Nationwide Estimate of Long-Distance Travel (NELDT)

Generation of External Trips for Local Travel Models

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Rolf Moeckel
Parsons Brinckerhoff
New York, NY 10016
(212) 465-5630
moeckel@pbworld.com

Rick Donnelly
Parsons Brinckerhoff
Albuquerque, NM 87110
(505) 878-6524
donnellyR@pbworld.com

Summary

Local travel models require data on regional trips entering or leaving the study area. Such trips contribute to local congestion, and an accurate accounting of them is essential for modeling the full universe of urban travelers. This paper presents an approach to generate long-distance travel within the United States. Trips that enter, leave or go through a specific local study area can be extracted and added to the local model as external trips. External data are provided as microdata, allowing them feed both traditional aggregate models as well as disaggregate activity-based model systems.

1 Introduction

Local travel models are designed to model all of the travel taking place within the area studied. Though the majority of simulated trips have both their origin and destination within the study area, there commonly are a significant number of trips that have one of both trip ends outside the study area. Almost all travel models address this problem by including an external trip model. In most cases, the external trips are exogenously given and either remain constant over time or are growth-factored for future years. Roadside surveys can be used to generate external trip data with origin, destination, occupancy, vehicle type and possibly traveler characteristics, but they are often not done because of resource constraints or concerns about safety or inconveniencing the motoring public.

This paper presents an alternative approach for generating these external travel data. Nationally available data are used to generate long distance trips throughout the United States, from which regional trips can be extracted for any local study area within the country.

2 Data

The Federal Highway Administration conducted the National Household Travel Survey (NHTS), which collects data on both daily and long-distance travel within the U.S. (FHWA 2009). The survey consisted of 69,817 telephone interviews conducted from March 2001 to May 2002. Contestants were asked about their daily travel patterns (short distance) as well as any traveling within the past 28 days where the furthest destination was 50 miles or more away from their home (long distance). This data set offers a rich source of information for long distance trips by all modes of transportation within the U.S. A total of 45,165 long distance data records were available, of which 39,251 data sets were complete enough to be usable for this study.

Because the NHTS data set is a sample of long distance travel, not all long distance trips of the entire population were included. The sample had to be extended to match the estimated total number of long distance trips. This control total had to be derived for a current year from other data sources. Air travel data are published by the Bureau of Transportation Statistics based on ticketed passengers (BTS 2009). These data provide number of passengers between all U.S. airports, distinguishing between passengers changing flights and passengers having their final destination at one airport. Data on Amtrak intercity flow are generally available, as are data on persons entering the U.S. from Canada and Mexico. The most difficult target data are those of the most commonly used mode of transportation, the automobile. Statewide totals can be derived by adjusting counts at the state borders to remove commuters and other habitual trips.

3 Generate missing data

For privacy reasons, the NHTS dataset only reports the origin state for trips from states with a population of 2 million or more. For smaller states, synthetic data records are generated based on travel data of surrounding states for which data are available. Figure 1 shows the number of data records with a long-distance trip by state. Most states without data records have neighboring states that can be used to synthesize missing data records. Maine records are generated based on Massachusetts data sets, and Montana records are generated based on Washington and Oregon data. To synthesize records, data records from neighboring states are selected randomly. The same record density (records per state resident) are created as in the neighboring states. Alaska is particularly difficult as it has no neighboring US states, and –given its size– it has a very unique long-distance travel pattern. Though distances are big in Alaska, the absolute number of long-distance travelers is comparatively small. As Alaska long-distance travelers barely affect volumes in the contiguous 48 states and Hawaii, Alaska travelers were not included in this research.

