Phase II studies described above and below. Its aim is to estimate the aggregate economic value of health damages due to major forms of air pollution in China. Chinese colleagues have projected that such valuations, if they can be estimated within reasonable uncertainty bounds, could potentially have major policy influence in the PRC.

This effort, led by economist Dale Jorgenson and including Harvard public health faculty Xiping Xu and James Hammitt, and Tsinghua environmental engineer Hao Jiming, consists of four components of research in a coordinated

strategy: 1) an economics team generating economic output, energy use, and emission levels; 2) an air transport group estimating concentrations of pollutants; 3) an epidemiological team translating concentrations and exposures into health impacts; and 4) a contingent valuation group estimating the costs of such health damages in local currency, Renminbi. The team is trying to improve incrementally on the analytical components of an earlier, related assessment conducted by the World Bank.<sup>15</sup> Following a couple of exploratory pilot efforts in the study’s planning stage,<sup>16</sup> contingent valuation field surveys were started in 1999 and a modeling simplification covering the topics addressed by the air transport and epidemiological groups (2 and 3 above) is being developed for the current phase.

### *Policy and Strategy Studies on Reducing CO<sub>2</sub> and SO<sub>2</sub> Emissions in Chongqing Municipality*

This multi-component pilot project was conducted on the PRC side, with principal investigators at the State Environmental Protection Administration (SEPA), Tsinghua University, Beijing Medical University, and the Academy of Social Sciences, as well as with support from the Ministry of Science and Technology and municipal authorities in Chongqing. Harvard UCE researchers chiefly served a periodic advisory role, and facilitated a portion of the study’s funding. The lead investigators at SEPA subsequently used the results to inform a U.S. \$1 billion, low-interest loan made by Japan to reduce severe air pollution conditions in Chongqing, along with two other Chinese cities.

Based on an application of the Long-Range Energy Alternatives Planning (LEAP) model to Chongqing, the group sought strate-

gies to reduce sulfur dioxide emissions in ways that might also meet eventual pressures to limit emissions of carbon dioxide, the leading greenhouse gas.<sup>17</sup> Among the recommendations of the team’s “enhanced environment scenario” were: 1) accelerating the Sichuan Basin’s natural gas development for energy use rather than as chemical feedstocks; 2) averting all new coal-fired power plant construction by increasing the proportion of hydroelectricity, gas-fired power, and imported electricity; 3) installing fluidized gas desulfurization (FGD) on existing plants that lack them; 4) creating incentives for coal washing; and 5) capitalizing on new rail links to import higher quality coal from northwest China for small- and medium-scale enterprise use.

The team made a lengthy list of incentive-oriented policy recommendations to achieve these aims. Among them were deepening local industrial reform, notably privatizing natural gas and coal distribution, and subjecting these fuels to market pricing. To target small-scale, disaggregated users of coal, the team recommended pollution taxes based on sulfur, ash, and even carbon content. They advised giving priority on natural gas and hydropower in government energy-sector investment, customs abatement for import of clean technologies, and pass-through of FGD operational costs in electricity pricing. To target small and medium-scale enterprises, the team also proposed greater central government support for dissemination of information, technical support, and training on energy conservation. The recommendations conclude with a more general aspiration for law-based environmental oversight, and enhancement of the institutional capacities of local environmental protection bureaus for inspection and management.

### Other Studies

- **Growth of Greenhouse Gases.** Assessing the Contributions of East Asia and North America. Michael McElroy of Harvard's Earth and Planetary Sciences, chairman of the UCE China Project, has led development of a three dimensional chemical tracer model of the atmosphere to explore net contributions of a range of important greenhouse gases in East Asia and North America. This approach takes into account both anthropogenic and natural sources and sinks of GHGs. The researchers, having constructed the model, are currently analyzing mid-term results from its early runs.
- **Environmental Law Drafting in the PRC.** William Alford, Director of Harvard Law School's East Asian Legal Studies Program, is leading a study of the environmental law drafting process in China, focusing in the current phase on the air pollution law and its revisions. An anticipated law review article reporting findings of this stage of the research is now in final revisions.
- **Management Teaching Cases.** Harvard Business School researchers led by Richard Vietor have developed several teaching cases on foreign investment and trade in China, and their environmental implications. The latest case examines the efficiency gains of Honeywell digital control systems installed in a Beijing district heating system and in a petrochemical plant in Anqing, Anhui, the locality of the "Human Dimensions" study described above.<sup>18</sup>
- **Air Pollution Epidemiology.** Xiping Xu of the Harvard School of Public Health, also co-Chair of the UCE China Project, has a long-standing research program on air pollution epidemiology in China in collaboration with Beijing Medical University and others. The China Project has provided supplementary support to

several large studies investigating such relationships as the effect of particulates and sulfur dioxide on pulmonary function in Chongqing<sup>19</sup> and air pollution on daily mortality in Shenyang.<sup>20</sup>

- **The Future of the Chinese Transport Sector: Emission Implications.** Peter Rogers of Harvard and Hao Jiming and He Kebin of Tsinghua are directing a next phase of modeling research to another sector with great local, regional, and global environmental effects: transportation. The team has initiated a study with two linked components. The first investigates emissions from urban mobile sources, starting with a now-completed pilot effort to develop a spreadsheet-based vehicle pollution information system for Beijing. The second component, exploring interregional freight and passenger transport flows, will be based on and linked to the optimization model used in the China Project's power sector study described above. In subsequent work the team plans development of an optimization model that can assess an array of options in urban transport—from new technologies to traffic management strategies—subject to pollutant exposure, emission, and/or cost constraints.

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### REFERENCES

- Alford, William and Yuanyuan Shen. 1998. "Limits of the law in addressing China's Environmental Dilemma." Chapter 12 in *Energizing China: Reconciling Environmental Protection and Economic Growth*, ed. Michael B. McElroy, Michael B., Chris P. Nielsen, and Peter Lydon. Cambridge, MA: Harvard University Committee on Environment (distributed by Harvard University Press).
- Chayes, Abram, Amanda Cohen, Karen Filipovich, and Alastair Iles. 1998. "A Suggested Model for Implementing the Clean Development Mechanism." Working paper presented at the First Workshop of the Harvard—Tsinghua Joint Working Group on CDM. March 27.
- Guo Jingfei. 1998. "Financial provisions of the Clean Development Mechanism." Working paper presented at the Second Workshop of the Harvard—Tsinghua Joint Working Group on CDM. December 5-7.
- He Kebin. 1997. "Issues and proposed research activities related to AIJ/JI." Working paper for the Harvard-Tsinghua Joint Working Group on JI (now CDM).
- Jahiel, Abigail R. 1998. "The Organization of Environmental Protection in China." *The China Quarterly* 156:757-787.
- Li, Jia, Joel Schwartz, and Xiping Xu. 1998. "Health Benefits of Air Pollution Control in Shenyang, China." Draft paper.

# ENDNOTES

Li, Jingwen, Minying Yang, Feihong Gong, Ping Chen, and Haibo Liu. 1998. "Research on Countermeasure for Economy Development, Energy Consumption and SO<sub>2</sub>, CO<sub>2</sub> Mitigation in Chongqing City." June.

Lieberthal, Kenneth. 1997. "China's Governing System and its Impact on Environmental Policy Implementation." *China Environment Series* of the Environmental Change and Security Project of the Woodrow Wilson Center. Washington, DC.

Murray, Fiona E. 1996. "Environment and Technology in Investment Decision Making: Power Sector Planning in China." Ph.D. Dissertation, Division of Engineering and Applied Sciences, Harvard University.

Ni Weidou, Li Deying, and Zheng Huai. 1998. "Provincial-level Countermeasure Research for Sulfur Dioxide and Carbon Dioxide Mitigation." March.

Rogers, Peter P., Karina Funk, et al. 1998. "China's Freight Transport-Carbon Savings in Dieselization." Working paper presented at the Second Workshop of the Harvard—Tsinghua Joint Working Group on CDM. December 5-7.

Rogers, Peter P., Fiona E. Murray, Yu Changching, Guo Yuan, and Yu Xiang. 1998. "Air Pollution and CO<sub>2</sub> Control in the Power Sector in China and a Cost Analysis for CDM/JI Programs with the U.S." Working paper presented at the First Workshop of the Harvard—Tsinghua Joint Working Group on CDM. March 27.

Wang Hong. 1998. "Valuing the Health Impact of Air Pollution in Yuzhong, Chongqing." Working paper for UCE China Project.

Wang Hanchen, et al. 1998. "Policy and Strategy Studies on Reducing CO<sub>2</sub> and SO<sub>2</sub> Emissions in Chongqing Municipality." Working Paper for UCE China Project.

<sup>1</sup> See Alford 1998; Jahiel 1998; and Lieberthal 1997 for discussions of such changes in China.

