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Mobile-Source GHG Modeling Institutions and Capacities in China:

Findings Based on Structured Interviews and On-line Surveys

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ABSTRACT

This paper provides an overview of practices of mobile-source greenhouse gas (GHG) modeling in China and related data sharing issues, based on structured phone interviews and two on-line surveys conducted in 2011. This paper finds most cities have transportation-land use models but few have mobile-source GHG models. A group of entities housed in the government have the strongest GHG modeling capacities and dominate the relevant consulting market. Data hoarding of public entities is the biggest barrier for entities without government ties to compete in the market. The reasons for data hoarding are: the government's concerns over political implications of data release, a tradition of data hoarding and lack of confidence in reliability and accuracy of data.

INTRODUCTION

Many countries, regions and cities have taken a variety of initiatives in response to global climate changes (1). Greenhouse gas (GHG) modeling is an indispensable part of the initiatives, which estimates the anthropogenic GHG emissions of a place for a base year and forecasts the corresponding emissions for a future year assuming certain events would or would not happen. The transportation sector accounts for a notable portion of all anthropogenic GHG emissions. For instance, the sector produced about 32% of all CO_2 (a principal GHG) emissions emitted in 2009 in the US (2). Therefore, GHG modeling for the transportation sector, that is, mobile-source GHG modeling, plays an important role in overall GHG modeling. But given the fact that GHG modeling is an emerging topic to most transportation officials and modelers across countries, there is still much they can learn from one another: from data collection to model building, and from institutional changes that accommodate mobile-source GHG modeling to peer learning that helps modelers improve their modeling skills.

As the largest GHG emitter and the most populous developing country in the world, China is facing both challenges and opportunities in the area of mobile-source GHG modeling. On one hand, the first generation of conventional four-step travel demand or related transportation-land use models ("transportation models" for shorthand hereafter) in most cities are still being envisioned, established or calibrated. Many modelers or institutions are still improving their skills or capacities in this process. On the other hand, due to the above status, it is still feasible to integrate a mobile-source GHG model seamlessly into ongoing transportation modeling efforts. To turn feasibility into reality, however, many important tasks need to be undertaken. One of such tasks is to evaluate capacities of different entities and common challenges faced by them. Specifically, we need to answer questions such as:

- Which entities play a dominant role in mobile-source GHG modeling practices;
- What technical capacities these entities have;
- What data are available for these entities to do the GHG modeling;
- What efforts have been made to enhance the GHG modeling at these entities;

- What are the institutional, technical, policy and data gaps in or barriers for the GHG modeling.

This study/paper attempts to address the above questions by interviewing selected transportation officials, modelers and professors in China, and seeking and synthesizing answers from them. Furthermore, to explore data access and sharing issues posed by some interviewees, two surveys were conducted.

This paper is therefore of relevance to:
(a) Persons who are interested in the transportation and mobile-source GHG models and related practices in China and beyond;
(b) Persons who want to learn from China's experience so as to build better mobile-source GHG models and to enhance related institutions;
(c) Persons who want to know more about data access issues when developing mobile-source GHG models in a developing country like China.

The reminder of this paper is organized as follows. Section 2(next section) reviews existing literature or projects in light of the above research questions. Section 3 introduces the interviews and surveys conducted in support of this paper. Section 4 summarizes answers to the above questions based on the interviews and surveys. Section 5 concludes and discusses future research.

RELEVANT LITERATURE

At the local or regional levels, China did not have its own officially recommended emission models, such as the MOBILE or MOVES in the US, for local mobile-source GHG modelers as of 2009 (3). But foreign models and emission factors from these models have been borrowed by the academia to estimate mobile-source emissions in leading Chinese cities such as Beijing and Shanghai (4-7). Given the differences in average road conditions, engine efficiency, travel behaviors and climate between China and foreign countries where the borrowed models were developed, mobile-source GHG emission estimates for Chinese cities based on foreign models do not have the level of accuracy that modelers would like to have (3,8). For the professionals, they were still calibrating their respective transportation models in which mobile-source emissions were rarely considered, no matter in Beijing, the capital of China, or in Kunming, a provincial capital in Western China, a less developed area in the country (9-15).

Recently, the academia have proposed and started developing mobile-source emission models with reference to foreign models (3, 7). At the national level, led by Chinese Academy of Social Sciences, an interdisciplinary and cross-entity team has also

started developing GHG inventory at the urban level in China since 2011[1]. Given the divide between academic/basic research and public policy making, however, it remains to be seen how these newly developed models by the academia would affect mobile-source GHG modeling practices in Chinese cities.

At the national level, several individual scholars have quantified how mobile-source GHG emissions in China could be reduced under different scenarios, for instance, with increased use of alternative fuels, improved vehicle technologies or introduction of bus rapid systems (16). From the perspective of energy consumption and conservation, several other scholars have indirectly estimated mobile-source GHG emissions of China in 2030 should the country adopt stricter fuel economy standards, promote wider use of alternative-fuel vehicles, improve supply of clean fuel and/or attract more people to public transit (17). The scholars predicted that China's fuel consumption in 2030 could remain at the level of 2005 if the multiple actions mentioned above are taken, even if China's vehicle fleet size might grow to 400 million by then (17). Very recently, Young Crane Consulting (YCC) (18) completed an independent study of annual transportation emission inventory for China and the country's 17 cities in 2011. YCC adopted United Nations Intergovernmental Panel on Climate Change (IPCC) "2006 IPCC Guidelines for National Greenhouse Gas Inventories" as a basic methodology for all national-level or city-level cases. YCC also provided a brief analysis of current data and statistics system problems. Two identified problems were that (a) fuel economy data of private or governmental vehicles were not available in most cases; and that (b) actual fuel consumption data were not kept track of by any authority. These problems posed great challenges for YCC's estimations, which relied heavily on fuel economy and fuel consumption data.

