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Project Summary Report 0-4377-S
Project 0-4377: Develop GIS-Integrated Traffic Models for MOBILE6-Based Air Quality Conformity and TCM Analysis
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PROJECT SUMMARY REPORT

Develop GIS-Integrated Traffic Models for MOBILE6-Based Air Quality Conformity and TCM Analysis: A Summary

Transportation planners, traditionally used to focusing on regional travel demand forecasting, now have the added responsibility of providing traffic data to air quality agencies for use in mobile source emissions analysis. Coordinated efforts among land use planners, travel demand planners, and air quality planners are needed to ensure the provision of safe and efficient transportation systems while also addressing environmental concerns. This is particularly so because mobile source emissions constitute a major fraction of total atmospheric emissions. Additionally, Clean Air Act legislations have mandated that air quality Implementation Plans of states with non-attainment areas establish emission budgets from mobile sources in the context of achieving reasonable further progress (RFP) toward attainment and actual attainment. Consequently, many metropolitan areas and states are depending on transportation control measures (TCMs) to reduce mobile source emissions as part of an overall strategy to reduce atmospheric emissions. Transportation conformity determinations are required periodically to assess the potential impact of various transportation control measures and to demonstrate that mobile source emissions do not exceed the State Implementation Plan (SIP) emission budgets. Such conformity determinations require accurate and reliable traffic input data to the mobile source emissions forecasting model. Hence, it is necessary to develop accurate and robust traffic input models that are accurate in their predictions, and at the same time are also useful to analyze the effects of demographic changes and transport policy actions. The current research contributes toward the development of such an integrated transportation air quality procedure. Specifically, the research has the following objectives: (a) Review the changes in traffic input requirements for the MOBILE6 emissions factor model, (b) Develop models for improved traffic input data for the MOBILE6 emission factor model, (c) Integrate all relevant models within a Geographic Information System (GIS) architecture and demonstrate the application of the comprehensive GIS-based modeling platform to an actual metropolitan region.

What We Did...

Reviewed the Changes in Traffic Input Needs for the MOBILE Model

The EPA advises the planning agencies of non-attainment areas to use local data in their emissions modeling instead of the national default values because each region is unique in its characteristics. Further, the use of national average data underutilizes the capabilities of the MOBILE6 model. MOBILE6 has a greatly expanded vehicle classification scheme and enables the user to enter inputs at a very fine spatial and temporal scale to produce more accurate emissions estimates. As a result, the input requirements for MOBILE6 model are vastly different from those for the MOBLE5 model. The changes have primarily been in fleet characterization and vehicle activity characterization data. Among these, there have been significant changes to the vehicle miles traveled data, vehicle registration distribution data, and mileage accumulation data. This research concentrates on developing models to predict (1) VMT mix distribution by facility, roadway type, and time of day and (2) vehicle registration distributions by vehicle class. Each of these is discussed in turn in the subsequent sections.

Developed Models for Traffic Inputs Needed by MOBILE6 VMT Mix Models

The MOBILE6 model requires several traffic related inputs, one of which is the Vehicle Miles Traveled (VMT) mix ratio. Current procedures determine the VMT mix ratio as a function of two control variables: roadway type (freeways/arterials) and area type (rural/urban). It is quite likely that there is substantial variation in VMT mix even after controlling for roadway functional classification and area type. The research undertaken in this project utilizes the Bhat and Nair fractional split model (RMC3

Project #1838) that determines the VMT mix ratio as a function of several variables, including the physical attributes of links (such as number of lanes and whether the link is a divided road or not), the operating characteristics of links (such as link free speed), aggregate area-type characterizations of the traffic survey zone in which the link lies (such as urban, suburban, and rural), and the land-use attributes of the zone (such as retail acreage and manufacturing/warehouse acreage in the zone). Bhat and Nair model, however, predicts only the 24-hour VMT fractions of the MOBILE5 vehicle classes. A significant difference in VMT input requirements of the MOBILE6 model compared to the MOBILE5 model is that MOBILE6 requires hourly VMT data as opposed to 24-hour average values. Hence, data from traffic counts was used to convert the 24-hour average VMT fractions into hourly VMT values. In addition, MOBILE6 uses an expanded classification of twenty-eight vehicle categories compared to eight vehicle categories in MOBILE5, which was accommodated in the current research.