<sup>2</sup> IPCC (Intergovernmental Panel on Climate Change). 1996. *Climate Change 1995-Economic and Social Dimensions of Climate Change*. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

<sup>3</sup> See Article 3.1. of UNFCCC. 1992. United Nations Framework Convention on Climate Change. International Legal Materials 31:849.

<sup>4</sup> Ibid.

<sup>5</sup> See Michael B. McElroy, Chris P. Nielsen, and Peter Lydon, eds. 1998. *Energizing China: Reconciling Environmental Protection and Economic Growth*. Cambridge, MA: Harvard University Committee on Environment. Cambridge: Harvard University Press.

<sup>6</sup> Richard Garbaccio, Mun S. Ho, and Dale W. Jorgenson. 1999a. "Controlling Carbon Emissions in China." Publication pending in *Environment and Development Economics*.

<sup>7</sup> Richard Garbaccio, Mun S. Ho, and Dale W. Jorgenson. 1999b. "Why has the Energy Output Ratio Fallen in China?" *Energy Journal* 20(3):63-91.

<sup>8</sup> Karolin Kokaz, Liu Bingjiang, and Peter P. Rogers. 1999. "Modeling Investment Strategies in China's Electric Power Sector and U.S.-China Carbon Trading." Draft paper.

<sup>9</sup> William P. Alford, Robert P. Weller, Leslyn Hall, Karen R. Polenske, Yuanyuan Shen, Binyan Wang, Xiping Xu, and David Zweig. 1999. "The Human Dimensions of Environmental Policy Implementation: Air Quality in Rural China." Draft paper.

<sup>10</sup> See Article 12 in Kyoto Protocol to the United Nations Framework Convention on Climate Change. 1997. FCCC/CP/1997/L.7/Add.1. 10 December.

<sup>11</sup> See Chayes et al. 1998; Guo 1998; Rogers et al. 1998a; Rogers et al. 1998b; and He 1997.

<sup>12</sup> Jonathan Baert Wiener, 1997. "Global Trade in Greenhouse Gas Control." *Resources* 129 (Fall):13-16.

<sup>13</sup> Liu Deshun, Ouyan Lihui, Zhang Yanlin, et al. 1998. "Case Study: The Cost and Benefit Analysis for CFBC/CHP Power Plant as AIJ Pilot Project in China." Working paper presented at the Second Workshop of the Harvard—Tsinghua Joint Working Group on CDM. December 5-7.

<sup>14</sup> Guo Jingfei. 1999. "Joint Implementation Analysis: A Case Study on the Japan-China Coke Dry Quenching (CDQ) Project." Draft paper for the Harvard—Tsinghua Joint Working Group on CDM.

<sup>15</sup> World Bank. 1997. *Clear Water, Blue Skies: China's Environment in the New Century*. Washington, DC: World Bank.

<sup>16</sup> See Wang Hong 1998; Li, Schwartz, and Xu 1998.

<sup>17</sup> See Wang Hanchen et al. 1998; Li Jingwen et al. 1998; Ni, Li, and Zheng 1998; Wang Hong 1998.

<sup>18</sup> Richard H.K. Vietor, and Julie Chow. 1998. Honeywell China. Harvard Business School case N9-798-068. Boston: Harvard Business School.

<sup>19</sup> Wang, Binyan, Zhonggui Peng, Xiaobin Zhang, Yu Xu, Hanjin Wang, George Allen, Lihua Wang, and Xiping Xu. 1999. "Particulate Matter, Sulfur Dioxide, and Pulmonary Function in Never-Smoking Adults in Chongqing, China." *International Journal of Occupational Environmental Health*, 5:1 (Jan-Mar):14-19.

<sup>20</sup> Xu Zhaoyi, Yu Daqian, Jing Libin, and Xu Xiping. 1999. "Air Pollution and Daily Mortality in Shenyang, China." *Archives of Environmental Health*.

# Transportation Infrastructure and Land Use in China

*Hu Mugin, sixty-three, was the third winner the other morning of a gleaming new \$15,000 Citroen—the top prize in the public lotteries that Beijing and many other Chinese Cities are holding all this week to raise money for victims of last years floods. “I’m so happy...I’ll give my car to my thirty-year old daughter, who is just learning to drive,” said Mr. Hu. “Everyone who comes here has just one goal, to win a car,” said Ling Xiaoping, a migrant from Southern China.*

*New York Times, 18 February 1999*

*Atlanta [Georgia, U.S.A.], 1999. Once a wilderness, it is now a thirteen-county eruption, one that has been called the fastest spreading human settlement in history...It consumes 500 acres of field and farmland every week. What it leaves behind is tract houses, access roads, strip malls, off ramps, industrial parks and billboards advertising more tract houses where the peach trees used to be.*

*Time Magazine, 22 March 1999*

*by Robert E. Paaswell, Ph.D., P.E.*

That land use and transportation are inexorably linked is well known. Less well documented is the quantifiable nature of that link.<sup>1</sup> Land use concerns the distribution of activities, while transportation is the spatial link among these activities. The transportation links are characterized by costs including travel time, trip reliability, and the price of the trip to the user. The attractiveness of the activities and the costs of gaining access to them define the transportation—land-use interaction. What seems a simple relationship, has been for planners quite complex. For example, enhancing the attractiveness of a shopping area might increase the demand for such development but it simultaneously creates a crowded area. Conversely, increasing the cost of travel might decrease the attractiveness of an important development. Motorization has a great impact on the perceived costs of travel to the traveler, as well as to the developer. These costs shape the overall accessibility, which is a concept fundamental to land-use and transportation discussions. Accessibility is the cost, usually figured as travel time, in reaching a variety of locations. The greater time it takes to reach a location, the

lower the accessibility. Accessibility to an area is increased as the number of activities increases at a given location. To translate this term into a concrete example, imagine if an individual has thirty minutes to shop and there is a choice of using public transport or a car. In a car the individual can visit more stores more quickly than on public transport. A car therefore increases the individual's accessibility to more locations.

The desire to travel quickly to many places (e.g., create greater accessibility) has shaped land-use and transportation decision-making and planning in the United States and other countries. The subsidization of housing costs combined with government subsidies for highway construction has, for example, dramatically changed the nature of American cities within two short decades. In 1940, most U.S. citizens resided in rural areas, but by the 1960s the majority of the population lived within urban areas. Since 1980, most of the urban population has moved to the suburbs with many commuting by auto to work. Households in the United States own, on average, more than one motor vehicle and in large states such as California there are actually more

motor vehicles than licensed drivers. To support these motor vehicles, the U.S. government has built more than 3.5 million miles of paved roadway—more than one paved mile per square mile of land area.<sup>2</sup> The United States started its process of motorization early in this century<sup>3</sup> and institutionalized it by establishing the federal Bureau of Public Roads to deal with roads in 1916.

Car ownership and land-use trends in other industrialized countries have replicated those in the United States. For example, in both Western Europe and Japan car ownership and miles traveled have increased at a faster rate than population growth. In Europe, growing battles are being waged over the proliferation of mega-stores in suburban and rural areas. Similar to the developments in the United States, these new mega-stores are changing the patterns of shopping from town center to peripheral shopping center. The personal automobile is also being embraced as a symbol of wealth in developing countries with rapidly growing economies such as the People's Republic of China.

While comparisons between countries are often difficult, examining the development of transportation in the United States could provide insights for countries like China that are in the earlier stages of developing this infrastructure. First, China and the United States are similar in size, but differ widely in terms of population size and concentrations. Each country has a contiguous land area of approximately 3.7 million square miles. The population of China, 1.2 billion people, is nearly five times the U.S. population of 272 million. The urbanized population of China (28.85 percent of the total population) is 346 million, which is greater than the entire population of the United States. Table 1 shows the



comparisons of several large urban areas in the United States and China and illustrates the great difference in density.

Second, the history of travel has been significantly different in the two countries. In the United States, mobility of people and the rate of trip making have always been high because of significant government infrastructure development. In contrast, prior to the economic reform era that began in 1978, mobility was not encouraged in China. In fact, Chinese citizens were required to obtain permission from their place of work to travel outside the area where they were registered. Third, and finally, there is the issue of differing levels of development of transportation infrastructure and motorization. In the United States, the preferred mode of travel has been the car and the structure of U.S. urban areas has changed significantly since 1950 to reflect these preferences. As noted, the U.S. population is predominantly suburban, but it has taken infrastructure investments over eighty years to create that situation. It is this investment which created the 833,600 miles (1,342,000 kilometers) of urban roads,<sup>4</sup> which serve an urban population of 203 million people.<sup>5</sup> In China, 65,100 miles (104,900 kilometers) of urban road serves a population of 346 million.<sup>6</sup> In the United States there are now 206 million motor vehicles (with over two-thirds in urban areas) and nearly one private car for every two persons. In China, there are over five million motor vehicles in urban areas which translates to one motor vehicle for every seventy persons. In comparing the two countries, it is important to keep these differences in mind.