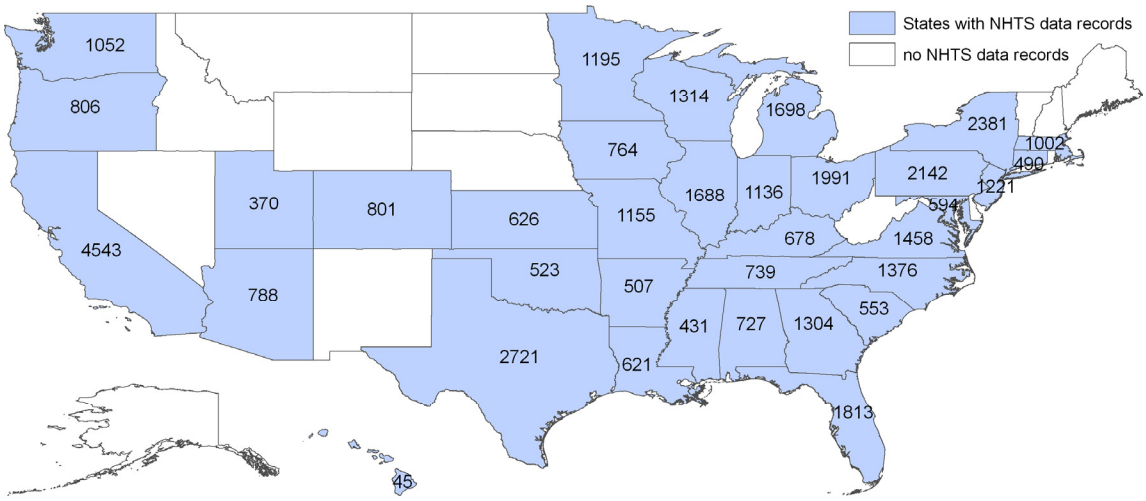

Figure 1: NHTS long-distance travel data records by home state

Because the NHTS is a national survey that interviewed long distance travelers in their home state no international visitors are included in the NHTS data set. International travelers are synthesized based on air travel data and land border crossings from Canada and Mexico. Their characteristics are assumed to be comparable to American long distance travelers, with the exception that all non-North American travelers are assumed to arrive by air or auto. Accordingly, data records from the national travelers are selected randomly to synthesize international visitors.

4 Model design

A Nationwide Estimate of Long-Distance Travel (NELDT) has been developed to simulate long distance travel within the U.S. Figure 2 shows the workflow of NELDT. The key input data are the NTHS data records. Section 3 described the two steps used to synthesize travelers from missing states and international travelers. The NHTS data records in combination with the synthesized records are considered to be a representative sample of long distance travel in the U.S. An expansion of these observations was used to generate all long distance travelers in the U.S. The NHTS reports trip origins and destinations by state and, if applicable, metropolitan area. To increase spatial resolution the trips are disaggregated to the county level. Long distance trips by auto, bus and train are assigned to a multimodal U.S. network to define routing of trips.

Finally, trips relevant for a particular study area are extracted. Commonly, these include internal-external (IE), external-internal (EI) and through or external-external (EE) trips.

