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Abstracts & Keywords

The Development and Current Status of China’s Transportation System
Wei Zhou, Joseph S. Szyliowicz

This paper analyses the development and current status of China’s Transportation System in detail, including the main aspects such as transportation infrastructure, equipment, transport management structure etc. Meanwhile, it also points out some crucial problems and challenges facing Chinese transportation development, including Investment of transportation infrastructure construction and maintenance, construction of integrated transport system, Costs of Transportation and transportation technical capacity building issues.

Keywords
Transportation infrastructure, equipment, management structure, integrated transport system, maintenance

Transport-Related Resource and Environmental Issues in China
Jiang Yulin & Feng Liguang

This paper analyses the status of transport-related energy and environmental and problems in China. The great challenges facing the energy and environmental development strategy in China are also discussed. Specific policy recommendations for sustainable transport energy and environment development are also advanced to provide effective references for government and decision-makes in the Chinese transport sector.

Key words
Sustainable Development, Transport Energy, Transport Environment, Pollution, Energy Consumption

Business, Management and Planning for Sustainable Transportation Development
Wang Yuanqing & Li jiangying

We discuss the Chinese transportation system according to the present and developing trends of business, management and planning. The Chinese market reforms began with economic changes and have achieved remarkable results in the past 20 years. So, in order to establish a sustainable transportation system, we must promote linkages to the government’s management goals and organizational reforms.

Keywords
Sustainable transportation, business, management, planning

Transportation Related Socio-Economic Issues in China
Feng Liguang

This paper analyses the transportation-related issues in China, including the state of transportation investments, transportation social equity, transportation
related health issues, transportation efficiency and the state of rural road construction, etc. The paper then advances some actual recommendations for realising sustainable transportation development in China.

**Keywords**
Transportation Socio-Economic issues, Transportation Equity, Transportation Safety

**Rural Transportation**
*(Adaptability and Fund Policy)*
Li Yang

Although China has made great achievements in rural road construction, it still cannot meet the demands for development of the social economy in rural areas. To achieve Chinese rural roads’ general development goals, it is essential to obtain construction funds. Accordingly, this article analyses the present financing system of Chinese rural roads and advances suggestions for a Funding Policy for the Development of Rural Roads that conforms to China’s national conditions. “Rural roads” in this paper refers to county roads, town roads and village roads.

**Key words**
Rural roads; Financing; Fund Policy

**Strategy Vision and Policy Recommendations on China’s Sustainable Transportation**
Wei Zhou & Joseph S. Szyliowicz

Based on the discussion and analyses of the issues and problems confronting China’s transportation system as presented in the other papers, we advance a strategic vision and specific policy recommendations that are designed to promote the development of a sustainable transportation system in China.

**Keywords**
Strategic Vision, Policy Recommendations, Sustainable Transportation, Economic and other policy measures, administration, External Impacts
A special issue on China is long overdue. China has achieved remarkable progress with its economic growth and poverty reduction programmes but the time is now ripe to take stock. In a globalised world of huge international trade flows, oil dependency, climate change problems and foreign policy interdependence it is right that this stock taking should be both external and internal. The world has a huge interest in China’s development path and its future trade balances, greenhouse gas emissions and ability to acquire increasingly large shares of available oil. Equally China has a legitimate role in commenting and, if appropriate, criticising those countries like the USA and the UK that have achieved rich country status on the back of very similar process of economic growth, industrialisation, urbanisation and trade. This criticism would be especially deserved if there was a hint of humbug or “don’t do what I did” in any stock taking of China.

China presents us all with the opportunity to comment on and resolve a dilemma. Success in economic growth must eventually come up against the disbenefits and problems associated with air pollution, congestion, loss of agricultural land, health impacts (including the 250,000 Chinese who die each year in road crashes) and societal stress associated with large scale migration and urbanisation. It would not be surprising if these processes were also associated with rising inequalities between rich and poor and rising environmental injustice as the poor bear the brunt of the pollution and the rich escape to more salubrious settings just as they did in 19th century Britain. The question for China but also for all of us is how do we create a high quality of life that does not propagate the disbenefits? The question is tough and more often dodged than addressed in an open and honest manner but China’s huge economic successes requires us all to re-evaluate our commitments to business as usual scenarios.

At the moment the USA, Australia and the European Union are all demonstrating a crude commitment to economic growth based on yet more infrastructure, more traffic, more congestion and more pollution. There is a touching belief that technology will rescue us but most know that technological gains are very easily cancelled out by growth in consumption. This has always been the case with traffic and continues to be the case with cars, trucks and aircraft. This deep commitment to growth and development is blind to social and environmental consequences but also means that we have very little to offer to China when it comes to alternative development paths. The stark implication of growing non-sustainability and growing global problems is that no one is able to offer leadership. Most of the world’s leaders are committed to the business as usual (BAU) model and have no authority to argue another course. They are long on the rhetoric of sustainable development but short on the practical implications of delivering lower levels of traffic and lower levels of flying. The growth of China as a world power with record rates of economic growth has exposed the moral and ethical bankruptcy of so-called developed countries. We can only observe with awe and fascination as Chinese levels of resource exploitation, pollution,
greenhouse gases and loss of nature threaten regional, national and global sustainability. There are doing what “we” did only much better.

This special issue concentrates on transport in China which is a key indicator of the scale of the disbenefits associated with BAU. The articles display intuition, insight and creativity around the ways we can deal with transport problems and they contain much that will help to create a China that is healthier, cleaner and smarter than what is currently on offer.

Sadly the potential to influence China in the way that it might develop its cities and transport systems is severely diminished by the lack of intelligence, leadership and courage on the part of those developed nations that could have charted a clear course towards sustainable transport and sustainable mobility. The world is a more polluted and dangerous place because of this lack of courage.

John Whitelegg
Editor

See page 36 for numbers on road traffic mortality – compare to WHO figures (of more than double)
Introduction

Joseph Szyliowicz and Zhou Wei

The remarkable economic growth that China has achieved in recent decades has been accompanied by the extensive development of its transportation system. Since the adoption of the economic reform and opening-up policy in 1978, the government, recognising that transportation plays an extremely important role in promoting socio-economic development and in improving the quality of life, has promoted the rapid growth of all the modes. Accordingly, by 2004 the rail network was the 3rd largest in the world, the road system the fourth largest, the expressways ranked second, and the airline passenger volume was the third largest. Furthermore, the long existing weaknesses of its transportation system have obviously been alleviated.

This expansion has not, however, taken place in an integrated manner or with adequate attention to its social, economic and environmental implications. At the same time, there has been a rapid and dramatic increase in automobile production and vehicle ownership. What was once a country where most people travelled by bicycle, a healthy and environmentally friendly mode, has become one with highly congested and polluted urban areas, regional imbalances, a high accident rate, a heavy and increasing dependency on oil imports, and serious distortions in social equity. In short, despite its tremendous achievements, China’s transportation system still confronts many serious problems that have to be resolved if it is to contribute to national development in a sustainable manner. And, given China’s enormous population creating such a system has obvious implications for the entire world. The recent global rise in oil prices, for example, is partially due to China’s increased demand for oil.

Recognising the seriousness of this situation and the potential for change, the China Council for International Cooperation on Environment and Development (CCICED) decided, in November 2003, to establish the Sustainable Transportation Task Force. The CCICED, established in 1992 by the Chinese Government, following an international environment conference held in Beijing in October 1990, is a high level non-governmental advisory body with the purpose “to further strengthen cooperation and exchange between China and the international community in the field of environment and development.” For the past ten years, the Council has been successful in articulating high-level advice and assisting Chinese decision-makers to better understand the links between environmental protection and economic development. Due partly to the Council’s influence, the Chinese Government is increasingly effective in defining and implementing long-term integrated environmental strategies and policies. The Council’s recommendations are part of the input used by relevant
ministries to develop policies and incorporate environmental considerations in their five-year planning process and the Council has contributed to a better public understanding and awareness of environmental issues in China. ([www.cciced.org](http://www.cciced.org))

The Sustainable Transportation Task Force was established with implementing a project entitled "strategy and policy for the development of sustainable transportation in China" with the goal of providing the government with a coherent and integrated strategy and policy framework for the future. It was a multinational, interdepartmental, and interdisciplinary research team, jointly led by Professor Zhou Wei, President of the China Academy of Transportation Sciences (CATS), and Professor Joseph S. Szylowicz (Graduate School of International Studies, University of Denver (U.S.A.), founder of the University’s Intermodal Transportation Institute.

Established in 1960, the China Academy of Transportation Sciences (CATS) is an innovative research institute subordinate to the Ministry of Communications. Its staff, consisting of over 350 professional technicians, more than 120 of whom are senior professionals, has conducted a wide range of studies ranging from strategy and policy for integrated transportation development to logistics and data processing. For this project, CATS also involved researchers from the Ministry of Communication, the National Development and Reform Commission, the Ministry of Construction, the Ministry of Railway, the Academy of Sciences, Tsinghua University, and Tongji University. The international experts were or had been affiliated with such institutions as the World Bank, the European Union, U.S. Department of Transportation, U.S. Department of Energy, the America Energy Foundation, the Italian Department of Environment, and the World Resources Institute.

After its establishment, the Task Force established four sub groups (strategy and administration, urban transportation, rural roads, environment and energy) which carried out such research projects as the following: (1) the development and current status of China's transportation system (infrastructure, equipment and capacity); (2) the administration, management and planning of transportation (coordination, capacity, and efficiency); (3) transportation-related energy and environmental issues (pollution and land take, etc); (4) transportation-related socio-economic issues (road traffic accidents, health and social equity); (4) rural transportation (adequacy and financing); (5) urban transportation (land use, growth patterns, public transit, etc); and (6) the role of transportation-related fiscal and monetary policies in China (congestion charges, fuel taxes, etc).