This paper will discuss three general themes: (1) the transportation and land-use issues arising in major Chinese urban areas; (2) how the United States addresses land-use and

**Table 1. Population Density and Urban Population in the United States and China**

City	Population Density Persons per sq. km. (Data for built-up or central area)	Population of Urbanized Area
Beijing	13,200	10,510,000
Shanghai	20,700	12,950,000
Guangzhou	15,900	6,240,000
National Average	11,100	
New York	9,264	19,100,000
Los Angeles	843	14,621,000
Chicago	2,082	8,238,000
National Average	109	

Source for China: *China's Urban Transport Development Strategy*, S. Stares and Liu Zhi, eds., World Bank: Washington, D.C., 1996. Source for United States: R. Paaswell and J. Zupan, "Transportation Infrastructure and New York's Competitiveness," *Citizen's Budget Commission*, New York, 1999.

transportation issues; and (3) lessons learned in the United States that may be used to inform future development in China.

#### CHINA: THE INFLUENCE OF ACCESSIBILITY ON LAND USE AND TRANSPORTATION

Data from Chinese cities show that congestion has made non-motorized modes—cycling and walking—as competitive as public transport for distances under ten kilometers (six miles).<sup>7</sup> In the United States, average travel speeds by auto of 33.6 miles per hour allow the driver in eleven minutes to travel the same ten kilometers that take a Beijing resident fifty minutes.<sup>8</sup> In fifty minutes a U.S. driver can gain access to more than twenty times the activities of her Beijing cohort—or have the same number of activities dispersed over twenty times the land area. In the

United States, it is this accessibility by auto that has allowed and encouraged urban areas to become dispersed. When travel modes were slower, or more onerous, workers lived closer to their work and cities were denser and more compact. Urban cores were the heart of commercial activities. Today, with the exception of four or five cities, the concentration of activities at urban centers has decreased. More Americans commute between a suburban home and a suburban job than into the core, because the cost of travel, which includes time, reliability, convenience, and price, encourages it. Even in around New York City—world famous because of its Manhattan core of activities—more commutes are suburb to suburb than to the core.<sup>9</sup> This dispersion occurs at high cost with potentially negative impacts on economic stability and environmental quality.

Understanding causes and impact of the decreased accessibility in



**Table 2. Areas of Major Cities in China and the United States**

City	Metropolitan Area (square kilometers)	Metropolitan Area compared to New York
Beijing	16,808	.78
Shanghai	6,341	.29
Guangzhou	7,434	.34
New York	21,551	1.0
Los Angeles	87,972	4.1
Chicago	17,174	.80

Source for China: S. Staes and Liu Zhi, eds. *China's Urban Transport Development Strategy*. Washington, D.C.: World Bank, 1996. Source for United States: R. Paaswell and J. Zupan. "Transportation Infrastructure and New York's Competitiveness." *Citizen's Budget Commission*. New York, 1999.

Chinese urban areas is important for it underlines the challenges China faces in balancing land-use and transportation issues. The first fact on accessibility is that Chinese cities are already dense (see Table 1) and have, compared to the United States, slow commute times under congested conditions. Even with extremely high densities of the central cities, extremely slow travel speed decreases accessibility, which in turn impedes the economic growth potential in Chinese cities.

Second, over the last two decades, China has undergone unprecedented economic growth, which has spurred growth in urban areas. Economic reforms freed many from work in the agricultural sector and these rural people have flocked to cities to seek employment. This has resulted in a massive increase in the number of "floating" populations in the large cities.<sup>10</sup> For example, in Beijing, there are over three million floating workers—people with no permanent residence in Beijing—who must make the journey to work along with resident workers everyday. The daily influx and egress of these workers exacerbate the congestion that is already present.

Third, the success of economic reforms has led to the growth in the number of large Chinese cities, with forty cities now larger than one million people. The primary modes of transportation in Chinese cities have been biking or walking. In Beijing, these modes encompass sixty-eight percent of trips; in Shanghai, sixty percent. The average distance traveled by bicycle is 3.9 kilometers. Because of the heavy dependence on bicycles, it has been more efficient in China to locate businesses near residences or vice-versa. Not surprisingly, these highly populated Chinese cities all have land areas that are small compared to large U.S. cities (See Table 2). Accessibility linked to slow travel speeds stimulates high densities; conversely, the ability to travel much further at speeds several times higher than their Chinese cohorts has led Americans to suburbanize and develop immense amounts of land. Suburbanization in the United States has been followed by demands for more highway building, which, by decreasing travel times, has increased accessibility.

Over the past twenty years, large Chinese cities, already congested from bicycle traffic and a growing

fleet of motorized vehicles, have become even more congested. Simply stated, the accessibility within these cities has decreased considerably. Two phenomena have emerged simultaneously. The first is the growth of congestion that creates the demand for relief. Two methods used to alleviate congestion are to either improve transportation by adding more capacity or to relocate activities to less congested areas, usually in the periphery. The second phenomenon is the quest for more luxury. As workers become more affluent, they have less tolerance for inconveniences such as buses crowded at more than eight persons per square meter; bicycle collisions; and the inability to walk freely in the streets. This desire for comfort has led to a tremendous growth of the taxi industry in China with more than 400,000 now in use. Because accessibility is cost, as the affluent workforce grows, they will create more demand for transport which is less costly in terms of time and comfort, reliability, and convenience, but are financially more personally expensive.

#### TRANSPORT AND CONGESTION

A great cause of congestion in Chinese cities is the inadequate capacity of the road network. A number of reasons explain this inadequacy. First, there are, by international comparison, too few kilometers of roadway per capita. Second, these roads are used by an incompatible mix of vehicular and non-vehicular traffic.<sup>11</sup> The inadequacy of the basic infrastructure and roads makes it difficult for public transit to serve the commuters any better than walking or bicycling. In Beijing, a bicycle trip of ten kilometers takes fifty-one minutes. The same distance is covered by bus in 48-51.5 minutes.<sup>12</sup> Increased road congestion has led to declines in both bus average speeds and over-

all motor vehicle average speeds in the Chinese cities in the last decade.

Building rail transit, an extremely expensive alternative to bus transit, is unlikely to ease current patterns of urban congestion. While rail is fast, it has a limited area of coverage, unless built as a dense network as in New York, Chicago, or London. All of these systems, now over 100 years old, were built as the cities grew and not imposed on existing development. Even if rail transit had room to be constructed, the demand for street space in Chinese cities is so high and their travel needs so great, that any traffic diverted to rail would quickly be replaced by other street traffic.

Adding to the congestion is the increasing rate of motorization in Chinese cities. The annual growth of the motor vehicle fleet is over fifteen percent, while road building to accommodate this growth increases at twelve percent per year.<sup>13</sup> Trucks make up more than fifty percent of this motor fleet. These trucks serve businesses and distribute most goods because the over-taxed rail system cannot meet all the needs of moving products to market. As economic expansion continues, there will be great pressure for more trucks and for a greater reliability (e.g., just-in-time delivery) in these movements. New roads are needed to provide additional capacity for these expanded needs. With the increases in business and personally-owned motor vehicles in China there is simultaneously a great pressure on land development to decentralize and move both housing and businesses to suburban rings.

#### PLANNING IN CHINESE CITIES

Chinese cities are currently engaged in a formal planning process that should help alleviate the congestion problems discussed in the above

section. However, the growing wealth of individuals leads to an increase in demand for personal cars, which in turn creates constraints on the ability of government planners to achieve plan objectives.

Land use and transportation are issues “joined at the hip.” Yet planners have had a difficult time in constructing plans that lead to the implementation of transportation infrastructure and land development that totally complement each other. This is true in the United States, Europe, and without a shift in thinking, soon, it will be true in China. While planning in most countries starts with the establishment of long-term goals and objectives, political realities and investment needs often shift planning from these far-sighted ideals to planning and building to take care of immediate problems. Certainly, high on the list of these immediate problems in China are the growing costs of congestion, such as decreases in accessibility and declines in economic productivity as delivery of goods is slowed. It is the declining accessibility in the core of urban areas, due often to declining bus service, that leads to pressures to decentralize development. Currently, housing and businesses are rapidly moving to suburban rings outside Chinese cities. Below are several key planning objectives Chinese cities must meet to address urban congestion.

- Provide more road capacity to meet the tremendous need.
- Sustain and balance a transport system that includes bicycles as well as a growing motor vehicle fleet.
- Provide increased access to jobs and to homes (permanent or temporary). This need will often lead to finding new land on which to build.
- Decentralize activities away from

the core.

- Maintain strict zoning control over land in order to control development.