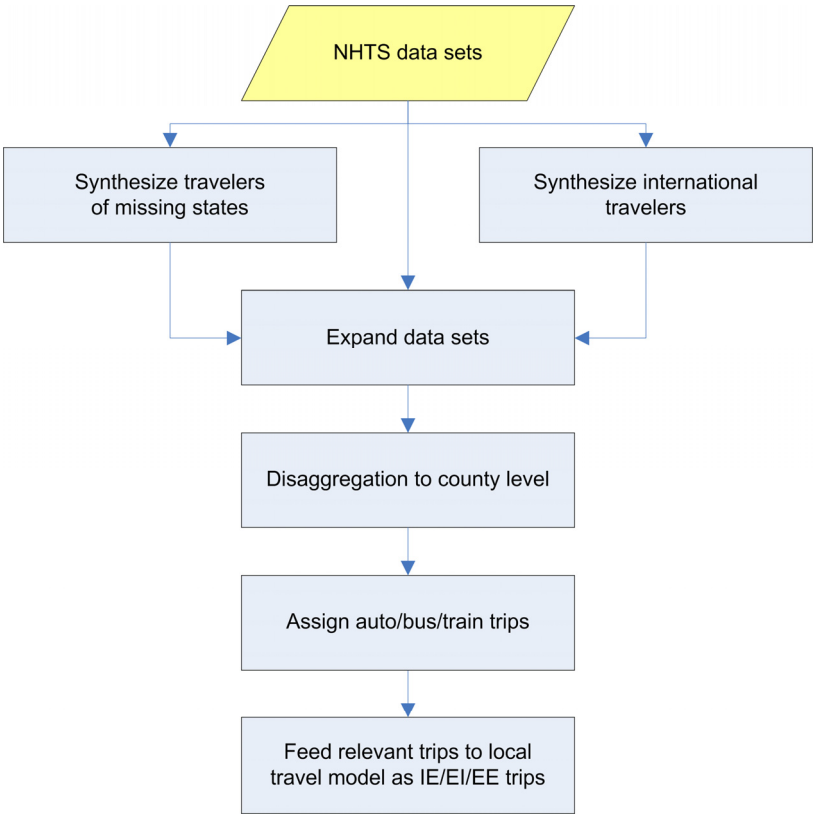

Figure 2: NELDT design

5 Data record expansion

Expansion factors are derived from air travel data. As unambiguous air travel data are available (BTS 2009), reliable expansion factors for long-distance air travel can be developed. Expansion factors are distinguished by states. If the NHTS data set was truly representative, the expansion factor would be identical for all states. Given the nature of the survey, however, some variation was expected. The analysis showed only smaller differences between states, supporting the validity of the data set. Because the NHTS data set provides a fairly representative sample of all travel modes, it is assumed that the same expansion factors may be used for all modes. The expanded data set is expected to cover all long distance trips of 50 miles of more for the entire U.S. except Alaska.

Even though the NHTS data set includes weights for every data record, simply expanding the records based on these weights is not recommended (FHWA 2005: 5-7). Long-distance travel is an event that is too rare to expand from single records. If, for instance, a person reported two trips in a 28-day period, expanding this trip to

2 trips / 28 days x 365 days = 26 trips per year

cannot be carried out with high confidence. This person may have made far fewer trips of greater than 50 miles in this year. Because long distance trips are relatively rare, a simple expansion produces statistically insignificant results. The above-described process of expanding the data set is more reliable, as it is constrained by the total number of air travelers per year given by independent air passenger data.

6 Trip disaggregation

The NHTS reports trips at the level of states and, if applicable, of metropolitan areas. Most local travel models work at a geography much smaller than states. To make these long distance trips usable for local models, trip origins and destinations are disaggregated to the county level. As business trips are most likely to visit offices, employment is used to disaggregate those. Trips with a personal trip purpose are disaggregated based on employment distributions. The disaggregation process is constrained by the destination state or, if available, by the destination metropolitan area given by each NHTS data record.

7 Long-distance travel assignment

If a local travel model covered Washington D.C., a long distance trip from Philadelphia to Miami could either go through the D.C. study area or avoid the city on the beltway. The route choice decision is simulated by a traffic assignment model, using the same assumptions and methods appropriate for urban travel modeling.

Only long distance trips are assigned to the network. Short distance trips of less than 50 miles are added as background volume to reflect accurate travel times faced by all travelers, particularly in urban areas. In rural areas, a Level of Service (LOS) C is assumed, with a corresponding volume-to-capacity (V/C) ratio of 0.6 filled by short distance trips. In other words, if the total capacity of a highway link is assumed to be 1,700 vehicles per hour per lane (vphpl), local auto flows fill 60 percent of this capacity. In urban areas, highways are assumed to be more congested and to operate between LOS D and E, such that the background volume of short-distance trips corresponds to a V/C ratio of 0.9. If applied for a specific local travel model, volumes of internal trips simulated by the local travel model should be used as background volumes instead.

8 Extract data for local study area

After assigning long-distance auto and bus trips to the highway network, EI, IE, and EE trips relevant to the local study area at hand can be extracted. These trips are fed into the local travel model as external trips. Trips need to be assigned to the network as described in section 7 to determine routing within the local model area. Because all of the expanded survey records that define the external travel and traveler characteristics are lumped together in a single trip matrix a multi-

class assignment process can be used if differentiation of different market segments is desired.

External stations in the target (urban or metropolitan) travel model are limited to the links entering and leaving the local study area from the U.S. highway network. This may result in missing volumes for external trips on minor roads at the edge of the local study area. This shortcoming is assumed to be minor as all major roads, which supposedly carry the majority of the regional traffic, are included in the U.S. highway network. Furthermore, all long distance travelers destined to the study area at hand may be added to the local population to add local trips while they are visiting the study area. In the opposite direction, long distance travelers that leave the study area at hand should be subtracted from local travelers, as they cannot make local trips while they are outside the study area. Accounting for who actually is traveling in the study area may be particularly significant in areas with a high number of tourists or business travelers.