Based on this research, the Task Force developed and presented two specific reports containing proposals that are consonant with China's condition and needs to the Chinese government. These were: "A Strategy and Policy Framework for the Development of a Sustainable Transportation System" and "Policy Recommendations on Establishing and Maintaining a Sustainable Transportation System". The research projects and these two reports have already attracted great attention from China's central and local governments. The articles that follow draw
upon these projects and reports and are designed to provide transportation professionals and colleagues throughout the world with insights into the work of the Task Force and a better understanding of China’s current transportation system and the kinds of reforms that are required in order to make it into a truly sustainable system.
The development and Current Status of China’s Transportation System

Wei Zhou, Joseph S. Szyliowicz

Introduction
Since China's reform and opening policies began in 1978, the Chinese government has implemented a series of effective measures, such as increasing road maintenance fees, imposing a surcharge for motor vehicle purchases, and implementing a policy for toll roads in order to realise the rapid development of the national transportation construction. Each transportation mode has achieved unprecedented development in competitive environments, which has eased pressures in transportation supply.

Transportation Infrastructure
After years of construction and development, China’s transportation infrastructure has improved greatly and a basic arterial framework for different transportation modes has taken shape, focused on trunk line railways, expressways, deep water channels, long-distance pipelines, and airport and port hubs (See Figure 1).

By the end of 2004, China’s total railway mileage reached 74,408 km (third in the world after the U.S. and Russia); total highway road length reached 1,870,700 km (fourth in the world after the U.S., India, and Brazil), including 34,288 km of expressways (second in the world); Navigable inland waterways reached 123,300 km. There were 4,197 commercial berths along China’s coast, of which 790 were 10 thousand ton class and above. China had 133 airports and 1,279 regularly scheduled flights and its total airline turnover volume ranked third in the world, as did passenger volume.
Transportation Equipment
China’s transportation equipment has experienced remarkable improvements. It ranks first in the world in total rail density. Locomotives are almost all diesel and electric. The number of motor vehicles in China has increased rapidly. By the end of 2004, China had roughly 28 million cars, and significant progress has been made in model design, ergonomic customisation, performance and comfort, as well as environmental technologies, energy efficiency and safety. Ocean-bound shipping technology and equipment are essentially on par with international levels. However, in inland waterway transportation, China still lags behind. Most of the civil airplanes are imported, mainly from Boeing or Airbus.

Transportation Capacity
With a larger number of transportation facilities and technological improvements in transportation equipment, China’s overall transportation capacity and quality have improved substantially. Expanded and improved transportation has supported China’s socio-economic development and has met rapidly growing demand for passenger and freight transportation at a basic level. In 2003, total passenger volume on all transport modes was 16.84 billion passenger trips and passenger turnover was 1,379.82 billion persons/km, 4.9 and 6.0 times 1980 levels, respectively. Total freight volume was 15.56 billion tons and freight turnover volume was 5.38226 trillion tons/km, 2.8 and 4.5 times 1980 levels, respectively.

Structure of Transportation
The structure of transportation in China has also changed substantially. Passenger and freight road transportation has increased rapidly. Air passenger transportation and ocean shipping have steadily increased. However, railways are under great pressure, and the small share of other transportation modes has increased. Overall, the market shares of different transportation modes have become relatively stable, a development trend that is roughly similar to that experienced by industrialised countries.

Figure 2: Changing Market Shares for Passenger Transport in China
Source: China Statistics Yearbook
Current Transport Management Structure

Transport management in China is organised separately according to different transport modes. Each transport mode works according to its own policies, operational strategies, and allocates projects and builds its own network of relationships across other authorised departments. For instance, road and water transport are administered under the Ministry of Communications; railroads fall under the authority of the Ministry of Railways; civil aviation is administered under the Civil Aviation Administration; oil and gas pipelines are managed mainly under PetroChina and Sinopec; urban transport falls under the authority of the local Construction Management Commission with the State Development and Reform Commission, Ministry of Construction, and the Ministry of Public Security simultaneously involved in corresponding elements of the administration of transport. Additionally, transport management also involves several other departments such as the Ministry of Finance, the Bureau of Land Resources, the State Forestry Administration and the State Environment Protection Administration, etc. Generally speaking, the transport system in China lacks comprehensiveness, while an integrated transport management administrative system is still inchoate. The organisation of the transport management structure is shown in Figure 4.
Problems
Although China’s transportation has made great achievements and the long existing transportation pressures have been alleviated, there still exist many issues and challenges.

Infrastructure for an Integrated Transport System Lags Behind
Many problems in the transport system arise from the lack of a comprehensive master plan: the infrastructure for an integrated transport system lags behind, the layout of transport network and routes are not rationalised, and the foundation for coordination in urban transport development is still weak. Integrated transfer stations are still rare, and connections are hard to make and coordinate for passengers. The objectives of having zero-distance transfers for passengers and seamless transfers for
modern logistics are not even close to being met; waste in transport resources is common and financing for infrastructure is not as effective as it could be. Railways are over capacity, the inland navigable waterways are not used to their full potential, and oil and gas pipelines are still lagging behind. These individual problems combine and can not live up to the requirement that various transport modes should be utilised according to local conditions.

**Insufficient Investment in infrastructure construction and Maintenance**

The railroads are still financed by one single investor (the government). Return on capital investment is slow and there is great difficulty in investing in the capital market for rail. Acting as the representative for the central government in railroad investment, the Ministry of Railways is still responsible for all the investment in railways infrastructure loan repayment for rail projects. Railway construction funds and bank loans are the major sources of infrastructure investment, with construction funds amounting to 209.4 billion RMB in the period between 1991 and 2000, and with 48.22% of the total investment by the Ministry of Railways. Loans from domestic banks total 96.1 billion RMB, accounting for 22.13% of the total investment in rail. Investments from the outside market account for less than 10% of the total rail project investment.

There has been increased diversification of investors and investments in road construction. However, major problems such as a heavy debt burdens and a large demand for maintenance capital still plague the system. In December 1984, the State Council implemented a series of policies resulting in rapid expansion of road infrastructure, including new standards for road toll collection applied to road maintenance, a vehicle purchase tax, implementing toll road policies, and key policies regarding the diversification in investors and investments. Despite this, the current debt burden for government departments relating to road transport reached 600 billion RMB. With the large-scale expansion of the road network, there has also been a steady demand for maintenance investment, with more needed daily; only 30% of rural roads can be maintained with currently allocated capital.

There are still no special investments to encourage construction of inland navigable waterways or urban public transport. Up until and including the time of the Ninth Five-Year Plan, the total investment for inland navigable waterway infrastructure was only 30 billion RMB, and the three years before the Tenth Five-Year Plan saw only approximately 14 billion RMB invested in this mode. This minimal amount of investment cannot meet the demand for inland waterway transport.

**High Costs of Transport**

Research from the China Logistics Information Centre shows that total logistics costs in 2003 was 2497.4 billion RMB, 21.4% of GDP. This percentage is more than twice the spending on logistics by developed countries such as the United States (9.5%) and Japan (8.7%). Within this total, transport costs account for 1402.8 billion RMB, storage costs for 737.6 billion RMB, and management costs for 357 billion RMB. Transport costs which contribute to half of the total logistics costs
(as represented by Figure 5) directly impact the competitiveness of China against other countries.

Figure 5: Components Contributing to Logistics Costs in China

Source: China Statistics Yearbook

**Low Capacity for Independent Innovation and a Minimal Amount of Science and Technology**

Currently, there is a low capacity for independent innovation in China, and the technological advances needed to support the transport industry come too slowly. Although there is an increasingly great market demand, a low capacity for independent innovation and the lack of system integration form large obstacles to the creation of a high value-added scientific industry, technology market and technology outputs, badly hindering the creation of a sustainable transportation system.

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Task Force on Sustainable Transportation, China Council for International Cooperation on Environment and Development, China Academy of Transportation Sciences & Ministry of Communication, P.R. China


Contact details of Authors:

Wei Zhou,
Professor and President,
China Academy of Transportation Science,
Ministry of Communication,
China
Ph: 0086-10-64411910
Fax: 0086-10-649642
E-mail: zhouwei22@vip.sina.com

Joseph S. Szyliowicz,
Professor, Graduate School of International Studies, University of Denver
Ph: 303-871-2992
Fax: 303-871-2456
E-mail: j szyliow@du.edu
Transport-Related Resource and Environmental Issues in China

Jiang Yulin & Feng Liguang

Current Status of Transport-Related Energy Consumption, Land taken and Environment in China

Transport-Related Energy Consumption Status in China

With the rapid development of the Chinese economy, the total amount of energy consumption is rising at a fast rate. Currently, China has become the second largest energy consumer in the world after the U.S. Figure 1 shows the total consumption of primary energy in China from 1980 to 2004. In 2005, China’s total primary energy consumption was 2.22 billion tons of standard coal, and the energy consumption per GDP (10,000 US$) was 1.43 tons of standard coal, 11.5 times as much as Japan, 7.7 times as much as France and Germany, and 4 times as much as the US. (Xinhuanet, 2006)

![Figure 1: Total Consumption of Primary Energy in China](image)

**Sources:** China Statistical Yearbook 2003 and data from the official website of China’s State Statistical Administration

Fig 2 shows China’s oil consumption from 1990 to 2004. It indicates that although China’s overall level of resource consumption was not always rising, oil consumption maintained a consistent upward trend, with an annual increase of 9.2%, far higher than the increase in other resource consumption during the same period of time (3.9%). By 2003, China, with its total oil consumption of 240 million tons, overtook Japan and became the second largest oil consumer in the world.
As is shown in Fig 3, energy consumption in the commercial transport service sector experienced an annual growth rate of 4.5% from 1991 to 1996, and 14.5% from 1996 to 2002, representing an increase of 60.565 million TCE. The share of energy consumption by the commercial transport service sector in the national total energy consumption increased from 4.5% in 1991 to 7.3% in 2002.