The national government in China has put in place a planning process intended to address these issues.<sup>14</sup> There remains, however, some obstacles to effectively execute these plans. For example, in urban areas, planners must deal with a number of conflicting situations simultaneously. They must address how major infrastructure improvements or land-use changes will impact current system behavior, accessibility, and the costs associated with travel. Urban planners must also examine how to make both needed capacity additions (e.g., new roadways, bus routes, and rail lines) and how to improve the capacity of the existing system (e.g., new signal controls, intersection capacity, bicycle streets, and parking controls).

At the national level, the State Council and the State Planning Commission set mandates for planning, including national economic policies and strategies. These planning mandates also may address motorization policy or conditions for new urban rail systems. These broad planning mandates are handed down to the Provincial Planning Bureaus and to the municipalities, where officials are more knowledgeable of local needs. Following the general central guidelines, concrete five-year plans are established by municipalities. The actual parameters for the plans originate from the agencies at the lowest levels—in townships and cities—and these plans work their way up to the municipal government, where balance among the various planning and implementing agencies should be found. After approval, the appropriate bureaus, in theory, carry out the plans. One significant gap in this planning process is that the central

government lacks significant financial power to impose sanctions or to create incentives to enforce these plans at the lower levels.

The planning function for public transport and road construction in Chinese urban areas falls under the auspices of the Municipal Construction Bureaus. The Municipal Bureaus of Public Security address safety and traffic control. Conflicting objectives among departments of these and other bureaus and problems of overlapping responsibility have hindered the optimal implementation of the plans. Moreover, once planning has been carried out and implementation of road and transit programs begin, there are no assurances that any coordination will take place between those bureaus responsible for street and road construction, traffic operations, transit operations, and bicycle and pedestrian circulation.

Another obstacle to effective planning is the lack of uniform regional planning in China. For example, in large municipal areas such as Shanghai and its surrounding environs, there might be a number of communities that carry out this planning process. There exists no requirement for a coordinated regional plan. This may lead to further conflict in infrastructure development and in land use. As the current momentum in Chinese cities is to add road capacity, undesired or unanticipated impacts on land, including undesired rates of decentralization, or difficult-to-support suburbanization might result. Throughout China many municipalities are now implementing road plans that impose ring roads, grid, or other road networks over the urban structure in an attempt to improve accessibility within the urban area and to stimulate motorization. These roads demand considerable land space and change the relationship between activity centers and the

roadways, much as they have in the United States. This parallel stems from the fact that the Chinese planners are borrowing pages from the U.S. practice of road building. The basic assumption is that accessibility increases will improve both the quality of urban life and the economic structure of the region. While levels of motorization are low—compared to European and U.S. levels—there might be some success in this effort. But, local planners are not having success controlling local land uses, ceding them to private economic markets, which tend to promote unregulated sprawl development outside of cities. This situation now arising in China is similar to the growth in sprawl development in the United States immediately after World War II. The United States has spent over eighty years addressing these concerns of planning and implementation; therefore, some overview of current transportation planning in the United States and its rationale will be explored below. Such experience may contain valuable lessons relevant to the development in China.

#### TRANSPORTATION AND LAND-USE POLICY IN THE UNITED STATES

The United States has evolved from a primarily rural country at the beginning of the century to a predominately urban one as we approach the year 2000. As noted above, nearly three-quarters of the U.S. population lives in urban areas, but more than one-half of this population lives in suburbs. As workers moved to the suburbs, so did their jobs, and the services that supported them. The primary commute in the United States today is single occupant vehicles travelling between suburbs instead of into the city centers. Public transit captures only four to five per-

cent of the transportation market; however, as Americans are extremely mobile, this market share is still nearly nine million trips per day.<sup>15</sup>

Over the last two decades, the impacts of motorization and suburban sprawl on the environment and on traffic congestion have become major concerns of city planners and citizens. Congestion is no longer a concern only of the peak hour commute to the city center, but an all-day concern on suburban roads that no longer have the capacity to meet the demand. Work trips, in fact, represent only eighteen percent of person trips taken and twenty-two percent of the miles traveled. Americans travel 4.2 trips per day, which is nearly double that of their Chinese urban counterpart. Americans make only six percent of their trips by walking or bicycling.

By the late 1980s, planners and government officials in the United States began to realize that the costs of suburbanization and the support infrastructure might be too great. The following list illustrates the broad range of these costly problems and provides insights for other countries such as China in the process of suburbanization.

- Suburban sprawl created housing at extremely low densities, which in turn demanded increases in road building and suburban road capacity.
- The costs of maintaining the existing transportation infrastructure were often more than could be managed by local governments. Rapid deterioration of roads and bridges occurred because of poor maintenance and high loadings—both in volume and weight. The roads had not been designed for such high loadings.
- Public transit was losing market share, which exacerbated suburb-

anization, for as transit service worsened more people in urban cores relocated to suburban areas.

- Highways built for inter-city access were becoming congested due to increased use from suburb-to-suburb travel. Moreover, the percentage of major highways with severe congestion continued to increase.
- Suburbs were being constructed without consideration of densities to support public transit and often without a concern for activity centers that could be reached on foot or by bicycle.
- The increased congestion led to sub-standard air quality in most urban areas.

In a 1991 attempt to remedy these concerns, the federal government passed the Inter-modal Surface Transportation Efficiency Act (ISTEA). In 1998, a subsequent version of this Act became law—the Transportation Efficiency Act for the Twenty-first Century (TEA21). TEA21 continues the major elements of ISTEA. Notably, these two acts reintroduced previous federal planning and road support programs. Since 1916, the U.S. federal government has traditionally provided significant capital support for highways and transit systems. Beginning in the late 1970s, the federal government also created laws and regulations that mandated a formal regional planning process. Specifically, cities were required to set up a Metropolitan Planning Organization (MPO) to carry out long-range transportation planning. Moreover, the MPO was responsible for developing an annual list of projects to be carried out to accomplish the long-range plan. This annual plan, the Transportation Improvement Program (TIP) required federal government certification and

had to meet six major planning criteria, including land-use planning. These mandated Metropolitan Planning Organizations and Transportation Improvement Programs fell into disuse in the 1980s, but with the pas-

and transportation planning mandated in the TEA21. The first factor is the fragmentation of transportation planning bodies and operating bodies throughout various local government agencies.<sup>16</sup> The second factor

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## The crucial question is whether China can avoid the kind of sprawl and environmental damage that has been created by motor vehicles in the United States.

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sage of the ISTEA and the TEA21 in the 1990s both the MPO and TIP were re-energized. TEA21 aims to ensure proper consideration of land use as transportation improvements and investments are made. For example, TEA21 demands that:

- no new capacity be developed to support single occupant vehicles;
- more powerful transit alternatives be developed;
- non-motorized vehicle alternatives must be considered;
- communities consider public transit-oriented design;
- transportation investments are to be designed to build sustainable communities; and,
- all transportation improvements must make positive improvements in air quality and relieve congestion.

To simplify program development, the federally-run TEA21 also provides flexibility by allowing funds to be shifted between highway construction and public transit projects. The ultimate success of land-use and transportation planning lies with the local-level government. However, there exist two factors that perpetuate the inability of local areas, unless they choose as part of expressed local policy, to achieve the national objectives concerning sustainable land-use

hindering sustainable transportation development is that all land use is controlled at the local level, down to the smallest town. The fact that development is often controlled by local zoning often means a community will not have to consider the impact of major development—such as a shopping plaza—on traffic generation away from the site, and certainly not on the next community.

ISTEA and TEA21 have changed transportation planning in the United States from highway-oriented to multi-modal planning. Yet, growing congestion during the period 1991-1998 have led to pressures to continue to improve roads, especially in suburban areas. In a study of U.S. urban growth patterns, Chinitz showed that no matter how much effort officials in central cities make in increasing their population, suburbs continue to grow at faster rates.<sup>17</sup> During the period between 1980-1990, the average growth in U.S. central cities was 0.64 percent while growth in suburban areas was double that rate at 1.42 percent. Sustaining this move of population to the suburbs is the continued movement of jobs to the suburbs. Three-quarters of the New York region jobs are outside the five boroughs, even though work in New York is associated with the core of Manhattan. Rail transit in New York

makes it possible to achieve employment densities in excess of 200,000 persons per square mile in the core of Manhattan, yet a sophisticated network of 37,000 miles of roadway is necessary to support travel outside the core. New York, which has developed suburban satellites, must support highway infrastructure similar to most large U.S. cities; yet, to sustain its economic vitality, city officials must support a public transit infrastructure similar to Paris, London, and Tokyo. The cost to New Yorkers for this kind of support is \$72 per year/person for highways and \$81 per person per year for transit.<sup>18</sup>

Transportation development in New York holds insights for densely populated cities such as those in China, for New York has, as have London, Tokyo, and Paris, made a commitment to sustain high densities of employment at the core. This means that primary jobs and services to support the jobs (e.g., financial and legal) and workers (e.g., food, drug-gists, personal care shops, and gyms) must also be located in the core. Public transit, walking, and telecommuting represent options to deliver people to primary jobs and support services. This dependence on public transport and walking underlines the continued need for high density development in urban areas.