Outside China, there have been many more mobile-source GHG models and tools developed, some of which have been used by Chinese researchers, as highlighted above. Some high-profile governmental agencies have summarized these models and tools, particularly the ones that can be used by their subordinates or local counterparts. US Department of Transportation, for instance, has a webpage containing introduction to 22 mobile-source GHG models and tools which can be used by entities in the US[2]. There are also more documents issued or endorsed by the governmental agencies to guide entities to quantify and to reduce transportation pollution and emissions, including GHG emissions. US Environmental Protection Agency listed 34 documents on its website as the topic-specific guidelines for entities to quantify their programs which aimed at reducing transportation-related air pollution and emissions[3].

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[1] More information about the progress of this team's work is at: http://iue.cass.cn/.

[2] For full list of these tools and models, please visit: http://climate.dot.gov/methodologies/models-tools.html.

[3] For more information, please visit: http://www.epa.gov/otaq/stateresources/policy/pag_transp.htm.

The above survey of existing literature by no means is exhaustive. But it covers a decent amount of representative literature or project information on the research topic which the authors (a) synthesized from information provided by the interviewed local experts and (b) found through two leading academic literature search engines in the Chinese and English worlds, CNKI and Web of Science, respectively.

As a whole, the survey indicates that:
(a) Scholars have studied the technical details about the mobile-source GHG modeling in China;
(b) Scholars have modeled the effects of various possible actions on China's future mobile-source GHG emissions;
(c) Little has been done on the questions proposed in this paper regarding the identity of mobile-source GHG modeling entities, their technical capacities, the institutional and policy arrangements within these organizations, and their data access for mobile-source GHG modeling. Therefore, this study would somewhat fill the void in existing literature.

INTERVIEWS AND SURVEYS

Overview of the Interviews and Surveys

To answer the research questions posed above, a series of structured phone interviews were scheduled and conducted from May 2011 to June 2011. To avoid potential biases in answers obtained from the interviews, the interviewees were deliberately selected to ensure that they well represented those who directly worked on transportation and mobile-source GHG models in China. The three criteria used to guide the interviewee selection were: **First,** recruiting at least two interviewees who developed or supervised the development of transportation and mobile-source GHG models for Beijing, Shanghai and/or Guangzhou, the only three *Class I* cities of national significance designated by the Chinese Central Government; **Second,** identifying interviewees from China Academy of Urban Planning and Design (CAUPD), which has always been the most prestigious national consulting organization in the fields of urban/transportation planning/modeling in China; **Third,** including interviewees who have used or developed transportation and mobile-source GHG models from a variety of entities: universities, CAUPD's provincial counterparts, private consulting firms and international NGOs.

Based on intensive outreach and referral efforts, a series of interviews were successfully conducted with the following people:
(a) Three officials who administrated transportation models in Beijing, Shanghai and Guangzhou;
(b) Five transportation planners/modelers from CAUPD;
(c) Three transportation modelers who were directly involved in developing, calibrating and maintaining transportation models in Beijing, Shanghai and

Guangzhou;

(d) One professor and two graduate students from Tsinghua University, and another professor and two of his/her graduate students from Beijing Jiaotong University (BJU);;

(e) Four transportation planners/modelers from Jiangsu Institute of Urban Planning and Design[4], who have not only used or developed transportation models for medium- or small-sized cities but also knew related research well in the Chinese context;

(f) One transportation modeler from ATKINS China Ltd., one of the largest private urban/transportation planning consulting firms in China;

(g) Three transportation modelers/planners from an international NGO's China Office, which had a mission to promote sustainable transportation in China. They were involved in developing a neighborhood-level mobile-source GHG model.

Each interviewee was asked the same set of bulleted-list questions shown above. They were also welcomed to recommend any good references if they thought their answers were incomplete or not detailed enough, which greatly helped the literature review above. To address confidentiality concerns and to encourage free talks, the interviewees were guaranteed that their name and contact information would not be released to third parties without their authorization.

Based on the interview notes, the authors identified an important problem that government agencies tended to hoard urban/transportation planning data they had collected. Consequently, a supplementary short on-line survey ("S-Survey" for shorthand herein) was sent to 2,000 persons, who had a micro-blog account with www.china-up.com, from October 05, 2011 to October 21, 2011. The website was one of the most popular websites for Chinese urban/transportation planners. It was operated and financed by CAUPD on behalf of Ministry of Housing, Urban and Rural Development (MoHURD) of China. MoHURD supervises urban and transportation planning affairs in China at the national level. Most existing users of the website anonymously registered for themselves and so we did not know exactly who they were. But we did know that they were at least interested in urban and regional planning issues in China.

S-Survey's purpose was to investigate the potential causes of the data-sharing problem and possible institutional or procedural changes that might help solve it. Discussions of the data-sharing problem in Section 4 were based on the responses to this survey as well as relevant existing literature. This survey was a multi-choice question and had seven choices. Details of the survey were offered in the appendix of this manuscript.

[4] This institute can be viewed as the CAUPD of Jiangsu Province, one the most developed and populous provinces in China.

S-survey produced 105 valid responses. The response rate was about 5%. It was low but we were still somewhat satisfied because (a) the survey was sent from an individual that most users of the website had nerve met; (b) the survey was voluntary and offered no incentives of any kind; (c) not all users of the website have regular access to Internet services; (d) most transportation/urban planning professionals were simply too busy with projects to pay attention to the survey.

Of all the 105 respondents, 17 were willing to reveal their employer's status and 59 were willing to share their employment or university location. It was not surprising that so few respondents were willing to reveal their employer status as (a) we made this relevant question optional; (b) it has been a tradition that people working in public or semi-public entities in China are cautious about revealing their employer status. They are afraid that their individual opinions might be regarded as those of their employer, the government. They are also concerned that some from the media would find fault with them no matter what they say.