**Energy Consumption by Motor Vehicles in China**

The share by vehicles in energy consumption has experienced a continuous increase, and has gradually become the dominant part. According to the International Energy Agency, 50% of China’s crude oil consumption is consumed by road transport. In 2003, road transport consumed 38.114 million tons of gasoline and 17.096 million tons of diesel, accounting for 87.9% of the national gasoline and 22.1% of the national diesel product volume respectively.
Table 1: Production of Gasoline and Diesel Fuel and Vehicle Consumption of Gasoline and Diesel Fuel from 1990 to 2002 in China (million tons/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude product</th>
<th>Gasoline</th>
<th>Diesel fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production (A)</td>
<td>Vehicle consumption (B)</td>
<td>B/A (%)</td>
</tr>
<tr>
<td>1990</td>
<td>138.3</td>
<td>21.6</td>
<td>19.8</td>
</tr>
<tr>
<td>1991</td>
<td>141.0</td>
<td>24.0</td>
<td>21.9</td>
</tr>
<tr>
<td>1992</td>
<td>141.7</td>
<td>27.3</td>
<td>25.2</td>
</tr>
<tr>
<td>1993</td>
<td>144.9</td>
<td>31.4</td>
<td>27.2</td>
</tr>
<tr>
<td>1994</td>
<td>147.6</td>
<td>28.5</td>
<td>25.8</td>
</tr>
<tr>
<td>1995</td>
<td>149.8</td>
<td>30.5</td>
<td>26.9</td>
</tr>
<tr>
<td>1996</td>
<td>157.3</td>
<td>32.8</td>
<td>28.2</td>
</tr>
<tr>
<td>1997</td>
<td>160.7</td>
<td>35.2</td>
<td>29.8</td>
</tr>
<tr>
<td>1998</td>
<td>161.0</td>
<td>34.7</td>
<td>29.5</td>
</tr>
<tr>
<td>1999</td>
<td>160.0</td>
<td>37.4</td>
<td>32.0</td>
</tr>
<tr>
<td>2000</td>
<td>163.0</td>
<td>41.3</td>
<td>35.5</td>
</tr>
<tr>
<td>2001</td>
<td>164.0</td>
<td>41.5</td>
<td>35.9</td>
</tr>
<tr>
<td>2002</td>
<td>167.0</td>
<td>43.4</td>
<td>38.1</td>
</tr>
</tbody>
</table>


Land Resource Consumption by Transport Construction

At present, transport infrastructure in China consumes about 42.09 million km², 0.44% of the country’s land area. According to the national development plan, the total area for transport infrastructure construction in 2020 will amount to 46.37 million km², 0.48% of the whole country’s area. From Figure 4 we can see that by 2020, roads will account for 90.2% of land use by transport infrastructure. Among the land occupied by transport infrastructure, 63.1% of it is farm land, about 29.1 thousand km², 3.06% of the country’s farm land; 15.2% of it is forest land, about 7 thousand km²; and 21.7% of it is land used in other ways, about 10 thousand km². Thus the loss of farming land is quite serious. It is calculated that construction of highways, railways, and civil aviation airports from 2004 to 2020 will consume 270 thousand km² of farming land. This will result in 3.7 million farmers losing their land (0.07 ha. /person).
In recent years, with the rapid transport development, environmental problems have become increasingly serious and hinder economic development and adversely impact social stability and public health. Now, pollution in many cities is changing from stationary source emissions to mobile source emissions. Table 2 shows the results of some studies regarding the emission and concentration shares of vehicles in Chinese cities. The emission and concentration shares of CO and HC are higher than 60%, even reaching 90% in some large cities. In Beijing, Shanghai, and Guangzhou, where vehicle population grows most rapidly, vehicle emissions have become the dominant pollution source, and their pollution characteristics and control progress is typical of other cities as well.

Table 2: Share of Vehicle Air Pollution in Chinese Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Year</th>
<th>CO (%)</th>
<th>HC (%)</th>
<th>NO\textsubscript{x} (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions Beijing</td>
<td>1989</td>
<td>39</td>
<td>75</td>
<td>46</td>
</tr>
<tr>
<td>Emissions Beijing</td>
<td>1995</td>
<td>77</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Emissions Beijing</td>
<td>1998</td>
<td>83</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Emissions Guangzhou</td>
<td>1995</td>
<td>85</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Emissions Shanghai</td>
<td>1995</td>
<td>76</td>
<td>93</td>
<td>44</td>
</tr>
<tr>
<td>Emissions Shanghai</td>
<td>1996</td>
<td>86</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Emissions Chongqing</td>
<td>1999</td>
<td>86</td>
<td>37</td>
<td>86</td>
</tr>
<tr>
<td>Emissions Jinan</td>
<td>2000</td>
<td>79</td>
<td>63</td>
<td>19</td>
</tr>
<tr>
<td>Emissions Nanjing</td>
<td>2001</td>
<td></td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Emissions Shanghai (within the inner ring)</td>
<td>2002</td>
<td></td>
<td></td>
<td>81</td>
</tr>
<tr>
<td>Emissions Shanghai (urban area)</td>
<td>2002</td>
<td></td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

Source: China Statistic Yearbook

Figure 4: Projection of Land Occupation of Various Transport Infrastructures in 2020
At present, the total emissions of CO₂ in China ranks second in the world. The emissions of other greenhouse gases such as methane and nitrous oxide are also very high. The net increase of CO₂ emissions in China totals 823 million tons and it is estimated that by 2020, CO₂ emissions in China will be 2.32 times the current level. Currently, CO₂ emissions per capita in China are below the world’s average level. The transport system is a major source of CO₂ emissions, especially in the road and aviation transport sector. Thus, it is crucial to reduce the CO₂ emissions to keep the concentration of GHGs in the atmosphere at a stable level.

Challenges of Transport Energy and Environmental Protection in China

Challenges of Energy Supply in China - Limited Energy Reserves
According to the June 2003 Statistical Review of World Energy published by the BP Company, given technology and cost limitations, the ratio of oil reserves to annual oil production (R/P ratio) was about 40.6 years; for natural gas, the R/P ratio was 60.7 years; for coal, R/P ratio was 204 years. The coal reserves in China total 1002.49 billion tons, but the part that can be mined is only 89.3 billion tons. The gasoline and natural gas reserves are estimated to be 93 billion tons and 38,000 billion cubic meters, but the proven parts represent only 20% and 6% of the total amount respectively and will last for a few decades. Coal mine methane reserves are 35,000 billion cubic meters (equivalent to 45 billion tons of standard coal), ranks 3rd of the world. However, the coal mine methane reserve has not been developed well. Table 3 lists how long the world’s proven energy reserves will last, according to the 1996 report of the U.S. Department of Energy.

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Natural gas</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>221</td>
<td>80</td>
<td>39</td>
</tr>
<tr>
<td>China</td>
<td>85</td>
<td>62</td>
<td>19</td>
</tr>
</tbody>
</table>

In China, the oil reserve per capita is even lower, only 2.6 tons/person. Table 4 provides the reserves of coal, oil, and natural gas per capita. The population of China accounts for 21% of the world’s total, while its oil resources account for
only 2.3% of the world’s total. Since late 1990s, China’s oil supply has been experiencing severe difficulty, making China a net oil importer with imports increasing every year. In 2002, China’s net import of oil was over 70 million tons, and it increased to 97.41 million tons in 2003. In 2004, China’s oil consumption totalled 290 million tons; including 140 million tons of imported oil, indicating a dependence rate of almost 50% on imported oil (see Figure 6).

Table 4: Reserves of Coal, Petroleum, and Natural Gas per Capita in 2000

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>World Average</th>
<th>US</th>
<th>Ratio: China to world average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal (ton)</td>
<td>89.8</td>
<td>162.5</td>
<td>876.4</td>
<td>55.4</td>
</tr>
<tr>
<td>Oil (ton)</td>
<td>2.6</td>
<td>23.5</td>
<td>13.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Natural gas (m³)</td>
<td>1074</td>
<td>24796</td>
<td>16843</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Source: China statistical yearbook 2000

Figure 6: Variation of Net Import Volume of Total Oil Products
Source: China statistical yearbook 1990-2004

Future Energy Consumption

Table 5 demonstrates the projected energy demands of China according to many research institutions and all projects that China’s total energy consumption will keep growing.
**Table 5: Comparisons of Projections of Energy Demand**

<table>
<thead>
<tr>
<th>Prediction organization</th>
<th>Time Year</th>
<th>Base Year</th>
<th>Prediction result, volume of energy demand (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>IEA</td>
<td>2002</td>
<td>2000</td>
<td>12.1</td>
</tr>
<tr>
<td>Tsinghua University</td>
<td>1994</td>
<td>1990</td>
<td>14.4-15.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13.9-17.1</td>
</tr>
<tr>
<td>Former Ministry of Energy</td>
<td>1994</td>
<td>1990</td>
<td>14.4-15.3</td>
</tr>
<tr>
<td>ERI</td>
<td>2003</td>
<td>1998</td>
<td>Low scenario</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium scenario</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High scenario</td>
</tr>
<tr>
<td>Chinese Academy of</td>
<td>1996</td>
<td>1990</td>
<td>Engineering</td>
</tr>
</tbody>
</table>

According to the predictions by the NDRC, China’s import of oil will reach 80-120 million tons by 2010, and 150-220 million tons by 2020, and in 2020 when 50% of China’s oil demand will be imported. The growing amount of imported oil will greatly threaten the security of China’s energy system and influence China’s economic development.