#### ACTIONS TO SLOW SPRAWL

In suburban areas workers face challenges of sprawl and more trips in the auto than their urban counterparts. Many communities in the United States, TEA21 notwithstanding, do not know how to cope with sprawl or are unwilling to address the issues of sprawl. In some progressive areas, however, actions to address the inefficiencies of land use and the environmental impacts of high levels of

auto use are being taken. In MPOs in California these planning bodies are charged with making transportation investments and land use development compatible. In Portland, Oregon, the MPO has the responsibility to insure that its transportation plans are compatible with its long-range growth plans. Portland also encourages in-fill, namely, building in denser areas of the urban core that are abandoned or unused. Growth limits create demands for smaller amounts of available land. Zoning at higher densities, however, must accompany these limits and transit must be put in place to support the higher densities. The decision of families to move to a higher density area means more trips can be satisfied without a car, and in ideal circumstances, household purchases of additional cars are delayed or put off altogether.

A recent and promising aggressive approach to address land use through transportation has occurred in Atlanta, Georgia where a regional transportation agency has been established by the state government to mitigate the urban-suburban problem of sprawl-related congestion. This agency has the power to deny infrastructure connections to new developments, to plan and build rail transit and bus lanes, and withhold local funding unless projects get appropriate approvals and meet congestion and air quality requirements. Despite the potential benefits, such state-wide initiatives are still few in the United States. Data suggest the traditional patterns of suburbanization are continuing, but in response to congestion and poor land use the national and local governments are taking actions to slow sprawl. Incentives and new services to relieve congestion are outlined below.

- Transit-oriented design. Suburban communities and activity

centers are built at densities that support transit between activity centers and walking within activity centers. Transit-oriented design can also be part of less dense urban areas. Here employment and residential areas can be mixed, access to transit can be made more direct, and corridors can be developed that support busways or light rail. In suburban transit-oriented design, the ability to do personal tasks, such as shopping, by walking in the neighborhood of the work site encourages transit use.

- Improved access to commuter rail. Local areas are being encouraged to provide bike access to commuter rail, as well as better transit access and park-and-ride facilities.
- Value-pricing. While not getting rid of the car, peak-period or demand-based pricing on highways can be used to mitigate congestion or stimulate mode switches.
- Reduced parking standards. Parking standards should be reduced in high-density areas in order to discourage car use. Parking should be priced to discourage using cars in congested urban areas.<sup>19</sup>
- Financial incentives. Subsidies to discourage private auto driving include transit passes or fare subsidies and ridesharing subsidies.
- Sustainable zoning. Zoning should be developed that examines land use and transportation simultaneously. For a proposed transit corridor, minimum density standards and mixed land uses could be specified.

These are just some of the initiatives being examined in the United States as planners begin to gain some control over land use, using transportation investment as the stimulus. The



pricing and zoning criteria work best in a community predisposed to put high values on environment and a quality of life based upon environmental considerations.

## LESSONS LEARNED

The Chinese government is now investing heavily in motorization, particularly the building of highways to support the growing fleet of cars and trucks. In light of this policy priority, the crucial question is whether China can avoid the kind of sprawl and environmental damage that has been created by motor vehicles in the United States. Through trial and error, planners in the United States have learned some lessons on how to prevent and correct such problems. These institutional and technical actions outlined below may contain some insight for land-use and transportation planning in China. These points are then followed by a brief discussion of factors that potentially hinder the transferability of these lessons learned in the United States.

**Institutional actions.** There are two major institutional actions that can potentially be transferred from the United States to China: regional coordination and funding capability.

1. The first institutional action deals with overall regional coordination. In the United States, urban regions must establish Metropolitan Planning Organizations (MPO). These organizations cut across all local governments and agencies providing transportation within an urban area. The MPO demands coordination among these agencies as one of the basic tenets of planning. It also requires that regional projects be coordinated with

long-term regional objectives—including land-use and environmental objectives. Thus, a suburban government must coordinate road or transit projects with other suburbs and the major central city they serve. Such an organization would provide for more efficiency of project planning and implementation, plus address impacts of motorization and suburbanization within the context of a regional growth strategy.

2. The second institutional action encompasses institutional funding capability. The U.S. federal government provides a significant share of capital funding for urban highway and transit projects. Knowing the projected levels of financial support allows for a continuity of planning and enables state and county governments to set planning targets to available resources. In China, local areas, after they get the “green light” to build, must raise the currency themselves—often in competition with other regional projects. By keeping funding—although the major concern—aloof from the regional planning process, projects can be developed as part of regional systems, to which they eventually will belong. A project-by-project basis leads to competition among development sites and competition between road and transit. We have learned in the United States that this is not the most effective way to plan. One source of funding at the national government level can be an infrastructure bank. Here capital can be given as loans to be repaid. Repayment would come from economic value added to the region based on the infrastructure investment.

**Technical actions.** These actions, which include aspects of design as well as implementation, address the types of facilities that could be created in China.

1. Transit-oriented design. The push for motorization is creating a demand for suburbanization in Chinese urban areas that will only grow with time. However, many mitigating designs can be applied in China. One is to make more extensive use of buses and bus connections through exclusive bus streets and busways. As new highways are built, bus lanes should be added, insuring that rapid transit access will follow communities designed for motor car access. To maximize use of busways, suburban communities should be designed at moderate densities, linked to activity centers easily reached by foot or bicycle. Transit terminals and transfer stations should be part of new community design.
2. Rail transit. Activities along rail corridors should be carefully planned. Rail provides high accessibility and affords the opportunity to cluster the highest densities near the stations. A variety of land uses can be integrated with the stations, including housing development. Access to a rail line by foot will keep both bicycles and motor vehicles off the road and will not add to poor air quality. It must be noted that while rail adds accessibility it does not reduce congestion.
3. Parking policies. Street space is a very valuable commodity and in American cities planners have learned how limiting spaces and increasing prices can discourage auto use. However, when auto use is restricted, adequate public

transit, including available taxis, must be provided. The auto user will look for a higher quality substitute for the current crowded buses. Rethinking the quality of public transit, an exercise now taking place in the United States, would be appropriate as a planning strategy to accompany new road construction. See Tilly Chang's article in this publication for current experimentation with public transit reforms in China.

4. Pricing. Road pricing has been, to date, very unpopular in the United States, but it can be used to differentiate among classes of vehicles and system use over selected periods of time. Correct pricing is a powerful tool and one that will become a standard part of regulating motor vehicles.

In addition to challenges in the existing urban infrastructure, there are financial and political factors that also potentially hinder the application of the above strategies in China. In terms of infrastructure, Chinese cities are much denser than those in the United States—only New York is comparable to the density of large Chinese cities. These densities in Chinese cities—which have historically occurred because work and travel were close together—pose challenges to incorporating new rail transit systems. This dense pattern of urban development has created broad networks of very small streets with only a small amount of roadway suitable for motor vehicles. Another complication for planners is that with the exception of the ring roads, most urban streets have to contend with mixes of motorized and non-motorized travel, which creates the worst of conditions for both types of travel. The speed at which ringroads and suburbs are expanding outside of cities also challenges Chinese planners

in designing transit and parking infrastructure.

Although Chinese planners are well trained and foreign experts are often brought in to provide advice, it is often the hindrances created by local governments that obstruct efficient execution of land-use and transportation plans. The decentralization of financial and administrative authority over the past twenty years in China has decreased the incentives for local governments to cooperate in regional planning issues. The central and provincial governments have lowered subsidies to local governments, which has reduced a key means to leverage cooperation from lower levels.

While the United States may provide useful lessons for Chinese planners, it is possible that the successful land-use and transportation development in Hong Kong could also be a valuable and more accessible model. The Hong Kong Regional government has been aggressive in pushing a balance between development and transportation infrastructure. Their main strategy has been to make the region attractive for development and push developers to finance infrastructure. For example, to accommodate the growing population they have planned new cities that will be located at new stops on a developing commuter rail line in the New Territories. This integrated planning will minimize the need for cars and maximize accessibility to the employment centers. There are conferences on development, environment, and infrastructure sponsored at the highest government levels in Hong Kong and such conferences could be repeated in dynamic growing cities in Mainland China such as Shanghai and Shenyang.

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### ENDNOTES

<sup>1</sup>A recent study provided an attempt to quantify some aspects of accessibility with land use and density. See Shunk, G. et al., *Land Use Modeling Conference Proceedings, Final Report*, United States Department of Transportation, DOT-T-96-09, Washington, D.C., February 1995.

<sup>2</sup> With the exception of Alaska and Hawaii.