9 Forecast

For future long-distance travel flows, assumptions about growth of traffic volumes must be made. Obviously, this involves uncertainty, including but not limited to long-term trends in gasoline prices, economic recovery, and individual travel behavior. Running a series of scenarios that cover a larger range of possible development trends is recommended for understanding and quantifying this uncertainty. For every scenario agreed on, the expansion factors developed in section 5 simply need to be growth-factored by the appropriate share. Auto, bus, train and air travel may also be evaluated using different growth factors.

10 Concluding remarks

A prototype of this model was developed for the Maryland Statewide Model (MStM) covering the states of Maryland and Delware, Washington D.C. and parts of Pennsylvania, Virginia and West Virginia (Weidner et al., forthcoming). In this first approach, all long-distance trips having one end within the study area were simulated microscopically. Figure 3 shows the simulated origins and destinations of long distance trips that start in the MStM study area (IE trips) as density maps. Mode choice for these trips is given by the NHTS data set. All auto trips are assigned to a national highway network. For transit trips (air, bus and train) an exit point is chosen, which is an airport, a bus terminal or a train station. The selection of the exit point is based on a typical distance distribution derived from an airport passenger survey. Mode choice and assignment from the home zone to the exit station are simulated by the local person travel model. The white zones in Figure 3 show origins and destinations that were not chosen in this simulation run. Because the model is built as a microsimulation, slightly different

zones are selected in every model run. The total traffic flows within the study area, however, are very stable over different model runs.

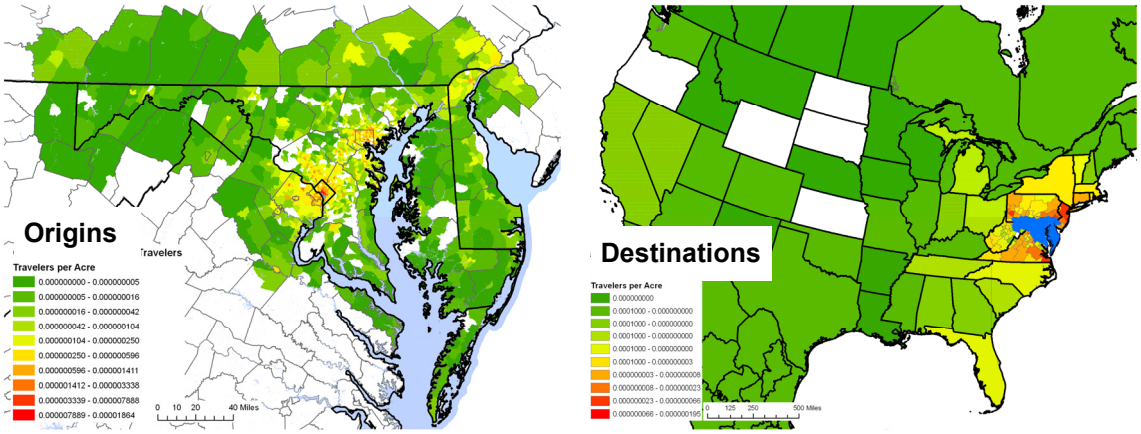

Figure 3: Long distance trips for the Maryland statewide model

The current approach generates individual travelers with microsimulation. Subsequently, all microscopic travelers are lumped together and assigned by an aggregate travel model. Unless a full Dynamic Traffic Assignment (DTA) is implemented, which is unrealistic for larger study areas, the richness of the micro data is lost in the assignment process. Alternatively, the assignment of long distance travelers could be done by an all-or-nothing assignment finding the shortest path. In this case, each traveler can be assigned individually, and the richness of the data set is preserved for further analysis.

A new NHTS was conducted in 2008. The results are expected to be released in early 2010. A significant difficulty of the current NHTS is that part of the interviews were conducted before September 11th, 2001, and part of them afterwards. The attacks had a significant impact on long distance travel. The new survey from 2008 does not have this distortion. Besides providing data that are closer to the average traveling in the last five years, the new survey also allows analyzing how long distance travel patterns change over time. With the availability of four long distance travel data sets, namely the American Travel Survey (ATS) conducted in 1977 and 1995 and the NHTS conducted in 2001 and 2008, extensive trend analyses can be done. Looking into the shift of mode split, trip duration, party size and trip destination will be a valuable exercise to make reasonable assumptions for future changes in travel behavior.

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