**Future Vehicle Oil Consumption**

According to the DRC, if effective measures are not taken, the oil consumption by the road transport sector will reach 256 million tons, accounting for 57% of the national total, with the increased amount and rate of increase far exceeding those of other sectors. The Study on China’s Vehicle Fuel Economy Standards and Policies conducted by Tsinghua University concluded that the oil demand of vehicles are 65.6 million, 119 million, 208 million and 379 million in 2000, 2010, 2020, and 2030, respectively. This means that the oil consumption of vehicles by 2030 will be 5 times that of 2000. This study also projected that the oil demand of the transport sector in 2020 will account for 58-71% of the national oil demand.

**High Energy Intensity in Transport Sector**

From 1990s, the energy consumption rate of transport in China increased gradually, from 2.71 kg standard coal /100 ton-km in 1990 to 3.28 kg standard coal /100 ton-km in 1998 (Table 6). At present, the vehicle fuel efficiency is 10-15% lower than that in European countries, 5-20% lower than in USA, and 20-25% lower than in Japan (see Figure 7).
Table 6: Comparison of Energy Efficiency* of the Energy System (%)

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>ECE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>The beginning of the 1970s</td>
<td>The actual possibility at the beginning of the 1990s</td>
</tr>
<tr>
<td>10.3</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

* Energy efficiency = energy mining efficiency * process efficiency * end-use efficiency.

Challenges of Transport

Environmental Protection

The vehicle population in China will be 45-50 million in 2010 and 0.1-0.13 billion in 2020.

According to the State Environmental Protection Administration (SEPA), the CO and NOx emission of vehicles in China in 2005 were nearly 3,500 tons and 500 tons respectively, accounting for about 79% of total urban pollution emissions. The CO and NOx released by vehicles will represent 85% and 45-50% of the total pollutant emissions respectively in 2010. It is projected that in Shanghai, 75% of the NOx, 94% of the CO and 98% of the HC will come from vehicles in 2010. The annual financial loss caused by air pollution amounts to 5% of China’s GDP. Illness and the death rate caused by air pollution has increased gradually but even if the vehicle population increases at a medium rate, the problems caused by emissions will further deteriorate or remain at a very serious level. Figure 8 shows the expected increase in vehicle emissions. If a proper system of control and regulation is not established, public health, the environment, the quality of life and economic development will all be seriously affected.

Figure 8: Predictions of Vehicle Emissions from 2000 to 2020

Source: Financial Policy to promote the sustainable transportation development in China
Policy Recommendations

A. For Sustainable Transport Energy Development

1). Establish Fuel Economy Standards for Motor Vehicles and promote new technologies

The fuel economy standards for commercial light trucks, heavy-duty vehicles, and motorcycles should be established as early as possible. Standards for steamships, trains, and other transport vehicles should be established as well.

Establish Mechanisms for Research, Industrialisation, Commercialisation, and Innovation for Advanced Vehicle Technologies. The focus of advanced technology development in China in the near future should be industrialisation/commercialisation of HEVs and, in the long term, on FCV and EV technology research and development.

Facilitate market entry mechanism for advanced vehicle technologies as quickly as possible so that marketing of advanced vehicle technologies can be ensured.

The government should make full use of policy measures to promote the demonstration, production, and the use of hybrid electric technologies in cars, passenger vehicles and trucks. Such policies should encourage the introduction of HEVs and encourage or require auto manufacturers to establish new vehicle assembly lines for HEV production.

Compulsory and incentive requirements should be established to encourage car manufacturers to provide HEV technologies to achieve energy efficiency levels in their vehicle products.

2) Formulate Policies to Encourage Use of Alternative Fuels

Make a comprehensive evaluation of product performance, oil saving potential, life-cycle environment, energy, and economic impacts of different alternative fuels to determine the potential of different alternative fuels on oil saving and environmental protection. Because coal is the main energy source in China, we should strengthen the analysis and evaluation of coal-based alternative fuels in particular by investigating environmental, energy, and economic impacts of coal-based methanol, DME, and coal-based liquid fuels in the near term.

3) Fiscal Policies

To set up fiscal and taxation policies such as vehicle and ship tax, insurance tax, and fuel tax, to help reduce use of vehicles and to increase use of energy efficient vehicles. The government should increase its investment in the research and development of energy resources to solve the problem of insufficient energy supply in China and to meet the demand for clean and efficient energy in achieving the goal of a well-off society in China. To provide governmental subsidies for use of clean alternative fuels. The government should offer certain subsidy to clean alternative fuels in terms of fiscal tax to assure that alternative fuels can be accepted by the market smoothly.
B. Policy Recommendations for Land saving in Transport

1). Rationalise Planning
Insist on resource-saving transportation development as the criterion for planning and implementation of all transportation development projects. The specific planning of resource saving and recycling including land, coastline and energy, etc., and circular economy development needs to be initialized and carried out. It is also imperative to accelerate the organisation, development and coordination of the planning of roads, ports and integrated transportation hubs.

2) Innovative Designing
Planning and design should give attention to the entire process of construction, operation and maintenance. The implementation of mandatory and recommended standards should be differentiated. It is necessary to utilise proper technical guidelines according to the situations and development demands of different regions and geographic areas. Properly using strip corridors and central controls can save lands and protect agriculture. Digging and filling should be carried out in a balanced manner, avoiding deep digging and large blocks.

3) Construction maintenance
Road construction should explore the maximum utilisation of existing road resources and avoid large-scale changes and rebuilding. The mechanism of land recovering and rebuilding should be implemented through such measures as: recultivating temporary used lands, rationally selecting fields to be used, reclaim abandoned lands, and so on. The principle of “deep water goes to deep, lower water goes to lower”, should be intensively used when constructing ports. Moreover, it is possible to begin to charge for using coastline resources.

C. Policy Recommendations for Transport Environment Protection

1.) Improving Pollution Control Level of Conventional Motor Vehicles
To deal with increasingly serious transport air pollution in cities, pollution control levels of conventional gasoline and diesel vehicles should be further improved. Rapid implementation of the strict standards on new vehicles will greatly reduce pollution by the Chinese transport sector.

2) Promoting Use of Clean Alternative Fuels
Some special vehicle types, such as buses and fleet vehicles, should be the first users of clean alternative fuels. Meanwhile, fuel production and vehicles technologies using clean alternative fuels should be constantly improved to promote the rapid development of alternative fuels in China.

3) Establishment of Enforcement Systems
Effective environmental certification and management systems need to be established. The inspection and maintenance system for motor vehicle emission control needs to be strengthened and effective centralised inspection administrative programs should be established.

4) Fiscal policy Recommendations for Sustainable Transport Environmental
development

Fiscal policies should be established to reflect the environmental impacts of different transport modes. That is, the external costs of different transport modes in terms of their environmental pollution should be reflected in the form of taxes or prices to ensure social equity and the most efficient and equitable allocation of transport resources. China should set up a tax reduction or exemption system for vehicles with low emissions and energy use. Meanwhile, it is suggested that environmental tax policy, tailored to Chinese conditions, should be formulated to control heavily polluting vehicles.

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**Contact details of Author:**

Centre for Sustainable Transportation, China Academy of Transportation Sciences, Ministry of Communications, Beijing, 100029, P. R. China

Jiangyulin@vip.sina.com
feng_liguang@163.com
Foreword
As the supporting and safeguard system in the national economy and in social development, transportation must satisfy the people’s changing mobility needs and adapt to the growing demands of industry. China is now in the process of industrialisation, marketing, urbanisation, and motorisation. The rapid economic and social development has to rely on the fast development of transportation. However, the large population and limited natural resources call for high attention to sustainable development principles. Although China has now made remarkable achievements in developing its transportation system, many problems in its business, management and planning remain.

Business
For developed countries, transportation is basically regarded as a business serving the public, in which the government takes the lead. The business aspect involves marketing as much as possible, with competition somewhat encouraged. In China, the transportation business involves management by as many as 10 departments, such as the State Development Commission (for business coordination, project establishment and price discussion), the Ministry of Railways (for railway transportation), the Ministry of Communications (for highway transportation), the Civil Aviation Administration of China (for air transportation), the China Petroleum and China Petroleum-chemical Corporation (for petroleum pipeline transportation), the Ministry of Construction (for urban transportation), the Ministry of Public Security (for transportation enforcement), the Ministry of State Land and Resources (for land examination and approval), the Bureau of Environmental Protection (for project environment examination and approval). In the above 10 departments, the Ministry of Railways, the Ministry of Communications and the Civil Aviation Administration of China take the main role in management. Although these three ministries clearly understand the reform and development issues, the different structures of governments and enterprises lead to different marketing. To make matters worse, the poor coordination of the policies, development goals and development progress among the ministries may also result in differences in coordination and connection. These institutional barriers are responsible for certain restrictions and problems in the management and business of various transportation systems.