Anyway, by employer status these 17 respondents were identified as:

1. Private planning consultants (n=2);
2. Urban planning professors or students (n=5);
3. Planners working for NGOs (n=3);
4. Planners working for the public sector (n=7).

Assuming that the 17 respondents well represented the unknown universe, it means government officials were not included. Thus, the answers based on the responses might be "biased" since they better represent those who need data from the government rather than those who are with the government.

Of the 53 domestic respondents releasing their employment/university location, 38 (72%) were from Beijing, Shanghai and Guangzhou (See Figure 1 for breakdown by employment location). Thus, these cities tended to be overrepresented in the responses. But there is probably no need for alarm as these cities had the most active urban/transportation planners/modelers and led in transportation modeling capacities in China. Most of these professionals also worked on various projects and were familiar with data-sharing situations in cities across China. Taking CAUPD professionals as an example, most of them were employed in Beijing but worked on projects in cities across China. Interestingly, six respondents were from outside China. This partially indicates that people abroad cared about data sharing issues in China as well.

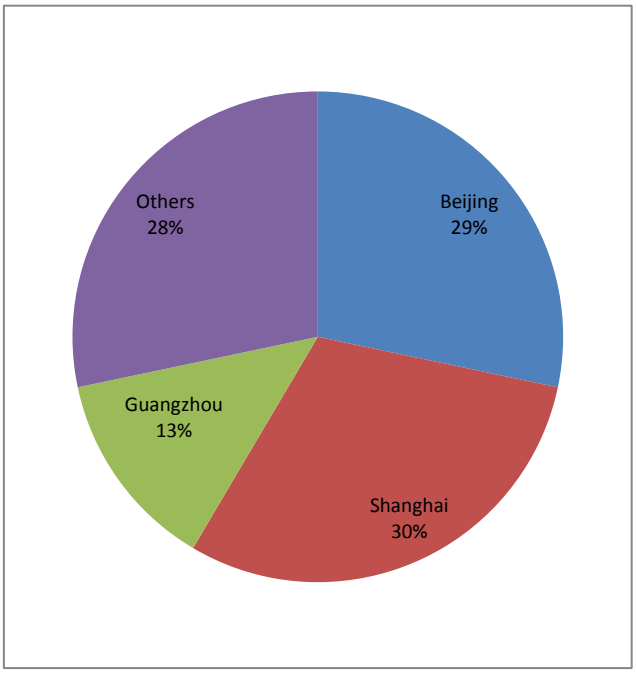


Figure 1: Survey Responses by Employment Location (N=53)

INTERVIEW/SURVEY FINDINGS

Which entities are responsible and/or capable?

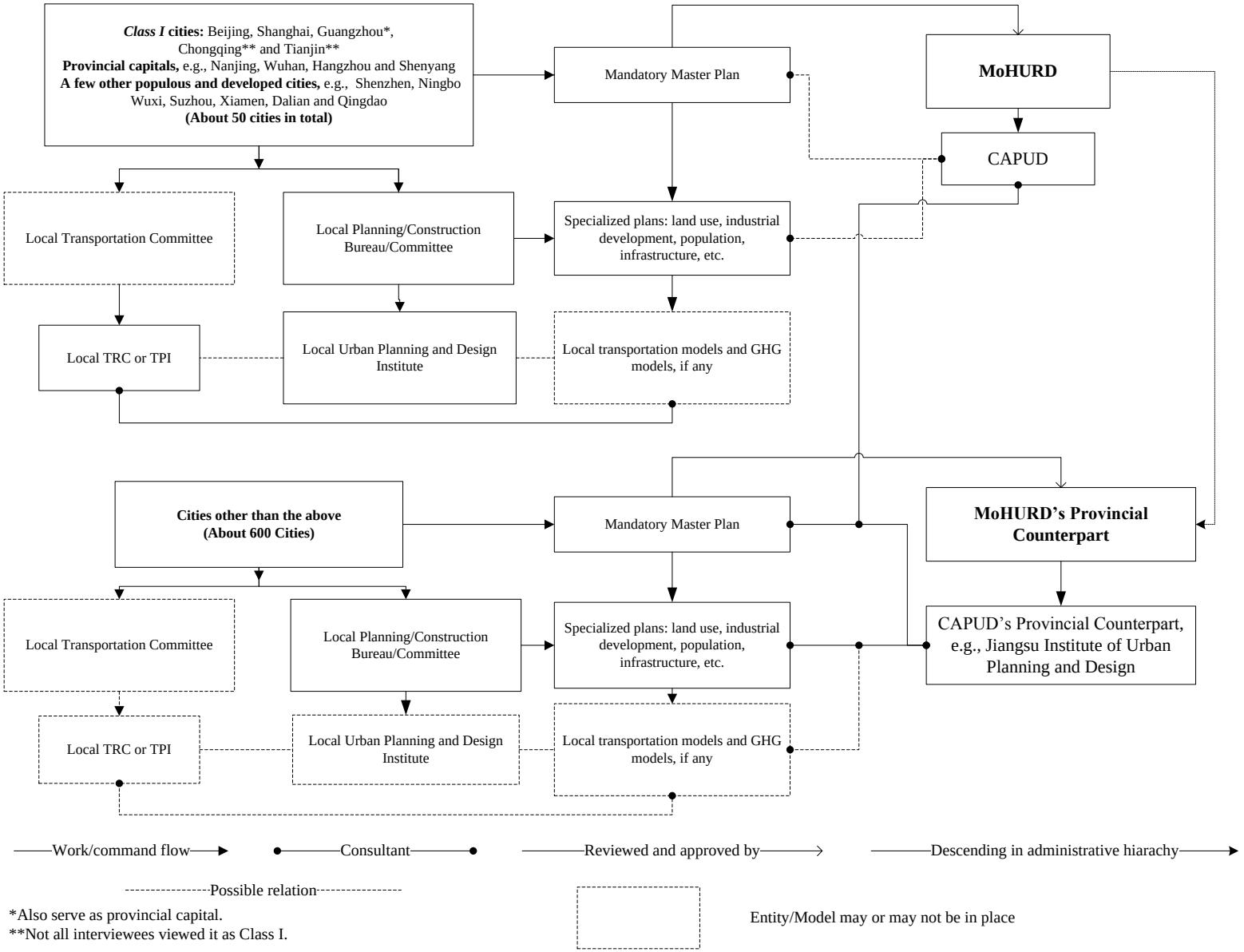
All interviewees indicated that transportation models had been receiving increased attention in the public domain in recent years in China. All cities were mandated by the Urban and Rural Planning Law of China to update and revise their city-level master or transportation plans regularly. The Chinese Central Government, via the National Reform and Development Committee (NDRC), had started working on provincial-level GHG emission inventory too. In large cities there was often one semi-governmental or pure governmental entity called "Transportation Research Center (TRC)" or "Transportation Planning Institute (TPI)" fully responsible for maintaining, developing and/or calibrating local transportation models, which may contain a mobile-source GHG component. There had also been cases where NDRC's local counterparts led an inter-agency team focusing on urban-level GHG emission inventory, in which mobile-source GHG emissions could be an important component. But few interviewees were involved in this area.