<sup>3</sup>The U.S. Congress started formal support of the roads program as early as 1916 when it created the Bureau of Public Roads. Shortly thereafter (1918-1921) it began funding roads throughout the United States and required each state to begin a Department of Highways to receive and allocate funds. These programs, albeit in altered form are still in place today.

<sup>4</sup>"*Highway Statistics 1996*," U.S. Department of Transportation, FHWA-PL-98-003, 1998

<sup>5</sup>"Statistical Abstract of the United States, 1994." U.S. Department of Commerce, Bureau of the Census, 1994.

<sup>6</sup>Zhou Ganshi, "Urban Transport Problems in Chinese Cities," in *China's Urban Transport Development Strategy*, S. Staes and Liu Zhi, eds., Washington, D.C.: World Bank, 1996.

<sup>7</sup>A. Wellman, C. Louiss, and D. Ligtermoet, "Bicycles in Cities," in *China's Urban Transport Development Strategy*, S. Staes and Liu Zhi, eds., Washington, D.C.: World Bank, 1996.

<sup>8</sup>United States Department of Transportation, *Our Nation's Travel: 1995*

*NPTS Early Results*, 1997.

<sup>9</sup>R. Paaswell and J. Zupan, *Transportation Infrastructure and New York's Competitiveness*, Citizen's Budget Commission, New York, 1999.

<sup>10</sup>L. Xiaojiang and Yu Li, "Land Use and Transport Planning in China," in *China's Urban Transport Development Strategy*, S. Stares and Liu Zhi, eds., World Bank, Washington, D.C., 1996.

<sup>11</sup>R. Paaswell, *Transport Issues: Beijing, Shanghai, Shenyang*, University Transportation Center, University of Illinois, Chicago, 1986.

<sup>12</sup>A. Wellman, C. Louiss and D. Ligtermoet, "Bicycles in Cities," in *China's Urban Transport Development Strategy*, S. Stares and Liu Zhi, eds., World Bank, Washington, D.C., 1996.

<sup>13</sup>Zhou Ganshi, "Urban Transport Problems in Chinese Cities," in *China's Urban Transport Development Strategy*, S. Stares and Liu Zhi, eds., World Bank, Washington, D.C., 1996.

<sup>14</sup>L. Xiaojiang and Yu Li, "Land Use and Transport Planning in China," in

*China's Urban Transport Development Strategy*, S. Stares and Liu Zhi, eds., World Bank, Washington, D.C., 1996. In addition, the author had a number of discussions with Eva Lerner-Lam, who provided great insight into the planning process.

<sup>15</sup>Travel times to work on these commutes, driving at thirty miles per hour, average less than twenty-five minutes, with longer commutes in the largest urban areas. For example, travel time in New York averages more than thirty minutes.

<sup>16</sup>New York City (e.g., the five Boroughs) provides a classic example of this fragmentation of authority in that local roads are the concern of the City Department of Transportation while major roads are under the State Department of Planning. Although the responsibility for transport services falls under the jurisdiction of the Metropolitan Transit Authority (MTA) the management for different areas of transport are separated into different units. For example, under the MTA the NYC Transit operates the subways

and buses while the commuter rail is managed by the Long Island Railroad. The bridges and tunnels are under separate authorities and each possesses the power to set tolls. Lastly, it is the Police Department that oversees adherence to traffic laws. Coordinating land-use and transportation planning among all of these agencies is a challenging task.

<sup>17</sup>B. Chinitz, "Urban Growth Patterns," in *The Land Use, Transportation, Air Quality Connection. Resource Manual*, Lincoln Institute of Land Policy, Cambridge, MA, 1994.

<sup>18</sup>R. Paaswell and J. Zupan, "Transportation Infrastructure and New York's Competitiveness", Citizen's Budget Commission, New York, 1999.

<sup>19</sup>Both of these strategies—value pricing and parking pricing—illustrate that pricing can be an incentive influencing mode choice.

## CHINABRIEF

The publication *Chinabrief* was founded in 1996 and its goal is to improve information flows to and between international agencies funding or implementing development projects in China, with particular emphasis on the work of nongovernmental organizations. The *Chinabrief* aims to share this information with Chinese government agencies and non-profit organizations, as well as promote the development of a more independent communications culture in China. Issues of *Chinabrief* (zhongguo fazhan jianbao) are twin publications in English and Chinese, reporting from Mainland China on international aid to the country—international aid to China currently totals U.S. \$5 billion per annum. The publications include regular coverage of environmental projects, with an emphasis on sustainable community development and rural livelihoods. Examples of specific publications include:

- A thirty-six page, quarterly English language publication containing sectoral analyses, project digests, news, and features covering social development, rural development, poverty alleviation, and environmental protection projects in China
- A sixteen page, quarterly Chinese language companion to each English edition, distributed free on request to mainland Chinese organizations. This contains original articles and information, tailored to the information needs of a Chinese readership.
- A *Directory of International NGOs Supporting Work in China* was compiled and published October 1999.

The founder of *Chinabrief*, Nick Young, has lived in China since 1996, having previously worked in Latin America and Africa for a variety of internationally recognized media, including *The Scotsman*, *The Financial Times*, *The Economist*, and BBC World Service. There are currently three Chinese and one other international member on the *Chinabrief* staff. Subscription sales and grants from ActionAid India, Kadoorie Charitable Foundations, the Ford Foundation, Save the Children (UK) and the Trace Foundation support *Chinabrief*.

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# A New Era for Public Transport Development in China

by D. Tilly Chang

The urbanization and motorization which fueled China's economic growth since the mid-1980s brought unprecedented demand for land, road space, and other urban infrastructure and services. As China's cities were being positioned as the new engines of growth, transport development between and within urban areas received high national priority. Government resources at state, provincial, and local levels focused on increasing infrastructure capacity and on expressways in particular, while industrial policy nurtured the nascent automotive industry. Some early policy and investment support was directed at public transport; however, these efforts were not deep enough to address structural weaknesses in management and operations. Thus, transit development lagged behind the growing demand for, and supply of, private modes of transport as China's economy boomed. As a result, traditional public transport services—mainly large buses—suffered significant ridership losses in the late 1980s and early 1990s.

This article surveys China's public transport experience over the past decade and a half, as China's environmental, energy, and economic development objectives have come into sharper focus. While the earlier industrial policy commitment to the "household car" has not been abandoned, there is growing recognition in cities that, even if private vehicle ownership is encouraged, this must be accompanied by prudent policies curtailing auto use. Moreover, the need to develop suitable alternatives to private auto travel motivates re-

newed interest in raising the efficiency, quality, and quantity of public transport services in urban areas.

## POLICY EVOLUTION

In the mid-1980s, the government of China established a policy that public transport should be the dominant mode of urban passenger transport in urban areas.<sup>1</sup> The policy emphasized development of public transport systems and containment of the growth of privately-owned vehicles. For large cities, this included support for the gradual development of rail transit. The need for continuation of such a policy is reflected in the words of one Chinese scholar: "Rapid rail transit with large capacities (including metro) must be put into our agenda for development and constructed with careful planning to meet the needs of large traffic flows."<sup>2</sup>

Due to the large capital investment and foreign exchange required, however, authorities at the State Planning Commission responsible for macro-economic investment were cautious about approving rail transit projects in all but the largest cities. Today, metros only operate in four cities: Beijing (43.5 km), Tianjin (7.4 km), Shanghai (16.1 km), and most recently in Guangzhou where the 18.5 kilometer Line 1 was open for full service in 1999. Light rail or trams built pre-liberalization (e.g., before economic reforms were initiated in 1978) operate in Changchun, Dalian, and Anshan. For most cities, however, regular gasoline and diesel-engine buses and mini-buses and electric trolley-buses remain the domi-

nant form of public transport in China.

Among its top priorities, the Chinese government investment in the transport sector was heavily targeted toward development of the nation's trunk highway system and other transport infrastructure. In urban areas, construction programs supported Master Plans which typically called for development of Beijing-style urban "ring roads." Public transit programs provided investment in vehicles to open new routes. For example, from 1985 to 1995, standard bus equivalent operating units nearly doubled and total route length increased eighty-nine percent. However, due to a variety of factors, this investment was met with disappointing results, as public transport ridership grew by only nine percent over the same period.<sup>3</sup>

As Figure 1 shows (next page), though route length and vehicles increased and vehicle load factors decreased slightly (implying service improvements), passenger density fell between 1985-1995 in China, in part reflecting broader service coverage but also anemic ridership growth.<sup>4</sup> Meanwhile, the growth of premium modes such as taxis and mini-buses exploded and traditional bus transit mode share steadily lost ground, with absolute ridership losses occurring in some cities.