Business usually means commercial, industrial, or professional dealing, and is
one kind of enterprise behaviour. The most important management question is how to achieve positive business achievements -- confirmation from customers and competitors, the staff values and the correct administrative behaviour which creates the basic tentative plan and technical superiority of the enterprises. Management involves three parts: the organisation environment (including prediction of the social and structural environment and market, customer and technical situations), the organisation mission (ultimate goal to be achieved), and the core competitive power (method to be worked out). The government controls the management environment and imposes certain restrictions. Only when all these are done well can public needs be satisfied. However, there still remain the following problems for the transportation business management:

- In the overall administration, there are some weak-points in the structural establishment involving such concepts as social benefits and competition. The construction of public services, the management system, and the policy-making system of the government are all deficient. There is a lack of elimination through selection or competition for those enterprises and inadequate attention is paid to following up on the achievements of those enterprises and their officials. What’s more, the enterprises cannot see a stable development period ahead.
- The reforms of railway transportation and air transportation are lagging. There still exists an operation monopoly for these enterprises, and a supervision system that looks after the public benefits is lacking. There are many other problems: the complex system for buying railway tickets, the loss of passengers’ benefits, the operational monopoly, the poor service, and the inhuman facilities. Besides, the government aviation management is too rigid, the scheduled flight arrangement and the ticket prices are not flexible. All these enterprises have shown great differences from the world levels and cannot meet the needs of the passengers.
- The highway transportation departments lack sufficient professional management, leading to a lack of a good system. In the highway transportation market, the supply exceeds demand and poor management by the government causes the over-loading of vehicles, the high occurrence of traffic accidents, costly road maintenance and the great waste of the social resources. In addition, excessive competition and poor service make it more difficult to satisfy passengers, develop transportation and reduce the production costs.
- The different departments of the government do things in their own way, and there is a lack of unified connection and control of the work between cities, towns and departments, which often results in the “vacuum space” in the construction and management. These deficiencies in construction and management often make it difficult for the operation of the business of the enterprises and even make a mess for transportation places like
Management can be defined as the act, manner, or practice of supervising or control. The key points of transportation management are unity, coordination and high effectiveness. The market sanction, supervision, investment and subsidising are the four leading instruments for the government. However, given the limits of system, financial resources and the condition of the government management level, there are still some problems remaining to be solved in the China transportation industry:

1. The management system is unreasonable
The following are the principal problems in the transportation management system:

- Lack of a unified, coordinated, highly effective management department. In fact, the job of coordinating between all kinds transportation modes is done by the State Council, which greatly increases the policy making rank order, creates more management processes and decreases the management effectiveness. To make matters worse, most of the decisions are made under the unitary administration examination and approval system, which can no longer meet the requirements of the scientific development of a sustainable transportation system.

- Delayed system reform for the railways and other transportation modes. The low level of marketability and the monopolistic operation not only restrict the development of the railway and air transportation but also hinder the coming into being of that coordinated market. The monopolised industries bear high management costs, cannot guarantee the priority of the public interest and, since the investment resources come mainly from the government, they cannot meet the needs of a rapidly developing society. However, only if we speed up reform, divide the enterprises from the government and clearly classify their functions, can we realise the harmonious development of the transportation industry.

- Great need of department conformity and a steady, reasonable investment channel. Because of the different investment resources and management organisation, the highways, urban roads and suburban roads can not grow synchronously. Those urban roads which are controlled by the government develop differently in different cities, and a few cities cannot reasonably break down the work between roads and other transportation means, aggravating traffic jams, a universal problem. Like people in cities, farmers are the end beneficiaries of their roads, but the investment channel relies too much on the transportation department instead of the local
government, which leads to the great shortage of investment in many places and a heavy load of transportation department.

- The transportation department's comprehension and implementation of its objectives are too simple. The decision maker should include environment preservation, energy conservation and a coordinated transportation structure under the TOD pattern when endeavouring to improve the transportation system. However, the structure and functioning of the system have led the transportation department to emphasise increasing transportation capacity but not on coordination with other requirements. In a word, we will never achieve harmonious development between the transportation system, the environment, energy, the city land exploitation system and the economic system unless we try hard to completely change this situation.

- The availability of transportation information and the construction of the 'sunshine government' are delayed. Only if we move rapidly in this direction, can we guarantee a low-cost, highly effective, public-interest-first and develop a sustainable industry for transportation.

- Practically no means are available to create a transportation science system based on independent innovations. The present-day technical research led mainly by the government can no longer contribute to a great improvement of the practical science level. Instead, we should settle the intellectual property rights issue and establish a domestic policy to make sure that new technology based on independent innovation can be put into practice, so that the independent-innovation-based technical development can flourish.

2. Prominent transportation structure contradictions and lack of transportation management coordination

- There is a structural contradiction between different transportation modes. They do not constitute an integrated system and coordination between modes is weak. Transportation facilities construction, the development of transportation equipment development and the transportation business management are not well planned. Transportation hubs which have a synthesising function have not yet been established. Information systems are not planned adequately. Existing practices do not fully manifest people-first thinking, nor conform to "zero distance transfer" and "seamless linkages" principles. And, the present system cannot satisfy the demand of logistics development either.

- The railroad network structure is not reasonable. Mixing passengers and cargoes on busy lines affects the speed the efficiency. The main airlines and branch airlines are unbalanced. The branch airports and the branch airplanes are obviously insufficient. Rural road conditions are still backward. The road conditions in the mid-west and the border areas...
also need to improve urgently. The harbour container facilities and the large-scale bulk cargo berths are insufficient, the common grocery wharf using ratios are dropping, and the water depth in major port and estuary routes is insufficient. Urban road construction lags, the road network structure isn't adequate, BRT systems have not been formed, and fast and large capacity public transportation such as subways, light rail, and the BRT are lacking, especially in big cities.

Planning
The concept of planning is: a scheme, program, or method worked out beforehand for the accomplishment of an objective. The problems of planning are directly related to the transportation management system and transportation development. The main problems and gaps are listed below:

- We need to intensify the “people-first” thinking, set plan to satisfy the public’s demand first. Because of such gaps, we don't place enough emphasis on transportation facilities construction which leads to dissatisfaction with safety, speed, comfort, price, environmental impacts, and energy consumption. For example, there are not enough passageways radial roads, and parking facilities in big cities. Transportation planning should emphasise land-use, low energy consumption, large capacity, high technology and good environment as their goals. They should also pursue transportation system optimisation through integration to achieve sustainable development in transportation.

- Transportation planning and land-use planning are not well coordinated. Big cities should coordinate synchronously land use planning and transportation planning. Reasonable land-use and transportation facilities layout should begin with the planning process. Effective planning is also required to avoid waste and negative environmental and economic impacts.

- Transportation planning needs to explore how to better utilise existing networks. According to the fundamental national condition and the sustainable development stratagem, it is necessary to utilise all transportation modes’ technology and economic characteristics to achieve an organic integration and to increase transportation development. We should build an integrated transportation network which has low resource consumption, minimises environmental impacts, and improves the development of the economy and people’s lives.

Brief summary
China’s sustainable transportation system should not only satisfy the people's increasing transportation demands, but also effectively coordinate all the
transportation modes to limit resource consumption and environmental pollution. Persisting in full-scale, coordinated development, combining the government function and market mechanism, and forming a far-reaching and high-coverage, high-ability and high-efficiency transportation system.

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Contact details of Authors:
Wang yuanqing & Li jiangying
Key Laboratory for Special Area Highway Engineering of Ministry of Education, Chang’an university, Xi’an 710064, China. wyq21@vip.sina.com
1. Transportation Economic Issues
Construction Capital Mainly Depends on Domestic Loan and Self-raised Sources
In recent years, the Chinese government has strengthened the transportation construction process. In 2004, the total investment of highway and inland waterway infrastructure construction amounted to 531 billion CNY, an increase of 28.5 percent compared with 2003. Funding for highway construction comes from the government’s investment budget (3.1%), purchase tax (11.0%), domestic loans (40.5%), foreign investment (1.3%), self-raised and other sources (39.3%), and surplus from previous year (4.8%). Thus the transportation construction financing in China mainly comes from domestic loans and self-raised sources.

Transportation Economic Equity
Transportation economic equity mainly refers to the balance between resource allocation and consumption, transportation investment equality in different areas, and the internalisation of transportation’s externalities, etc. The Chinese government has made great strides in implementing the fundamental principle of “only charging the consumers” in the past 20 years. The State Council has also made such significant decisions as increasing the road tolls standard, charging taxes for buying highway construction vehicles, as well as market reforms of transportation enterprises that shift partial responsibilities for transportation construction and capital use from the general tax-payers to the consumers. Yet the amounts invested by the government and the policy of constructing roads through deficit financing have not changed. For example, the total debts of the Highway Department are over 0.6 trillion CNY and the issue of capital conflicts between construction and other use is obviously serious.

Now China’s government is carrying out the strategy of “the West Developing Plan” and “Rising of the Middle Area”, but funding difficulties have seriously hindered its efforts to narrow the gap of transportation investment between east and west. Chinese policymakers and planners also attach importance to the issues of internalising external problems such as air pollution, noise pollution, etc caused by the rapid increase in vehicle ownership, but no feasible solutions have yet been developed.

Transportation Social Equity Issues
“Transportation social equity” emphasises the importance of effective public
participation and of maintaining its rights when making and implementing transportation policies and relevant rules.

Following the process of democratisation and opening of public opinions, the Chinese government has started to hear witnesses when making important policies and rules and to listen to appeals for public benefits. The transparency of the political process increases gradually, reports and attention from the media on significant transportation affairs are also increasing. As a result, victims of significant nuisance events, often supported by the mass environment protection movement, are increasingly able to impel the government to solve the problems and pay compensation through petitions lawsuits. However, a lack of effective communication and compromise by some local governments, too eager to obtain financial contribution, leads to under-paying compensations for cultivated land and resettlement, thus triggering a series of social issues in resolving land compensation and resettlement issues.

**Rural Road Construction**

By the end of 2004, the urbanisation rate in China was 42% so that the rural population amounts to 58 percent of the total. Rural issues have great influence on public policy in China. In recent years, the Chinese government has paid great attention to the construction of rural roads. The mileage and density of the rural road network have obviously upgraded; this has visibly improved the travel condition of rural people. By the end of 2004, rural roads amounted to 1.42 million km (excluding village roads), an increase of 53 thousand km over the previous year. They accounted for 88 percent of the mileage of all newly built roads. The rate of villages with accessibility to roads amounted to 93 percent. In February 2005, the state council authorised the “National Rural Road Construction Plan”, which plans to invest 100 billion CNY to construct and upgrade rural roads during the nation’s “Eleventh Plan”. The “National Rural Road Construction Plan” also seeks to achieve travel quality with the features of “convenient, Safe, comfortable”, and to connect all villages with qualification of road accessibility by 2020.