It was the quantity and quality (capability) of modelers of the TRC of TPI in a city that determined whether the city had a mobile-source GHG model and how solid this model was. The quantity and quality of modelers depended on the city's economic situations and local political leaders' willingness to support relevant efforts. In populous cities such as Beijing, Shanghai, Guangzhou, Shenzhen and Wuhan, their TRC or TPI could have as many as 50 employees, most of whom were well-trained transportation modelers and can establish sophisticated transportation models

(including mobile-source GHG models) in house.

For cities with a smaller population, there was usually no TRC or TPI. External entities such as CAUPD and its provincial-level counterparts developed transportation and mobile-source GHG models for them. To summarize, Figure 2 visualizes the above consultant, model/plan and client relationship and related market segmentation described by the interviewees.

FIGURE 2: Consultant, Government, Model Relationship



*Also serve as provincial capital.
**Not all interviewees viewed it as Class I.

Most interviewees regarded CAPUD as the most prestigious and strongest institution in China which has developed transportation models for cities across China. As of when the interviews were conducted, CAUPD had as many as 700 active planners, of whom about 100 were transportation planners or modelers, making CAUPD the largest of its kind in China with the most transportation planners or modelers. Most CAUPD planners or modelers held degrees from top planning/engineering programs at home or aboard. They also had to pass rigorous entrance exams and probation to secure a continuous position at CAUPD. Given the overall credentials of their colleagues, it was also extremely challenging for any CAUPD planner or modeler to get promoted or recognized within CAUPD. Once they did, however, they would always be recognized nationwide in their respective fields. A few top experts or officials at CAUPD had become members of National Academy of Engineering and/or National Academy of Sciences, the two most prestigious associations of academics and professionals in engineering and sciences in China.

Several interviewees indicated that CAPUD had achieved a prestigious and somewhat monopoly position largely because of three facts:
(a) Top-down planning and policy-making were still dominant in China. CAUPD is housed in and administrated by MoHURD.
(b) Master plans of important cities designated by the Chinese Central Government must be reviewed and approved by the State Council of China. MoHURD officials in general and CAUPD experts in particular play an important role in this review and approval process.
(c) CAUPD helps MoHURD with it policy analysis, plan review, standard/code development and even financing. This greatly increases visibility and credibility of CAUPD experts among top MoHURD officials, who could directly influence the fate of the above master plans.

Provincial-level Institute of Urban Planning and Design (IUPD), that is, "CAUPD" within a province, usually only developed transportation models for cities within the provincial territories. For instance, Jiangsu IUPD in most cases only developed transportation models for cities without a dedicated transportation entity such as a TPI or TRC in Jiangsu Province. There were exceptions. Several municipal-level TPIs, for instance Shenzhen TRC and Nanjing TPI, Ltd., were technically strong and enjoyed a very good professional reputation. They sometimes competed nationwide with CAUPD or provincial-level IUPDs for transportation modeling projects in cities without a TRC or TPI.

Provincial governments were responsible for reviewing and approving master plans of 600 cities listed in the lower left in Figure 2. Similar to what happened at the national level, MoHURD's provincial-level counterparts played a central role in this review and approval process. The relationship between a provincial "MoHURD" and IUPD was comparable to MoHURD and CAUPD. This gave IUPDs invisible but valuable

market advantages especially when cities wanted to expedite the top-down mandatory master plan review and approval processes.

In theory, any private planning and modeling firms with a *Class I Qualification* ("*甲级*") urban planning license issued by MoHURD and a regular business license can develop transportation models and mobile-source GHG models of any kind in Mainland China. But most of them cannot compete with CAUPD or IUPDs, due to the latter's governmental origin and connections mentioned above. The latter did, sometimes, hire private firms to complete some mobile-source GHG models. CAUPD, for instance, hired a firm to help with its Guiyang Comprehensive Transportation Improvement Plan project, which contains a mobile-source GHG model task. ARUP, a private firm, assisted Jiangsu IUPD in 2010 with its project which forecasted mobile-source GHG emissions of Jiangsu Province in 2020. As subcontractors, understandably, private firms only played a secondary role.

What technical capacities these entities have

CAUPD, TRCs or TPIs in the 60 or so large cities highlighted in Figure 2 had the strongest technical capacities. These entities were all able to develop a transportation model for a large city from scratch. A mobile-source GHG model at the city level was not a norm yet, as GHG emission inventory at the city level was still not required by any domestic laws. But interviewees from Beijing, Shanghai and Guangzhou all indicated that they were either planning to develop mobile-source GHG models or already had something primitive in place.