## TRENDS AFFECTING PUBLIC TRANSPORT

Several factors contributed to the gradual decline of China's traditional, state-owned public transport companies starting around the mid-1980s. Primary among them was the rising demand for private passenger transport and premium public transport modes, made possible by rapid economic growth and wealth creation following economic liberalization. By

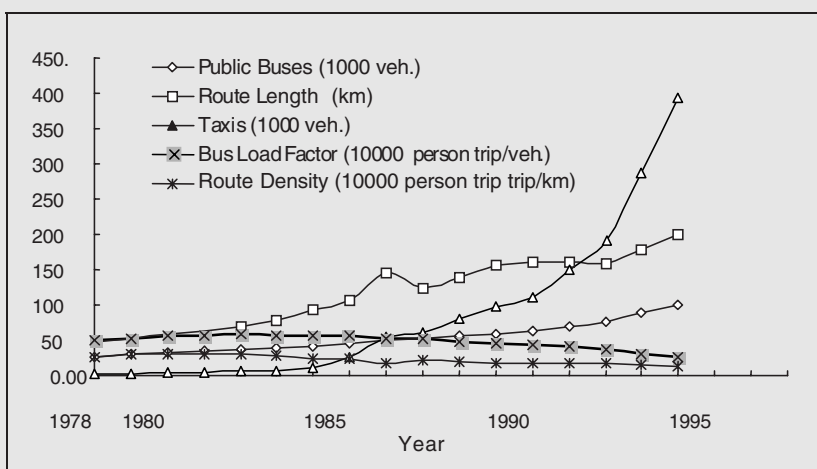


the end of “the Eighth- Five Year Plan” (1991-1995), China’s minibus and taxi industries had grown from insignificant numbers to fleets of approximately 100,000 minibuses and 585,000 taxis.<sup>5</sup> During this time, central government authorities were also eager to develop the domestic automotive industry as a means to exploit the forward and backward economic linkages of motorization. In 1994, the central government promulgated industrial policy establishing the automotive industry as a “pillar industry.” Moreover, officials at the State Planning Commission began to promote the notion of the “household car.”<sup>6</sup>

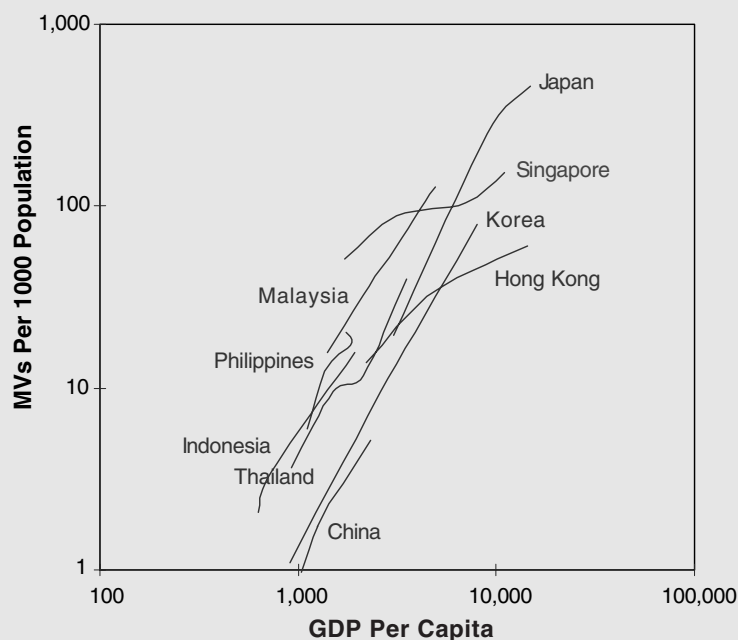
Although China is in the early stages of motorization (see Figure 2), the growth of motor vehicle ownership and use has the potential to create massive problems in urban areas.<sup>7</sup> Nation wide, passenger vehicle growth rates averaged eighteen percent per annum between 1985-1995. By 1995, motor vehicle ownership had reached ten vehicles per 1000 population, every two of which was a passenger car. The national average of two vehicles per thousand belies the high concentration of car ownership in urban areas. Of the 600 or so cities in China, thirty-four cities account for fifty percent of the national ownership of motor vehicles.<sup>8</sup>

Prior to motorization, buses carried about a third of all trips in most cities, with bicycles and walking comprising the balance. With more vehicles on the road, poor traffic management, and little protection from congestion in the form of priority treatments, bus speeds fell. Inadequate service coverage, low route efficiency, vehicle breakdowns, and poor passenger facilities worsened service levels and added to travel times. As a result, traditional bus services became very unattractive. For cities with a population of one mil-

**Figure 1. China Public Transport Trends**



**Figure 2. Motorization In Asia (1960-1990)**



lion or greater, it is estimated that public transport journey times averaged almost twice (fifty minutes) the average for all other modes (twenty to thirty minutes) in 1995.<sup>9</sup>

Unsurprisingly, bus riders left for other modes. Those able to afford and willing to pay for premium modes chose motorcycles, minibuses, and taxis; while others shifted back to bicycles—especially lower-income passengers—as bicycles began to offer

competitive door-to-door journey times compared with old, slow buses, which required too many transfers, long waits, and inconvenient stop locations.

Thus, despite stated government policy support for public transport backed by some investment in vehicles and services, the effectiveness of increased capacity in public transport was eroded by a decrease in public transport efficiency and quality of



services, relative to other modes. Table 3 shows the mode shifts over time for Shanghai (urban population 12 million) and Shijiazhuang, the capital city of Hebei Province (urban population 1.5 million) over this period.<sup>10</sup> Note that transit appears to lose mode share to bicycles and autos in Shanghai, and to other motorized modes in Shijiazhuang.

Ridership loss created a revenue crisis for many public transport operators who were already experiencing cost shocks as price controls for certain inputs were lifted with the transition to a market economy. Constrained by employment policies protecting labor, management tended to look to lower fuel quality or deferred maintenance for cost savings. These measures, at times instituted in combination with fare increases, caused many transit enterprises to enter the classic “vicious cycle” whereby loss of ridership and revenue fed on themselves, leading to the steady decline of public transport.

#### PUBLIC TRANSPORT ENTERPRISE REFORM

During the early 1990s, China was tackling hyperinflation in the

economy and managed to achieve a “soft-landing” following the imposition of economic austerity measures. These measures included restriction of government investment only to those projects warranting the highest priority. As a result, in late 1995, China’s State Council issued orders to shut down subway and light rail projects in Qingdao, Nanjing, Shenyang, and Tianjin, as well as put on hold the applications from seventeen other cities.<sup>11</sup>

Policy attention in the public transport sector therefore concentrated on reform of public transport enterprises. This policy shift was consistent with general state-owned enterprise (SOE) reform, but was mainly instituted as a matter of fiscal and transport policy. China’s municipal coffers were hemorrhaging from the provision of large and growing operating subsidies to transit. By 1994, operating losses in urban public transport totaled Y1.0 billion (1 Yuan = U.S. \$8.50 in 1994) and total government assistance to public transport reached Y2.9 billion nationally.<sup>12</sup>

As with reform of SOEs in other sectors, corporatization emerged as a major strategy to commercialize bus operations, manage subsidy relation-

ships with government, and attract private investment. In parallel, under the principle of “comprehensive planning, unified management, and coordinated development” (*zonghe jihua, tongyi guanli, xietiao fazhan*), fair and reasonable competition was declared beneficial to the development of public transport. As a result, supply of municipal transport services was liberalized to expose bus companies to competition from other modes, primarily mini-buses and taxis.<sup>13</sup> However, lack of experience with economic regulation would hamper realization of a “level playing field” within public transport and among urban transport modes in general.

Various reform models exist in China, ranging from less to more aggressive deregulation of the public transport sector.<sup>14</sup> The most common arrangement is the “three-tiered contract responsibility system,” (*sanji zeren xitong*) which sets performance targets for each layer of the organization (company, sub-company, and vehicle team). In Shanghai, there has been deregulation of the municipal bus company with the result that operating companies are much more independent and actually compete for operating concessions as they come

**Figure 3. Transit Mode Share Loss in Shanghai and Shijiazhuang**

	Shanghai	Shanghai	Shijiazhuang	Shijiazhuang
Year	1986	1995	1986	1998
Non-motorized	73%	78%	92%	88%
Walk	41%	33%	34%	34%
Bicycle	31%	45%	58%	54%
Motorized	27%	22%	8%	13%
Auto/Motorcycles	3%	7%	2%	5%
Taxi				2%
Company Car			1%	2%
Transit	24%	15%	5%	3%
Other				2%
Total	100%	100%	100%	101%

up for tender. In addition, in Shanghai and Guangzhou, the public transport companies exhibit diversified ownership arrangements. For example, in Shanghai the Pudong Bus Company—one of the thirteen new companies established after deregulation—is a joint-stock company. Five joint-venture companies have been operating in Guangzhou since 1994.