Vehicle Registration Distribution

Vehicle Registration distribution refers to the distribution of the regional in-use fleet among various age and vehicle classes. MOBILE6 allows the user to input twenty-five age fractions for each of the sixteen composite vehicle types. These represent the fraction of vehicles of each vehicle class for each age group. Earlier studies have found that there are several local factors that affect vehicle purchase decisions such as socio-economic characteristics, land use patterns, and local roadway management practices. One of the important revisions to the MOBILE model has been the expansion of the vehicle classification from eight classes in MOBILE5 to twenty-eight vehicle classes in the MOBILE6 version. For the purpose of registration distribution, these twenty-eight classes are aggregated into sixteen groups by the MOBILE6 model. This expanded classification of vehicles is designed to translate into more accurate emissions factors. The vehicle registration data for 1998 was obtained from TxDOT's VTR division and was geocoded onto the zonal map of the Dallas-Fort Worth area to identify the zonal locations of the vehicles. A fractional split model structure was used to model the age fractions of the MOBILE6 vehicle classes at the Traffic Analysis Zone level.

Integrated Relevant Models within a Geographic Information System (GIS) Framework

In addition to formulating and developing models for improved traffic inputs to the MOBILE6 emissions model, this research focused on integrating the traffic models within TransCAD, a commonly used GIS platform for transportation planning. TransCAD is ideally suited for transportation air quality analysis because such an analysis is intrinsically spatial and requires the storage and manipulation of vast amounts of spatial data. The current research develops graphical user interfaces in the TransCAD environment to implement the traffic input models described earlier. These user interfaces are easy to