In Beijing, future household travel surveys would include contents such as age and class of vehicles, which could be used for mobile-source GHG models. As of when the interviews were conducted, there were no specific mobile-source GHG modeling efforts at Beijing TRC. In Shanghai, Shanghai Environmental Protection Bureau (SEPB) had a local mobile-source emission model. According to the interviewee from Shanghai Transportation Planning Institute (Shanghai TPI), SEPB used an adapted MOBILE and output of Shanghai TPI's local transportation models to estimate Shanghai's mobile-source emissions. Guangzhou TPI did not perform any mobile-source emission analysis unless mandated by local government occasionally. If this was the case Guangzhou TPI would simply develop an ad-hoc mobile-source emission model to get by. There, no systematic efforts had been made to develop an in-house mobile-source emission model.

Usually, each TRC or TPI in the 60 or so large cities highlighted in Figure 2 had 20 to 50 modelers. These modelers were usually well trained as most of them hold their degrees from famous transportation programs across China. In recent years, an increased percentage of the modelers received some education and/or training abroad. Taking BTRC as an example, there were 50 modelers/researchers as of May 2011. Among them, 15 held a PhD degree from home or abroad and 10 had a foreign master

degree. Many modelers thus have been exposed to popular transportation models (including mobile-source GHG models) and software packages such as Cube, VISUM, VISSIM and TransCAD. In addition, foreign transportation modelers were frequently invited to TRCs or TPIs in China for peer learning purposes. BTRC, for instance, welcomed at least a foreign modeler or a modeler delegation every other month. Such exchanges had greatly expanded the network of and increased technical capacities of local modelers.

What data are available for mobile-source GHG modeling

In China, regular surveys had been conducted to support traffic model development and calibration, especially in large cities. Beijing, for instance, had conducted five waves of household travel surveys since 1986. In the past twenty years or so, BTRC or its predecessors were in charge of the above surveys. These surveys and other data provided by sister government entities, for example land use data, had provided local transportation modelers with sufficient data to establish and calibrate city-level transportation models (see Table 1 for more details). But most of the input data for the models were not even shared internally among government agencies. For instance, usually a TRC or a TPI was responsible for household travel surveys, and they often thought that they paid for and therefore "owned" most if not all the relevant survey data. They thus rarely shared the data with any other entities or individuals, particularly those outside the government. There were also no regulations or laws regarding how to share the above data.

Existing government information sharing mandates by the State Council of China were general regulations and contained no specific provisions about sharing urban/transportation planning data. Government entities can send a formal data request to the TRC or TPI in their city for the household travel survey data. Such a request would be satisfied if it is endorsed by a high-ranking official of the city, say, the mayor or the Chinese Communist Party Secretary of the city. In other occasions, the TRC or TPI would have the discretion as to how to handle the request. Data requests from entities or individuals outside the government unfortunately were subject to such discretionary handling. One interviewee from Guangzhou joked that if an individual really wanted to get data from government entities in China, she or he would better have friends or relatives working for the right entities in the government system or have the approval from officials who directly supervised the entities that collect and own the data. Underlying this joke, there was still some truth: personal connections and orders from the right officials in charge might allow one access to transportation modeling data in China.

Mobile-source GHG emissions had only received attention recently in China. Thus, most entities were still envisioning rather than developing a relevant model. Luckily, modelers working at entities such as BTRC would get most data or information they need to develop any models. But again, whether such data or information collected for

mobile-source GHG modeling efforts would be available to people outside the government remained to be seen. Some interviewees emphasized that data used to support mobile-source GHG modeling were "politically sensitive", given that they would disclose sensitive information such as actual levels of certain air pollutants. Such information is regarded as detrimental to the image of a city or even a threat to attract more external investment. Either case, political considerations had made it very difficult for the general public to gain access to any data the government regards as sensitive. Very recently, whether a Chinese city should release daily $PM_{2.5}$ emission level to the public, for instance, had triggered a heated debate between the government agencies in charge and the public.

Efforts made to enhance mobile-source GHG models

A variety of entities had claimed to establish or enhance mobile-source GHG models. BTRC, for instance, had emphasized the need to consolidate in-house surveys and relevant data processing to enhance its GHG modeling efforts. BTRC's technical capacity of developing GHG modeling was not mentioned as a challenge at all. In Shanghai, SEPB (Shanghai Environmental Protection Bureau), rather than Shanghai TPI, was reviewing and improving local GHG models based on the adapted MOBILE 6 model. According to the interviewee from Shanghai TPI, Shanghai TPI was happy with such arrangements. CAUPD on one hand welcomed collaborations with competent foreign firms to develop mobile-source GHG models for Chinese cities; on the other hand, it was in the process of establishing data collection, coding and formatting standards for city-level transportation models and creating a scalable database to store various city-level data CAUPD had collected and would be collecting. Working with consultants hired by the World Bank, CAUPD completed a mobile-source emission modeling project in 2010 for Guiyang, Guizhou Province. This project was regarded a herald that CAUPD officially started working on mobile-source emission/GHG models at the city level.

At BJU (Beijing Jiaotong University), a few professors were executing funded research to develop China's own mobile-source emission models. Entities other than Beijing TRC, Shanghai TPI, BJU and CAUPD, for instance, had no detailed plans or specific actions regarding mobile-source GHG models as of June 2011 even though most of the interviewees from the above entities agreed that mobile-source GHG models would become increasingly important. The reason behind this was that most entities already had too many ongoing profit-rich or political projects that were regarded by the government as more important or urgent than mobile-source GHG models ----especially according to interviewees from Guangzhou, Beijing and Jiangsu.

Characteristics of existing models

Few interviewees were willing to share details about their transportation and mobile-source GHG models, two closely related models. Based on limited and discrete information they were willing to share and other information one can find in

CNKI database, the largest academic database in Chinese, Table 1 summarizes the latest transportation and mobile-source GHG models in selected Chinese cities.