**Transportation Equity of the Disadvantaged**

It is estimated that there are roughly 500 million “disadvantaged” people in China,
including: 60 million disabled, 88.1 million elderly, 45 million poor and 290 million children under the age of 14. As disadvantaged groups have special transportation needs, more convenient, economical, and safe conditions should be provided for them. Practically insuring their legal rights and satisfying their reasonable needs are not only moral principles in our society, but also in accord with modern basic social values which are well accepted worldwide. Not only is there a large disadvantaged population but we all are likely to belong to this group for a long period of time in our life span. So, we should take special action for this special group. For example, vehicles designed for the disabled are similar to regular vehicles in terms of their environment effects, but we cannot equate them in transportation management. Seldom is adequate consideration given to these issues.

In another aspect, as a core target of sustainable development strategy, "inter-generation equity" should not only emphasise environment protection and preserving recourses, but also the protection of city sights and historic cultural districts. Population, cities, and cultivated land are concentrated in the east and middle areas of the country, which takes about half of land area. The imbalance in space relationship between population and fixed resource (i.e. land) and the contrast between large populations and external food supplies mean that we cannot vacate the cultivated land for urban expansion by importing food like other middle-size developed countries. But according to the plan for 2020, infrastructure will consume 3.06% of the cultivated land, and the loss of cultivated land -- an extremely serious loss. Besides, for present and future citizens, historic cultural legacies and unique scenes including some cities (or districts) in addition to historic sites are invaluable assets. Anything which causes irretrievable damage for temporary economic gain is unworthy and unfair in the long term. But the attention given to the loss caused by the tide of transportation development and road construction by all levels of government is absolutely insufficient.

Transportation Efficiency State
Traffic Congestion Problems in larger Cities

With the fast urbanisation and motorisation in China, traffic congestion in large cities has become an outstanding problem. This has heavily disturbed the quality of life of citizens and has also caused great economic loss. Take Beijing for example; in 2003, over 40% of the work trips of Beijing inhabitants were longer than 1 hour and only 5.5% of work trips were less than 20 minutes. The average speed on 11 main urban roads is 12km/h. The total economic loss caused by traffic congestion in Beijing amounts to CNT 40 million per day. Another example is Shanghai: in 2003, the traffic congestion caused an economic loss of 10% of its GDP.

The Deteriorating Congestion on National Trunk Roads

According to the Ministry of Communications, in 2004, the average traffic congestion degree on national trunk roads was 0.53, an increase of 6% compared with 2003. In the middle and eastern part of China where the per capita GDP is relatively higher than in the western part, the national trunk roads are
rather congested, with an average congestion degree of exceeding 0.6. In Tianjin, Guangdong province, Hebei province and Shanghai, the congestion degree exceeds 0.8.

In 2004, the Annual Average Daily Traffic (AADT) on China’s national truck roads is 8696, an increase of 12% compared with 2003. The AADT on the expressways is 17736 standard cars per day, an increase of 16.4%.

**Transportation Related Health Issues**

“Transportation health equity” means that people who use public transit, personal vehicle owners, non-motorised vehicle users, and the vulnerable groups should enjoy equal rights of safety assurance and health. The question can be viewed from two aspects: first, reducing traffic injury, second, demanding that vehicle-users compensate for positive externalities such as air pollution, noise pollution, etc. China’s traffic safety problems are the world’s most serious; it has the highest number of road accident fatalities in the world. In 2004, there were 517,889 traffic accidents, which caused 107,077 deaths, 480,864 injuries, and direct property loss of 2.39 billion CNY. The most direct victims are youth and men in the prime of life. Also, it puts the poorest people and the vulnerable groups under the heaviest pressure. China’s government has realised the importance of the problem, but designs for legal policy and organisation are still stagnant. And, as we mentioned above, there are no workable plans on compensation for positive externalities.

**Transportation Environmental Problems**

In recent years, with the rapid transport development, environmental problems have become increasingly serious and hinder the economic development and adversely impact societal stability and public health. The emission and concentration share of CO and HC is higher than 60%, even reaching 90% in some large cities. The annual financial loss caused by air pollution amounts to 5% of the GDP in China. The illness and the death rate caused by air pollution increased gradually. If a proper system and regulations are not established, public health, public environment, the quality of life and economic development will be seriously affected.

2. **Suggestions on policy of building transportation equity in China**

Obey the following principles strictly in selecting policies that can help to solve transportation’s socio-economic issues in China:

- Majority priority principle;
- Consistency with the demands for national conditions and sustainable development principles;
- Consistency with the cities’ and national long-term profit principle;
- Protecting the disadvantaged groups’ rights

A policy should conform to these basic judging standards and satisfy objective
Transportation development should benefit all people, and shift its focus from the solution of traffic jams to improving people’s trip environment and the effective mobilization of freight, thereby propelling the development of society. Fully carry out the “only charging the consumers” policy and promote the vehicle reforms of administrative institutions in pursuing consistency between transportation installation benefits and costs. In order to internalise positive externalities, we should collect taxes for environment protection and the fuel use of vehicles as soon as possible; all levels of government should put appropriate investments into poor areas while delegating transportation construction to the private sector. All these will promote transportation economic equality.

We also should change the situation of over-centralising the policymaking power and arrange for the government to encourage the mass to participate in transportation planning and policy making, and bring transportation information into the open. The government should know that implementation of any policy relies on support of the public, so we must plan cautiously, communicate frequently with the masses, and pay compensation that is not less than their losses. The relevant local government officials should be responsible if the issues of compensations for cultivated land and migration cause social unrest.

We should truly attach significance to the damage to “health equity” and quality of life caused by traffic congestion; we should learn from the experience of foreign countries such as Hong Kong, Macao, and Singapore and limit automobilisation and restrain the overgrowth of transportation. We should also take effective steps to develop skills and management to provide the elderly, children, the disabled, and the poor with good transportation service, and to build a safe and convenient traffic environment.

Education on sustainable transportation, particularly publicity and educational activities regarding transportation safety, should be carried out. This kind of education should be strengthened and expanded among pupils and students through the media or various educational activities, thus forming a national educational system for sustainable transportation. The transportation safety management functions of government authorities at all levels should be consolidated and the accident investigations and accountability system strengthened as well.

References
Address for correspondence

China Academy of Transportation Science, Ministry of Communications Beijing
E-mail: Feng_liquang@163.com

Wang Yongsheng
China Academy of Transportation Science, Ministry of Communications Beijing
E-mail: Yongshengwang@sina.com

China Academy of Transportation Science, Ministry of Communication, China
Ph: 0086-10-58278102
E-mail: leey@iicc.ac.cn
Rural Transportation (Adaptability and Fund Policy)

Development of Rural Roads in China

Li Yang

The rural highway is an important component of the highway network of China, accounting for over 80% of its total length. Currently, in the vast rural areas of China where the population accounts for 61% of that of the entire country, its mobility is highly road dependent. Speeding-up rural highway construction is the direct and effective way to develop the rural economy, promote urbanisation and industrialisation, narrow the gap between the rural and the urban areas, raise the living standard of farmers, alleviate poverty and promote social progress in the rural areas. It is the important precondition for the all-round promotion of a well-off society in rural areas and would influence the entire social and economic development of China. Rural roads have developed from 1.03 million kilometres in 2000 to 1.55 million kilometres in 2005. As a percentage of total road construction investments, rural road investments rose from 13% in 2000, to 25% in 2005. The proportions of town and village roads are 99.9% and 92.3% respectively. The bituminous/cement roads of rural roads had reached 1 million kilometres, compared to 460,000 kilometres in 2000, During the 10th Five-Year Plan period," the Newly constructed length surpassed the total of the first 50 years. Great achievements have been made in the construction of rural highways in China ever since the opening-up and reform. However, it is still far behind the requirements for meeting the social and economic needs of the rural areas and the improvement of farmers’ lives. The highways in rural areas do not reach enough remote areas. The technology level is fairly low and the condition of the rural highways is rather bad, with unbalanced development in the east, middle and west areas. The major reason is that there has long been the problem of lacking stable and adequate construction funds for the rural highways in China. The overall ratio of the investments for rural highways has varied between 10-17%. The funds for the rural highway
construction are mainly raised by local
governments and the farmers bear a heavy
burden. The investment of the governments
at various levels is less than 40%.

**Development Goals of Rural Roads**
The general development goals for China's
rural roads are: almost all the towns and
administrative villages with appropriate
traffic conditions will be equipped with
highways that will form a rural road
network with high service level that will
enable the farmer to go on a journey
conveniently, safely and more comfortably.

The stage goals are: by the last stage of
11th Five-Year Plan period**, all towns and
administration villages with appropriate
traffic conditions will have highways. The
towns and administrative villages of the
Eastern area and part of the Middle area
will have bituminous /cement roads; the
bituminous /cement roads proportion of
towns and administrative villages of part of
middle area and western area township
township (town) will be distinctly enhanced as
follows: (1) The roads accessibility of towns
and administrative villages with appropriate
traffic conditions will achieve 100%. (2) The
bituminous /cement roads accessibility of
administrative villages will achieve 75%.

During the “11th Five-Year Plan” period, the
nation will rebuild 500,000 kilometres of
bituminous /cement roads and will increase
newly constructed rural road length by
330,000 kilometres. By 2010, the rural road
length of county and township roads will
amount to 1.85 million kilometres. The
depth of the accessibility, technical
condition and service level of rural roads
will be significantly enhanced and the bus
service goals for rural passenger
transportation will be met so that farmers
will be able to travel easily to market.