Municipalities are also engaging various forms of concessioning in an effort to manage subsidies and expand services with minimum public finance. Examples include “joint-operations” arrangements, as found in Shijiazhuang (Hebei Province) in which the municipal public transport company (PTC) contracts with former staff to lease and operate its vehicles on a three-year net-cost basis. Also, in Shenyang (Liaoning Province), the PTC contracts with owner-operators and transport enterprises for public transport services to supplement its own services. In the Liaoning cities of Anshan and Fushun, these strategies are employed in combination with negotiated concessions for scheduled, route-based premium bus services involving private Hong Kong-based operators. Route-based concessions are also being implemented in Beijing and Shenzhen. Finally, as mentioned above, Shanghai has been the most aggressive in terms of deregulating the public transport industry and establishing competitive tender of operating rights for new routes and services.

These reforms are already yielding benefits to municipalities in terms of reducing public operating subsidies and to public transport users in the form of more and better public transport choices. The promise of reform is the redirection of public investment to public transport infrastructure such as passenger terminals, bus priority measures, and fixed rail transit, with the goal of increasing the

number of attractive choices for users. The private sector can participate in this arena as well, and not only in the fixed-rail market. For example,

tate various policy-based user charges. It remains to be seen how this tax is to be implemented, especially in urban areas.<sup>15</sup> Bus transit is at the fore-

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## **Although China is in the early stages of motorization, the growth of motor vehicle ownership and use has the potential to create massive problems in urban areas.**

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Beijing Public Transport Company is actively studying joint development of bus terminals in the city center area with the private sector.

### **A NEW ERA FOR PUBLIC TRANSPORT**

China has twenty cities with a population exceeding five million, creating a huge demand for efficient transport networks. In recognition of the need to manage this demand well, many medium-sized and large cities are leading in the adoption and implementation of urban transport policies favoring public transport. Examples include the auction of motorcycle and car licenses in Shanghai, minibus controls in Beijing and Shenzhen, and the establishment of bus priority measures in Kunming, Shenyang, and Beijing.

National policy emphasizing sustainable development is also causing public transport to be viewed not only as an important strategy for efficient urban transport but also for environmental protection. Broader efforts to target mobile-source air pollution in China include: the removal of lead from fuel; conversion to cleaner fuels (pilots are on-going in ten cities); and—though not directly passed to meet environmental objectives—a recent amendment to the national Highway Law authorizing the levy of a motor fuel tax which could facili-

front of current pilots in natural gas, as companies experiment with dual-mode and natural gas (CNG)-powered engines. Electric-powered trolley buses are already in operation, and central government agencies, such as the State Science and Technology Commission, are sponsoring research and development of electric fuel-cell powered vehicles.<sup>16</sup>

Very recently, China lifted the moratorium on rail projects and began approving more subway projects to support urban infrastructure construction. In March 1999, China's State Council approved the first phase of the Shenzhen metro project and revived the Nanjing light rail project begun earlier. Approvals for work to begin on subway systems in Chongqing, and to resume studies in Qingdao and Shenyang quickly followed. Several other cities have already submitted applications to the State Development Planning Commission for new rail lines. The length of the proposed subway lines totals 430 kilometers, with investment estimated at 140 billion yuan (U.S. \$16.8 billion).<sup>17</sup> However, prerequisites for approval—including demonstration of adequate financing—will likely temper the pace of additional new projects going forward in the near future.


Despite these new and encouraging developments, China faces a number of challenges if public trans-

port, and mass transit in particular, is to play a significant role in cities on a sustainable basis. Chief among these is the fragmented nature of policy and institutional capacity in the urban transport sector. Responsibility for policymaking, planning, and finance of urban transport (and especially public transport) is highly decentralized to the cities, where institutions mirror the stove-pipe structure found in central government. Within most cities in China there are several agencies with an interest in urban transport planning and operation. The most significant agency is the urban construction commission that is responsible for construction and maintenance of transportation infrastructure. Organized beneath

this commission are usually found the public utilities commission—responsible for public transport provision and regulation—and the transport department—responsible for motor vehicle licensing, including long-distance buses. Municipal planning bureaus are responsible for Master Plans; the public security department work encompasses traffic management and enforcement, and the environment bureau regulates and monitors vehicle emission controls. Lastly, regulating user charges such as bus and taxi fares falls under the jurisdiction of the municipal price bureaus.

This fragmentation of authority limits the ability of local governments to effectively promote a high degree of coordination among policies, plan-

ning, finance, and traffic management activities. For example, at the operational level, implementation of bus priority measures on a wide-scale requires better technical coordination among public transport operators, city engineering design units, and traffic police. Also, while institutional mechanisms for the coordination of urban land use and transportation development exist through the “master planning” process, the relationship between these two systems is not well understood. Consequently, while cities are improving their ability to do route and service planning, coverage is not keeping pace with city development. This reflects several factors having to do with the need to coordinate better land-use and transpor-




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tation planning, (de)-regulation of peri-urban transport services, and relative inexperience with complex user charge and cross-subsidy arrangements that can be critical to financing arrangements for new infrastructure and services.

Indeed, financing is perhaps the most difficult aspect of public transport development for city officials. Although rail transit is popular and becoming a reality in some larger cities, bus transit will remain the mainstay of the public transport system for most Chinese cities. In both cases, if the public transport system is not well managed and structured, capital and ongoing costs can potentially bleed a city of resources. Viable fares and an appropriate regulatory framework for private participation are essential to the provision of sustainable finance for the sector. Fortunately, the decentralized nature of urban management is breeding innovation—especially among the more affluent and sophisticated coastal cities as mentioned above—which is being modeled in other cities. Through these incremental initiatives, it can be observed that public transport reform is liberalizing the provision of transit services across China, albeit slowly. These efforts, together with the promotion of increased competition and the capacity to regulate it, are the challenges of the coming era.

## CONCLUSION

It will take time for China to navigate the all-too-common pitfalls of motorization and urban development. Facing a number of strategic choices, China is confronting dilemmas that have plagued many countries before it, though with the added complexities of its huge population and the transition to a market economy. Yet, as reforms take hold

and efficient urban transport increasingly is increasingly recognized as critical to sustaining the productivity and quality of life in urban areas, support for public transport is growing. Advances in enterprise reform, decentralization, and finance suggest that China's public transport sector is on the precipice of a new era.

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All views, findings, interpretations, and conclusions expressed in this article are entirely those of the author and should not be attributed in any way to the World Bank, its affiliated organizations, members of the Board of Executive Directors, or the countries they represent.

## ENDNOTES

<sup>1</sup> State Council Document No. 59 of 1985; 1985 Blue Book of Technology Policy; Sector Policy, 1989.

<sup>2</sup> Wang Jingxia, et al., "Theme Paper 7: Reform and Development of China's Urban Public Transport Enterprises," in *China's Urban Transport Development Strategy*, ed. Stares and Zhi, World Bank Discussion Paper No. 352, Washington, D.C. (1996) 314.

<sup>3</sup> Ibid.

<sup>4</sup> Zhao Boping et al. "Prospect and Characteristics of Urban Public Transport in China," in *Proceedings of ASCE 1<sup>st</sup> International Conference on Public Transport*, 2000.

<sup>5</sup> Ibid.

<sup>6</sup> Technical and Economic Institute of the State Planning Commission, "The Development Strategy for Cars to be Used by Households in China," *Economic Daily*, October 24, 1994.

<sup>7</sup> Stephen Stares and Liu Zhi, "Theme Paper 1: Motorization in Chinese Cities:

Issues and Actions," in *China's Urban Transport Development Strategy*, ed. Stares and Zhi, World Bank Discussion Paper No. 352, Washington, D.C. (1996).

<sup>8</sup> Zhao, "Prospect and Characteristics of Urban Public Transport in China."

<sup>9</sup> Ibid.

<sup>10</sup> Eric Ho, et. al., "Socioeconomic, Land Use and Travel Patterns of Shanghai," in *Proceedings of ASCE 1<sup>st</sup> International Conference on Public Transport*, 2000.

<sup>11</sup> Patrick Tyler, "China's Transport Gridlock: Cars vs. Mass Transit," *New York Times*, May 4, 1996.

<sup>12</sup> Wang, "Theme Paper 7: Reform and Development of China's Urban Public Transport Enterprises," 329.

<sup>13</sup> Ibid.

<sup>14</sup> See also Tilly D. Chang and Zong, Yan, "Public Transport Reform and Development in China: World Bank Experience and Perspective," in *Proceedings of ASCE 1<sup>st</sup> International Conference on Public Transport*, 2000.

<sup>15</sup> Ian Johnson, "China Eliminates Most Toll Roads, Choosing Gas Tax to Fight Debts," *Wall Street Journal*, November 2, 1999.

<sup>16</sup> United Nations Development Program, Project Document "Capacity Development for Fuel Cell Powered Buses Development and Commercialization in China," Project No. CPR/96/313/01/99, (November 1996).

<sup>17</sup> Shen Bin, *China Daily*, May 20, 1999.