TABLE 1. Latest Transportation and GHG Models in Selected Chinese Cities

City	Transportation Model						Mobile-source GHG model
	Main data source	Model study area; Analysis zone systems	Key variables used in the model	Model type/structure	Software packages used	Model application/purposes	
Beijing	1986, 2000, 2005 and 2010 Household Travel Surveys or 1990 Driver Survey; Master Land Use Plans of base and future years*; Employment Surveys of different years; Transportation network info*	Central city (about 1,370KM^2, 6 million registered residents); 1,000 zones**	Income; gender; travel cost; percentation of differet modes; chosen travel path; mode choice; commute distance; employment by zone; residential location; work location; geographic files for road/transit networks	Metropolitan area-central city-district-subdivision models; Four-step plus activity-based models; Customized models for special events or metro corridors or multimodal terminals	Trips; Citilabs suites; PTV suites	Transportation system development strategies; traffic impact studies; Traffic circulation for special events	Under development; possible data source in addition to those used for transportation model: Public Traffic Safety Bureau's vehicle registration data and revised Household Travel Surveys in future
Guangzhou	1984, 2005 Household Travel Surveys; 1995 Transportation Model Maintenance Report; 1997 Transportation Development Report; Master Land Use Plans of base and future years; Employment Surveys of different years; Transportation network info	Central city (about 7,434 KM^2, 7.3 million registered residents); 1,788 zones**	Similar to the Beijing	Four-step plus activity-based models	Citilabs suites; EMME2, 3 and a series of customized simulation packages at the subdistrict level	Regional transportation planning; Road network planning; Price elasticity of road users; Travel demand management; Traffic circulation for special events	Only estimated emissions when was asked by the government; used speed and volume data from traffic assignment to get rough estimates but a separate emission module is under consideration.
Nanjing	1986, 1997 and 1999 Household Travel Surveys; 1997 Annual Transportation Report; 1986 Socioeconomic and Road Traffic Survey; Master Land Use Plans of base and future years*; Employment Surveys of different years; Transportation network info*	Central city (about 4,723KM^2, 5 million registered residents); 700 zones**	Similar to the above	Four-step model taking into account public transit; Traffic assignment taking into account road pricing and road restriction; travelers include "floating population"	EMME3	Transportation system development strategies; Traffic impact studies; Terminal circulation studies	Under consideration
Shanghai	2007 Household Travel Surveys; 2007 Central City Arterial Speed Survey; 2007 Small-sample Metro Rider Survey; Master Land Use Plans of base and future years*; Employment Surveys of different years; Bus OD Surveys of different years*; Transportation network info*	Central city (about 3,900 KM^2, about 10 million registered residents); 1,059 zones**	Car ownership; traffic volumes at screenlines; OD tables of previous years; land use at the zone level; geographic files for road/transit networks	Four-step model at the metropolitan area level; Customized models for special event or metro corridor or multimodal terminals	EMME2, 3	Transportation system development strategies; traffic circulation for special events; public transit planning; road building or improvement	SEPB is responsible for this, which used locally adpated MOBILE 6 and traffic assignment results of local transportation model as input
Shenzhen	Baseline year and future year land use and transportation network info; Transportation network info	The whole city (about 2,000 KM^2, about 7 million registered residents); 5,44 zones**	-	Four-step model at the metropolitan area, district and subdivision levels; Dynamic data collection and processing for model updates; Enterprise databases for key data/variables; Customized models for special events or metro corridors or multimodal terminals	TransCAD+EMME2; Citilabs suites	Transportation plan evaluation; Traffic impact studies; Micro-simulation of local traffic	Under consideration

* Data usually provided by local sister government agencies, these agencies include: Land Survey Bureau/Institute, Urban Planning and Design Institute, Public Transit Companies and Land and Resources Bureau.

**Including external zones.

Table 1 shows that:

First, government entities in different cities have their own schedules regarding when they would conduct surveys or collect data to establish, calibrate or enhance their respective models. They also have the discretion regarding what data they would collect and use in their models.

Second, except in Shenzhen, study areas of the models adopted by the selected cities are a "central city". A city in China is higher in administrative hierarchy than one in the U.S. and usually jurisdiction of a city government covers a number of districts, suburbs and counties. Take City of Nanjing as an example: it consists of six districts, five neighboring suburbs and two counties as of 2011. But "central city" in Table 1 only considers districts and neighboring suburbs of a city, excluding counties. For Nanjing, the study area of its model would include only six districts and four neighboring suburbs. Two counties were excluded from the model. This makes Nanjing's transportation model notably different from most US transportation models at the metropolitan level. For instance, if a US-type model was adopted in Nanjing, it would cover a study area that consists of all districts, suburbs and counties there and even a few other counties around Nanjing.

Third, traditional four-step models still dominate across Chinese cities but some improvements or enhancements have been added to such models to address local concerns such as special events, "floating population", planned subway corridors and/or envisioned multimodal terminals.

Fourth, mobile-source GHG models have emerged but progresses made in these models varied across cities. According to two interviews, this variation mostly reflected the differences in local leadership's preferences and ambitions. Shanghai and Beijing were the most aggressive among the studied cities in terms of planning for or using relevant models.

Fifth, transportation and land use models are separated in most modeling efforts. For instance, except Shenzhen, transportation modelers in all four other cities acquired land use data or modules from another government entity when developing their transportation models. According to several interviewees, this reflected the tradition of "horizontal labor division" within the Chinese administrative system. At the national level, for instance, it was the Ministry of Land and Resources (MLR) in charge of land use planning affairs and related quota allocation and control while urban/transportation planning affairs were in the hand of MoHURD. At the provincial and local levels, governments simply followed how it was done at the national level. In China, the provincial and local governments had little autonomy regarding creating new institutions or agencies that cannot find their counterparts at the national level. But Shenzhen was a special case and was specially treated by the Chinese Central

Government as one of the frontiers and experimental sites for the cause of opening-up and economic and political reforms of China.