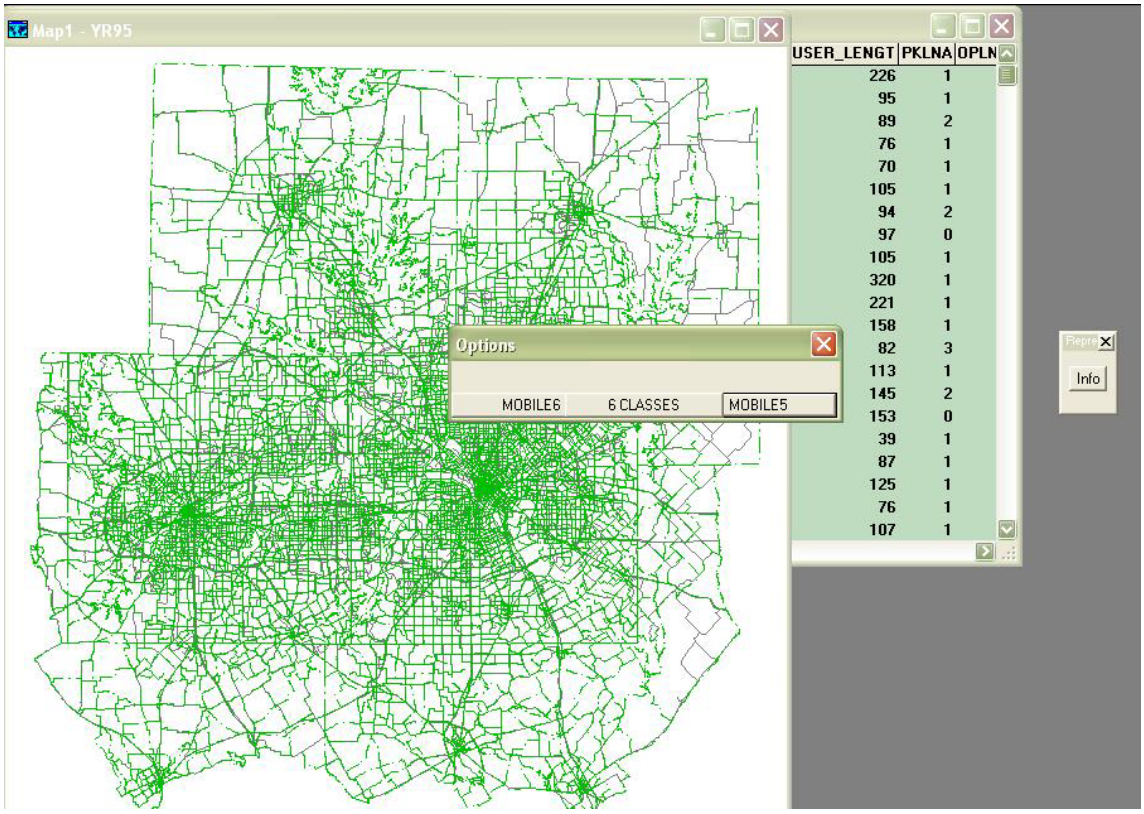

Figure 1: Display of the User Interface for the VMT Mix Distribution Model for the DFW Metropolitan Area

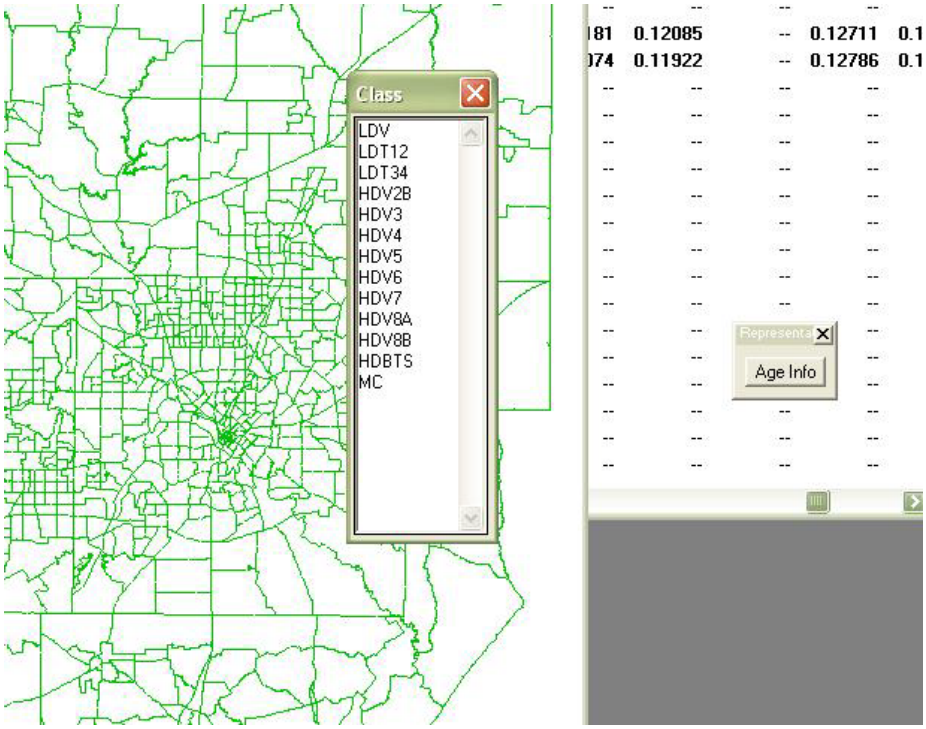

Figure 2: Display of the User Interface for the Vehicle Registration Distribution Model for the DFW Metropolitan Area

use and guide the user through the modeling process using dialog boxes and prompt windows. These GIS applications will help the user extract information interactively and view it in the form desired. Further, these GIS applications facilitate TCM analysis and allow the analysts to evaluate the effects of different TCMs on VMT mix and vehicle registration distributions.