The target for rural highway construction in
China by 2020 is: to complete the
engineering projects of “Reaching Rural
Areas” and “Smooth Transportation”; the
total length of the rural highways in the
entire country will hit 2.5 million
kilometres; bitumen (cement) highways will
be constructed in over 98% of the
townships and over 90% of the
administrative villages; and a rural highway
network with sound service capacity will be
basically set up. In order to achieve the
target, a legally guaranteed funding supply
system with enough stable financial sources
for the rural highways should be set up.

**Funding Sources for Rural Roads
Construction**
The Chinese rural highway construction
funds are presently composed of two parts:
One is the central funds; the other is local
funds, and the latter being the main source
of funding.

Central funds include the investments from
the central financing and special-purpose
funds for highway construction. Central
financing mainly refers to state budgetary
funds, special-purpose funds and the policy
of “replacing the subsidies with
employment” for Aid-the-Poor. Special-
purpose funds for highway construction
refer to Vehicle purchase taxes and the
capital investment from the Ministry of
Communications which are mainly used as
a subsidy for rural roads construction.

Local funds include local financial funds,
investments from local transportation
departments, loans from banks and
investments by farmers.
(1) Local financial funds.
These include the funds provided by the provincial, local/city, and county/town governments. The most important of these are those provided by county/city/town financial funds. Local financial special-purpose funds are provided by the central government which arranges for the local financial departments to use such funds. They are responsible for repayment (local governments cannot issue governments bonds according to relevant laws in China).

(2) Investments from local transportation departments.
The local transportation departments mainly include provincial (municipal) departments of transportations and city/county departments of transportations. The capital investments from the provincial departments of communications are mainly in transportation fees imposed and managed by the departments of transportation such as auto road tolls and surcharges for passenger/cargo transportation. The capital investment from the city/county departments of transportation is mainly the road tolls paid by local tractors, motorcycles and agricultural trucks. Also called tractor road maintenance fee or truck road maintenance fee, this is the main stable capital source for rural roads construction.

(3) Loans from domestic and international banks.
Loans from domestic banks are mainly used in the construction of those rural roads with large traffic volume that can realise “building with loans and repaying loans with road toll”. Loans from overseas are mainly provided by international financial organisations such as the World Bank and the Asian Development Bank.

(4) Investments from farmers.
The investments from farmers are mainly the funds raised from farmers who contribute capital instead of their labour, and the money raised by investments and donations from enterprises that gain benefits from the construction, donations from individuals and units at home and abroad, in addition to social donations as well. Although many sources are involved, this accounts for a rather small portion of the total capital investment in rural roads construction.

For many years, state financing of rural highway construction has been extremely limited, and unstable and all the other sources are also inadequate and difficult to obtain. Village road construction ultimately depends upon the villagers to provide voluntarily labour and funds. Thus, how to finance rural highway construction has become the main problem.

Suggestions on Fund Policy for the Development of Rural Roads
In order to achieve the planned targets, a legally guaranteed funding system with enough stable financial sources should be set up. The policy recommendations on funding are as follows:

1. To utilise the current fund channels and set up specific funds for rural highway construction
According to the current situation in China, the specific funds for rural highway construction could use the following existing fund channels:
   - Vehicle Purchase Tax. The vehicle purchase tax could be an important financial source for the Central Government to carry out macro regulation and control of rural highway
construction. It is recommended that the Central Government should provide about 15% of the rural highway construction funds each year, and some of it should be reserved for the middle and the west of China.

- Highway Maintenance Fee of Vehicles. A certain ratio of this should be used for developing rural highways. It is recommended that the provincial investment funds provide about 20-25% of the total for rural highway construction each year. And, in the east of China, the percentage should be higher.

- Highway Maintenance Fees of Tractors. The levy mechanism of highway maintenance fees of tractors should be regulated and the levy should be enhanced. Its management and supervision needs to be strengthened so as to solve the problem of not levying all the appropriate fees.

- General Finance Subsidies. It is recommended that a specific expenditure item for rural highway construction be set up by the local governments to which a certain ratio of the tax revenue is assigned so as to set up a long-term stable financial source for rural highway development.

2. To Seek New Specific Financial Channels for Rural Highway Construction

Rural highway construction cannot be financed only by the above-mentioned financial channels. The following new sources should be set up for rural highway construction:

- Make the vehicle utilisation tax the specific tax for rural highway development.
- The taxes and fees levied in the process of highway construction should be returned to rural highway construction.
- The taxes and fees levied by the toll-highways

3. To establish Universal Service Funds for rural roads

Since it is impossible to obtain sufficient construction funds through a fees system, it is necessary to establish the Universal Service Funds to be managed by the government. This would represent an effective long-term means to develop rural transportation. The rural road Universal Service Fund might take the non-tax revenue income from the central financial revenues, include the central financial special bank account, and implement "the revenue and expenditure two lines".

4. To take the opportunity and carry out policy of levying fuel tax

China has decided to levy a fuel tax. Due to various reasons, it has not yet been put into effect. The earliest possible implementation of this tax and the assignment of a certain ratio for rural highway construction would have the following benefits. Firstly, it would enhance the central government and provincial governments’ ability to regulate and control highway construction funds. Secondly, it would slow down the trend towards decreasing energy supply and increasing environmental pollution. Thirdly, it would be equitable since the more a person drives, the more he/she pays for it.

5. To arouse popular enthusiasm, raise funds from multiple channels and save them for rural highway construction

Efforts should be devoted to further arousing the enthusiasm of all segments of the society and raising funds from multiple channels and saving these funds for rural
highway construction. This is an effective measure to raise necessary funds for rural highway construction and could include: 1) persuading the entire society to contribute to the financial mechanism; (2) continuing to implement the policy of "Replacing the Subsidies with Employment"; and (3) seriously implementing the mechanism of "Specific Discussion on Specific Issue".

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Contact details of Author:
China Academy of Transportation Science, Ministry of Communication, China
Ph: 0086-10-58278102
E-mail: leeey@iicc.ac.cn
Strategy Vision and Policy Recommendations on China’s Sustainable Transportation

Wei Zhou & Joseph S. Szyliowicz

Strategic Vision
To establish an integrated transportation system that is safe, convenient, highly efficient, economic, equitable, and environmentally friendly and promotes socio-economic development in China.

This system should be able to meet the demands for mobility in both the passenger and freight sectors while remaining in harmony with nature and society.

The transportation system should follow the social and economic development trajectory of China: meet the demand for transportation to build a balanced and healthy society, continue rapid industrialisation and urbanisation, promote globalisation and facilitate participation in the international economic scene.

The transportation system should consist of a diverse modal mix. It should benefit the society by providing a range of mobility choices to all segments of the population while still reaching the goal of functioning as a safe, reliable, convenient, comfortable, and cost-effective system.

The transportation system should develop in harmony with the natural environment. It should be based on the circular economy principle so as to utilise resources in a constructive, waste-minimising, and recyclable way, and limit polluting emissions and wastes in order to prevent transportation development from seriously damaging the natural ecosystem and the environment.

Policy Recommendations
To realise the strategic vision, six specific policy measures are recommended:

1. Implementing Administrative System Reform in China through a Two-stage Process
In the first stage, different modes of transportation in China should continue to be managed separately. A centralised, comprehensive transportation administrative organisation—the National Integrated Transportation Coordination Commission (NITCC)—should be established. The NITCC should improve the consistency and coordination in development strategies, development planning, and industrial policies, and
financial management of different transportation modes. NITCC, as suggested here, should be made full preparation to promote China’s sustainable transportation development.

In the second stage, when appropriate conditions have been created, an integrated organisation for transportation (a National Transportation Commission or Ministry of Transportation) should be organised in China. This commission or ministry should be responsible for a uniform management of transportation system including railways, highways, waterways, aviation, pipelines, urban transportation, and transportation safety and environmental protection to realise a more efficient integrated transportation system.

2. Utilising Economic Instruments to Promote China’s Sustainable Transportation Development

Implement the fuel tax system:

- The fuel tax is an important measure because it reflects the “user-pays” principle, implements macroeconomic control over transportation development, encourages the development of different transportation modes, vehicles, and energy sources and curbs excessive motorisation. It also promotes research on new-type s of vehicles, and ensures adequate funding for the development of sustainable transportation. China has already enacted fuel tax legislation. Now, the pace of implementation should be quickened.

- The total revenues derived from the fuel tax should be used to fund maintenance and macro-control costs.

Establish a “National Transportation Fund” in China. Such a fund is the key to China’s sustainable transportation development. Specific implementation planning should be developed by NITCC (or led by National Development and Reform Commission and Ministry of Finance), and be implemented after the approval of China’s central government.

- The National Transportation Fund should be funded by revenues from existing transportation taxes, all the revenues from the forthcoming fuel tax, and a share of revenues from the proposed increase in the value added land tax.

- NITCC, as suggested here, should centrally administer and allocate the fund, and oversee its use as well. To ensure transparency and accountability, the NITCC shall publish annually a statement outlining the planned expenditures of the Fund and the reasons for the selection of particular projects. It should also provide an evaluation of the progress of ongoing projects and of the impacts of completed ones.

- The fund should focus on transportation modes and relevant plans promoting sustainable transportation development. It should assign priority to those areas in greatest need of assistance such as urban public transportation, rural road construction and maintenance, development of sustainable transportation technology, transportation for the disadvantaged and safer bicycle and pedestrian ways.

Internalise the external impacts:

- Appropriate subsidies and incentive
policies should be granted to transportation modes that have low external costs, such as railways, waterways, and urban public transportation.

- Un-sustainable transportation imposes very high costs on society (delays, ill health, global warming, injury and death). These externalities should be taken into account in the cost accounting and pricing management of the transportation modes according to the “Polluter Pays” principle. Only when prices reflect true costs will the market mechanism be able to ensure that individuals and businesses make sustainable transportation choices.