Gaps in or barriers for developing mobile-source GHG models

Public entities, NGOs and private firms had different perceptions of the gaps in, and barriers for developing the mobile-source GHG models. Interviewees from public entities emphasized that the lack of a legal imperative about mobile-source GHG models was the biggest barrier. The modeler from ATKINS complained that the relatively exclusive master and transportation planning market had been the biggest barrier. Both the interviewees from the NGO and private firms indicated that accessing data was a big challenge in developing models of any kind, even though they were eligible to develop models for Chinese cities. The interviewees from the NGO cited a case to show how difficult it had been when they were collecting household energy consumption and commute data in Jinan, Shangdong Province. The purpose of the data collection was to develop a piece of freeware to estimate aggregate household GHG emissions by neighborhood. Besides good intentions, personal connections, grants to local entities, extra staff time and frequent "friendly reminders" were all employed to help collect data or get access to existing data owned by different governmental entities. In contrast, CAUPD or an IUPD would encounter relatively fewer troubles in getting local data once they had been retained by a local government as a consultant. In this case, the government would often issue a top-down mandate, ordering its subordinates to provide the consultant data collection assistance or data access. Most of the time, such a mechanism worked well for domestic consultants like CAUPD or its provincial counterparts.

Data sharing issues

Given the above data access and sharing issues, another survey was conducted to identify causes of these issues. Figure 3 below summarizes the survey results. "Data are politically sensitive" was regarded as the most important reason for data hoarding practices (71%), followed by "no tradition" (62%) and "data accuracy concern" (43%). Specifically, governments treated some data as politically sensitive and believed that sharing them could threaten their normal operations. What's a little surprising was that data inaccuracy and unreliability was the third most important reason. Cost of sharing was not a major reason why the government was not sharing data. In addition, seven respondents specified their own reasons, which included:

(a) Some government agencies and individuals treat access to data as an exclusive and profitable resource (n=2);
(b) Most data collected at the city level are random and discrete and are not ready to share, and sometimes even important data for planning can be missing (n=2);
(c) Lack of systematic documentation of available data and little attention to data sharing mechanism (n=1);
(d) Agencies do not know which data should be and can be shared (n=1).

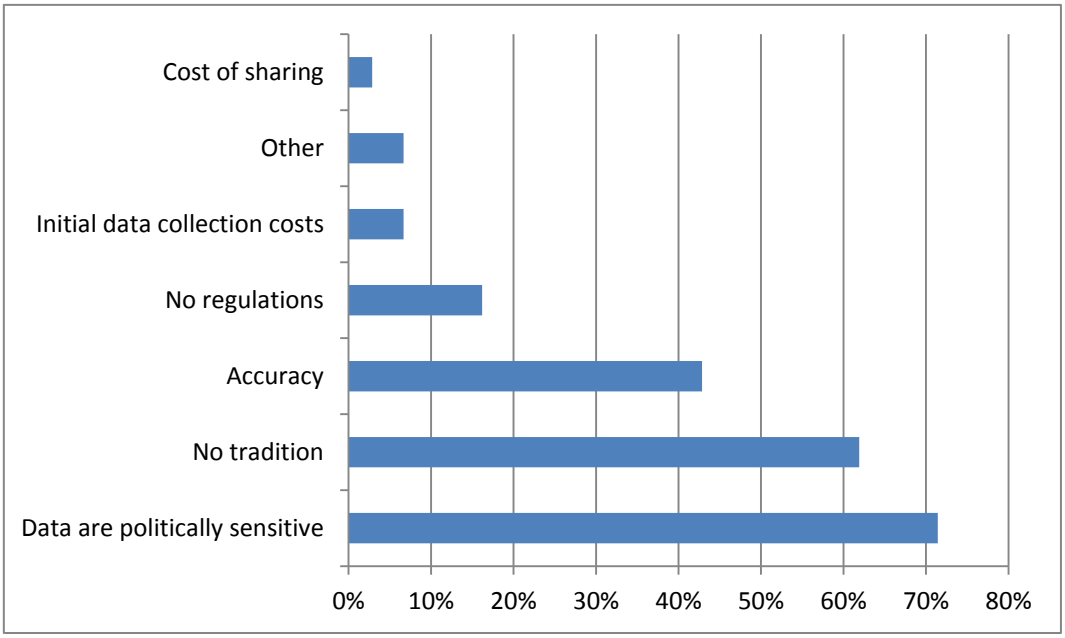


FIGURE 3: Why Governments Hoard Data (N=105)

To best address the data access and sharing issues, a small-scale follow-up survey was conducted among the S-Survey respondents. As of October, 2011, this follow-up survey generated 16 responses. Of these responses, 69% recommended passage of specific and enough laws and regulations to improve data sharing; 38% recommended more open discussions of data-sharing issues and more attention to the full life cycle of data using: from data collection to data validation, and from data classification to data declassification; 19% recommended stakeholder education, increasing their awareness of the benefits and costs of data sharing. Figure 4 provides more details about the distribution of the 16 responses.