What We Found...

The following constitute the broad findings of this research.

First, the VMT mix on a link is a function of not only the link characteristics such as free speed, roadway type, number of lanes etc., but is also a function of the attributes of the traffic analysis zone in which the link lies. The zonal retail and office acreage, and the degree of urbanization are just a couple of such attributes that impact the VMT fractions of a link.

Second, the model developed for the prediction of vehicle registration distribution in any Traffic Analysis Zone indicates that fractions of vehicles in different age categories are a function of zonal characteristics such as zonal basic employment, zonal retail acreage, zonal acreage of infrastructure, and zonal retail employment etc. Further, the factors influencing the age fractions vary quite significantly by vehicle class. Hence, the development of vehicle registration distribution models specific to each vehicle class improves the accuracy of estimates and is useful to develop TCM scenarios to attain air quality conformity in ozone non-attainment regions.

Third, the current approaches to obtain VMT mix by vehicle class and time of day, the soak time distribution, vehicle registration distribution, and mileage accumulation rate can be substantially improved by developing models based on local vehicle classification counts and survey data. Since the emissions computations in the MOBILE model are very sensitive to these inputs, it is important that metropolitan planning organizations consider pursuing such efforts. Further, it is also important to conduct local traffic counts for every hour of the day (as opposed to 24-hour vehicle counts) on a sample of different roadway types so that the variation of VMT mix by time of day can be modeled accurately.

Finally, the visualization of the final traffic output results graphically on the Texas network is useful for gaining a better understanding of the traffic patterns and provides an effective intuitive means to check the functionality of the models. In addition, the implementation and evaluation of TCMs is much easier if the GIS-based tool is used. Since the software displays the results graphically, it is easier to understand the impact of TCMs and to compare the before and after TCM implementation scenarios.

The Researchers Recommend...

Our recommendations are provided under two categories: Implementation and Further Research.

Implementation Recommendations

The models developed as part of the integrated transportation air quality procedure are immediately implementable in the Dallas-Fort Worth area. The implementation of such traffic input models for other non-attainment regions would require model estimations to be performed based on data collected locally for that region. It is recommended that TxDOT pursue such implementation-related work for other non-attainment metropolitan areas in Texas.

Research Recommendations

The vehicle mileage accumulation rate is an important traffic input to the MOBILE6 model and developing a model to predict the vehicle mileage accumulation rate based on local data will significantly improve the accuracy of the emissions predictions. This could not be accomplished in the current research effort due to lack of mileage accumulation data. It is recommended that TxDOT collect data that will facilitate such an analysis. The researchers also recommend a detailed analysis of weekend travel since air quality violations for ozone are extending to weekend days in many metropolitan regions. In addition, it is recommended that further research be undertaken to analyze seasonal variation in vehicular emissions.

For More Details...

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The research is documented in the following reports:

4377-1 *Review of Input Requirements for Emission Factor Model MOBILE6* January 2002
4377-2 *Data Acquisition and Development of Traffic Inputs for MOBILE6* August 2002
4377-3 *Develop GIS-Integrated Traffic models for MOBILE6-Based Air Quality Conformity and TCM Analysis* September 2003
4377-4 *User's Guide to the GIS-Based Application for Traffic Inputs to MOBILE6 Emissions Factor Model* September 2003

To obtain copies of a report: CTR Library, Center for Transportation Research,
(512) 232-3138, email: ctrlib@uts.cc.utexas.edu

TxDOT Implementation Status April 2004

The research developed an activity-based travel demand model embedded in GIS for the purpose of analyzing transportation control measures with EPA's MOBILE6 model. The model will be implemented in ozone non-attainment areas to assist in meeting federal conformity requirements.

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Your Involvement Is Welcome!

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