- Taxes should be levied on cars according to the costs that they impose upon the environment in regards to energy use, traffic congestion, pollutant discharges, and traffic accidents.

3. Integrate Planning and Optimise Transportation structure

Develop an integrated spatial planning system. Land use and the developed infrastructure have a huge effect on mobility needs. By developing an urban structure which provides all kind of services locally for the inhabitants, less transportation is needed. Furthermore, mobility choices like good access to public transportation are easier to achieve when integrated planning is the norm.

Develop integrated transportation planning which reflects government policies and priorities in regards to the development of various transportation modes. Such planning should take into account the rational utilisation of the “corridor resource” of the transportation system, strengthen the planning and construction of intermodal terminals and hubs, and realise coordinated development between transportation modes.

Formulate new policies for transportation. Policies that are designed to promote the development of sustainable transportation must be based on such concepts as “circular economy” and “green economy”, and incorporate relevant scientific and technical innovations.

Speed up railway development:
- China’s legal and regulatory system in regards to Railways should be improved and the Railway Law should be amended to make clear the relationship between governmental functions and commercial operations, and to provide a legal foundation for further railroad development.
- Promote the reform of the railway investing and financing system and accelerate its marketisation. Multiple investing and financing channels should be adopted to facilitate the construction of high-speed rail lines for inter city passenger transportation, urban rail transit, and heavy transportation corridors for freight.
- The current railway construction fund should be preserved as a stable and
sustainable funding source for railway development by levying service fees on passengers and freight.

- Increase the central government investments in railways. The government should have explicit responsibility for providing financial support for construction and operation of the rail lines that are relevant to the national defence, poverty reduction or key land development. The government should allocate more financial support to Western China and to coal transportation.

Support inland waterway transportation:
- The central and local governments should establish special funds for inland waterway transportation to ensure a stable source of funds for its development.
- An appropriate legal and regulatory system should be established as rapidly as possible. For example, the "Law of Navigation Channels" should be amended based on the currently effective "Regulations Concerning Management of Navigation Channels" to provide a legal basis for investments in inland water transportation.
- Coordination between relevant departments should be strengthened and problems relating to water conservation and hydroelectric power generation should be resolved in order to realise more efficient utilisation of water resources.

**Promote Transportation Equity**
Enhance public awareness of sustainable transportation and strengthen public supervision and participation in transportation planning and decision-making:
- The public should be given appropriate opportunities to provide inputs when legislation concerning sustainable transportation development is under consideration. Opportunities for participation and supervision by the public and social entities, including non-governmental organisations, should be strengthened at all stages of the policy process, including the implementation of laws and regulations.
- Transportation information facilitating public participation in policy making should be widely disseminated. The results of inspections and legal processes should be reported promptly and accurately in order to increase public awareness and participation and thus strengthen the inspection and regulatory process.

Enhance public consciousness of transportation safety and strengthen the accident investigation and accountability system:
- Educational programs on all aspects of sustainable transportation, including safety should be strengthened and expanded. Various educational channels and activities should be utilised to reach students at all levels, thus forming a comprehensive national educational system for sustainable transportation.
- The transportation safety management functions of government authorities at all levels should be consolidated and the accident investigations and accountability system strengthened as well.

Convenient Transportation for Disadvantaged Groups:
• Such groups should be accorded special opportunities and benefits. Labourers from rural areas (with certificates) should enjoy an inexpensive trip home every year, the price of their tickets remaining unchanged. The disabled and the elderly (over 60 years old) should enjoy discount rate bus tickets. Compensation should be provided for people whose livelihood is threatened by land expropriation and removal.

Promote Public Transportation Development and Implement Mobility Management

Integrate transportation and land use development:
- Develop modern urban mobility management concepts and provide guidelines for the design of new cities and the development of existing cities. Synchronized master planning and comprehensive transportation planning should be developed according to integrated land use and transportation policies and plans that incorporate transit orientated development measures (e.g. multiple-mode transportation corridors).
- Urban development should be strategically shifted to avoid overexploitation and densification of urban central areas and to minimise urban sprawl.
- The traffic impact assessment system should be strengthened and the transportation impact compensation mechanism should be formulated and implemented.
- Integrated transportation corridors with interoperability between different transportation modes should be developed to ensure that public transportation could guide urban and land development (the TOD model). Establish the mechanism that levies land value-add tax to feed back public transportation investment.
- Demands of public transportation and non motor vehicles should be given priority in urban road design and planning to ensure their road resources.
- Establish public hearing system for large-scale urban infrastructure and transportation projects.

Development of public transportation should be given first priority:
- Efforts to improve public transit should be integrated with a larger vision of the future city. Public transportation infrastructure (including dedicated transit lanes, stations, hubs, and information facilities) should be improved in order to create an efficient, integrated service network for public transportation. The share of public transportation should be set as an index to evaluate the achievements of major urban leaders.
- Urban and inter-city rail transit should be promoted. Policies governing licensed operators should be adopted in areas along rail lines, in order to promote the development of rail transportation in mega cities and city clusters.
- Bus Rapid Transit (BRT), deserves careful consideration because it is financially viable, increases speed and safety, and diminishes pollution. Promote BRT wherever it is possible.
- Intelligent technology systems and other technologies should be utilised to improve the efficiency and quality of service of regular bus systems.
Managing mobility effectively to avoid congestion through balancing travel demand and supply:

- There can be no doubt that steps should be taken to encourage people to use public transit and/or non-motor vehicles to the greatest possible extent. Car use should be a choice not a necessity. This means managing mobility in such a way as to reduce demand for unnecessary travel and providing viable alternatives to car use.

- Car users should pay the true cost of using the car in crowded urban environments either through parking charges, congestion charges or other forms of road pricing.

- The time structure of traffic should be regulated and controlled and flexible work times should be used to stagger peak hours.

- With advanced traffic management methods and intelligent transportation system technology, updated transportation information can easily be provided so that citizens who have to travel by car can choose the most appropriate routes to take before and during their travel so that they can reach their destination in the shortest possible time and not contribute to congestion.

- The Chinese government should centrally coordinate the space data enquiry regulation and transportation information service demands to provide real time and reliable transportation information.

Setting up a special account for urban transportation:

- The account would be composed of the revenues from different taxes and fees including, for example, revenues from urban land lease, transportation impact compensation fees, consumption taxes, and fixed asset taxes, vehicle purchase taxes (e.g. from a 2-5% surcharge for large volume limousines), congestion charges, parking fees, and fines imposed on traffic regulation offenders.

- To ensure transparency and accountability, annual reports should be published to identify the measures that have been funded and the impacts of previously funded measures.

Implement Resource Conservation and Promote Environmental Friendly Transportation

Improve transportation environmental protection systems and strengthen governmental monitoring and supervision capability:

- Implement Strategic Environmental Assessment (SEA) for policies, plans and programs to recognise environmental effects early in the decision-making process and therefore contribute to a cost efficient and highly benefited sustainable transportation system.

- Establish implementation guidelines for environmental impact assessment of integrated transportation planning. Require environmental impact assessment during formulating national and regional integrated transportation planning.

- Strengthen the environmental protection responsibilities of transportation management departments at all levels and establish the accountability system.

- Strengthen public participation and promote the development of non-government environmental organisations. Formulate...
environmental damage compensation laws and optimise the environmental dispute resolution regulations. Develop systems to disseminate environmental information and formalise public hearing on environmental issues.

Slow growth in transportation energy use, especially oil consumption:

- Optimise motor vehicle fuel consumption standards. Establish fuel oil consumption standards for all new-type motor vehicles by 2008 and enforce the Limits of Fuel Consumption of Passenger Cars. Fuel consumption of new motor vehicles should be reduced by 40-50% per hundred kilometres by 2015.
- Develop policies for the research, popularisation, and utilisation of clean alternative energies. Clean alternative fuels should be first used in such vehicles as buses and governmental vehicles.
- Optimise technical approaches for the development of advanced vehicles techniques and formulate relevant policies to focus on the introduction, research and industrialisation of the hybrid synergy drive.

Land occupancy conservation:

- Develop technical standards with a strong scientific basis for transportation facilities. Based on the principle of full cost and environmental protection, flexible technical standards for the construction and maintenance of transportation infrastructure should be established with a consideration of regional differences. Shorten the period of standard revision and ensure a practical, timely and authoritative technical standard.
- Implement stricter utilisation, compensation, and restoration systems for natural resources conservation. Amend the transportation land compensation system and carry out onsite or off-site excess compensation for nature reserves, wetlands, forests and grasslands. Limitation for temporary land use should be used to the land occupation index of transportation construction projects.

Air pollution control to improve urban air quality:

- Adopt and implement vehicle emission standards GB3 and GB4 including PM 10 as soon as possible to help the Chinese enterprises reach the technical level of vehicle emission control in developed countries.
- Establish and carry out strict fuel quality standards to facilitate the implementation of emission standards for new motor vehicles. In particular, promote the supply of gasoline and diesel oil with sulphur contents below 150ppm and 350ppm respectively in the whole country in 2007, and with sulphur contents below 50ppm from 2010, and then oils with super-low sulphur contents that are below 10ppm.
- Realise the coordination and cooperation between transportation development and air quality improvement according to the local conditions. Implementation plans for reaching the pollutant emission standard in each city should be formulated through the joint efforts of different departments and the deadline to reach the standard should be set to meet the overall demands of urban air quality.
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Wei Zhou,
Professor and President, Professor,
China Academy of Transportation Science, Ministry of Communication, China
Ph: 0086-10-64411910 Fax: 0086-10-649642
E-mail: zhouwei22@vip.sina.com
Joseph S. Szyliowicz, Professor,
Graduate School of International Studies, University of Denver
Ph: 303-871-2992 Fax: 303-871-2456
E-mail: jszyliow@du.edu