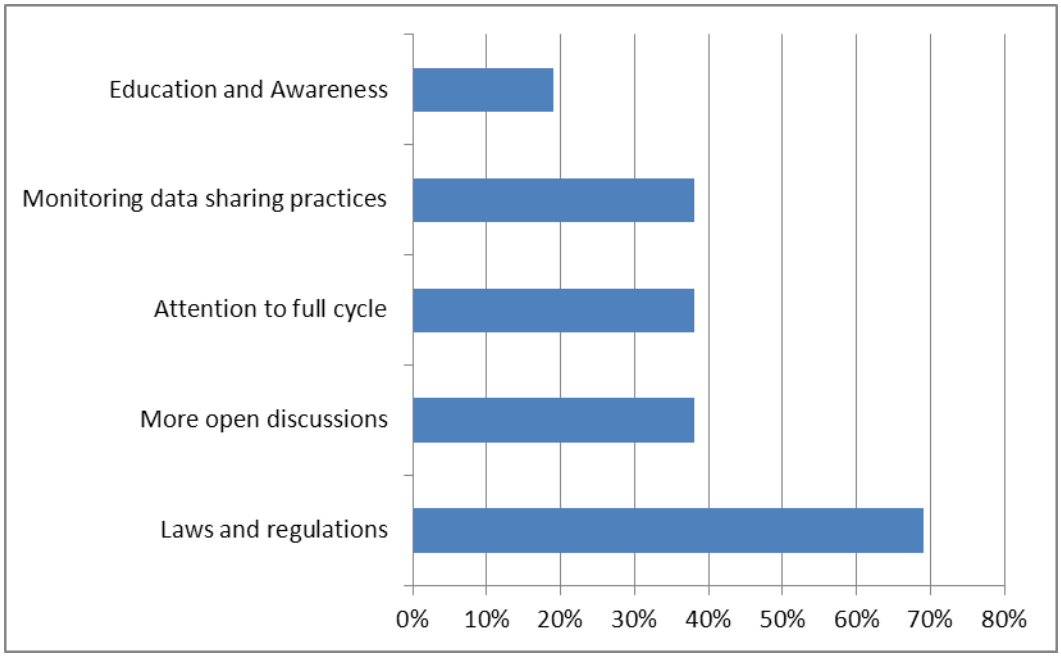


FIGURE 4: How to Address Data Access and Sharing Issues (N=16)

CONCLUSIONS AND DISCUSSIONS

Largely replying on the Urban and Rural Planning Law and the top-down plan review and approval mechanism, China has made it a norm for all Chinese cities to regularly update their master and transportation plans. In support of making these plans, city-level transportation models have been developed and updated regularly as well in most if not all cities. However, a mobile-source GHG model may or may not be part of these transportation models as such a model is not yet mandated by laws or regulations or is not on the priority list of local governmental officials. With more and more importance attached to a GHG inventory at various geographic levels in China, we expect that it would trigger more transportation entities, consultants and researchers to develop reliable modeling tools to serve the needs of the inventory, including a mobile-source GHG model.

Public entities consisting of CAUPD, its province-level counterparts, and special-purpose entities such as TPIs or TRCs in a few large cities have the strongest technical capacities for mobile-source GHG modeling. It is also in these large cities where regular surveys had been conducted or scheduled to support a mobile-source GHG model. It is also in these cities where modelers can expect more data input for various modeling efforts. In other small cities without a TPI or a TRC, governments often hire an external entity as their consultant to develop or upgrade such models. The consultant often can get most of the input data for its modeling efforts. Typically, CAUPD or one of its provincial counterparts serves as this consultant.

Given their governmental connections or origin, CAUPD and its provincial counterparts can help their clients (often city governments) expedite mandatory top-down plan/model reviews and processes. This makes it challenging for private firms to compete with them in China. But these firms do have opportunities to work as subcontractors for the former.

Lack of a legal mandate for a mobile-source GHG model at the city level and data access and sharing issues are the barriers for the mobile-source GHG modeling efforts in China, particularly for NGOs and private firms. Based on the S-Survey, the reasons for data hoarding in China include:
(a) The government regards the data as something politically sensitive that could threaten the normal operations of the government;
(b) The government has no tradition of sharing data and is still adjusting to increased data needs from the public;
(c) The government has concerns over data accuracy and reliability.

Key proposals from the survey respondents to address these issues are:
(a) To establish necessary laws and regulations about the data sharing practices;
(b) To encourage more open discussions of data-sharing issues;
(c) To pay attention to each component of the full life cycle of data using;
(d) To educate stakeholders and to increase their awareness of data sharing.

We fully realize that this paper has limitations and the following improvements should be made in future research: **First,** increasing the size of the interviewees and the response rate of relevant surveys, in particular, including interviewees from cities other than *Class I* cities. Otherwise, our findings could be biased towards the situations in leading Chinese cities rather than the overall situations in China. We are planning to involve professional associations in our future interviews and surveys. We will send out both electronic and hard-copy survey instruments. We also hope to host focus-group meetings to collect more people's opinions about data hoarding and sharing issues. **Second,** differentiating the survey respondents by employer type and by location. Respondents working for different employers or from different locales could face very different barriers when developing or calibrating transportation or mobile-source GHG models. This can be better addressed once we have a much larger number of responses or interviewees. Of course, we need to better address the concerns of respondents so that they are more willing to share their employer and location information. **Third,** conducting in-depth case studies of transportation and mobile-source GHG modeling efforts at the city level. This would enable readers to have more insights into transportation and mobile-source GHG modeling practices in Chinese cities. In its current form, this paper only provides very generic information about these practices. We have already successfully recruited a few volunteers to help conduct the proposed case studies.

Last but not least, this paper is among the first to examine mobile-source GHG modeling practices in China and to explore the related data hoarding and sharing issues. The preliminary results have built a foundation and provided references of comparison for future work seeking to enhance transportation and mobile-source GHG modeling practices in China and elsewhere.

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Appendix:

Survey to Find Out Reasons for Data Hoarding

among Government Agencies in China*

1. Why are government agencies in China unwilling to share with the public the data they have collected for urban/transportation planning purposes?

Choices (Choose up to three):

(1) Data are politically sensitive and could threaten the normal operations of the government;
(2) The government has long been accustomed to not sharing any data;
(3) Data were collected and paid by individual agencies and they do not think they are obligated to share;
(4) Providing data to the public requires extra labor and time;
(5) There are no laws or mandates that require the government to share;
(6) The government has no confidence in the reliability and accuracy of the data collected;
(7) Others (Please explain).

2. Could you tell us a little more about yourself? (Open-ended)

2.1 Employer Status.

2.2 Employment/University Location.

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* Original survey was in Chinese.