TECHSUMMARY *October 2019*

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Development of a Mode Choice Model to Estimate Evacuation Transit Demand

INTRODUCTION

Current models of hurricane evacuation demand use subjectively determined evacuation participation rates to estimate evacuation demand. However, as shown in past studies, evacuation behavior is sensitive to the dynamic properties of a hurricane, the evacuation network, operational decisions made by emergency managers, the conditions the population are exposed to, and their ability to withstand them. In trying to accommodate these influences in a modeling framework, the Louisiana Transportation Research Center (LTRC) has developed hurricane evacuation demand models over the last decade.

What is currently missing among the LTRC models is the ability to estimate the use of other modes of transportation in evacuation beside the private vehicle. Of particular interest is the use of transit and the ability to model it as a function of the level of transit service provided, location of shelters, characteristics of the population, etc.

Transit use during an evacuation virtually limits the choice of destination type to public shelter. Similarly, choosing the home of a friend or relative, or a hotel/motel, as a destination, strongly favors the use of private vehicle. Thus, a close link exists between mode choice and destination type choice. For that reason, the joint choice of destination type and mode is modeled in this study.

OBJECTIVE

The objective of this study was to develop a joint mode/destination type choice model for hurricane evacuation and demonstrate its use in New Orleans.

SCOPE

The scope of this study was limited to the development of a joint mode/destination type choice model for hurricane evacuation, but its application was intended to be geographically universal. It was assumed that the number of households that evacuate in each time period is known. This serves as input to the model. The output from the model was the number of households choosing each combination of mode and destination type in each time period.

The model was estimated based on joint data from three evacuation behavioral surveys conducted after Hurricane Gustav (2008) in New Orleans and Hurricane Irene (2011) and Hurricane Sandy (2012) in New York. By estimating a model on this joint data, while disregarding its geographical origin, one implicitly assumes individuals evaluate conditions in the same manner irrespective of their residential location, and all factors affecting the evacuation decision are incorporated in the model, including locational characteristics. That is, the judgment people apply, the evaluative process they use, and the values they employ in decision making, remain stable from location to location. Allied to that, and necessary for the former assumption to be true, is the assumption the model includes factors that capture the influence of local conditions such as levees, barrier islands, topography, the evacuation network, and the evacuation plan of the area. Typically, local conditions such as these are

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captured in the model by including variables that are sensitive to areas that will be flooded, type of housing, population affected, capacity of the network, and how evacuation is managed (timing of evacuation orders, initiation and termination of contraflow, closing roads, etc.). For the joint mode/destination type models developed in this study, factors such as community characteristics, level of social networking, quality of transit service, and characteristics of local hotels and motels, were taken into consideration.

METHODOLOGY

A nested logit (NL) model specification was used to estimate this joint choice model, so the dependency between destination type and mode could be tested. The selected structure of the NL model has destination type on the upper level nest and mode choice on the lower level nest, because it provides the best results in terms of multiple statistical criteria, such as the likelihood ratio index (rho square), significance of parameters, and whether logsum parameters are within a feasible range (0 to 1). The estimated model shows significant linkage between mode and destination type choice, which validated the choice of a nested structure for the model. Selected variables included both household and zonal characteristics, reflecting the attributes of alternatives, the characteristics of households, and the interactions between them. Most of the selected variables were significant at a confidence level of 95%. The estimated model was applied in two different cases on data different to that on which it was estimated, and the prediction errors were small.

CONCLUSIONS

The diversity of household behavior was increased in this research by using datasets from different storms (i.e., Hurricanes Gustav, Irene, and Sandy) and study areas (i.e., Louisiana and New York). The variation in behavior provided an opportunity to capture the impact of factors that influence evacuation but are often stable in individual data sets. Factors affecting household behavior in the choice of destination type and mode appear to have been identified more fully than in previous research. The estimated models reasonably predicted mode and destination type choice in the other two post-storm behavioral surveys (i.e., Hurricanes Georges and Sandy) covering different study areas (i.e., Louisiana and Mississippi; New York and New Jersey). With a better ability to estimate transit demand, the location choice on pickup points and shelters can be better optimized, and a more precise prediction on traffic flow on the network can be expected.

The developed joint choice model would be easy to apply elsewhere because data used in the model are generally available for all the selected variables. For example, synthetic households with all their characteristics can be generated by common transportation planning tools (such as TransCAD). The inputs to create synthetic households come from two sources. The first part is a household database, which provides rich information on household and personal characteristics. The Public-Use Micro Data Sample (PUMS) from the U.S. Census is a common choice for this data. The second part is a zonal database, which contains aggregate marginal household statistics. Zonal level data can be easily collected from American Community Survey (ACS) and other named open data sources in this study.

RECOMMENDATIONS

Future researchers will be able to build upon this work by incorporating additional variables or alternatives to explain new emerging choice behavior. An area of particular significance is the emergence of ride-sharing programs. When enough data on this choice alternative is accumulated in the future, adding a new alternative to the current model structure will update the model to reflect the new emerging behavior.

There is a portion of the population who are barely captured in current surveys, such as the disabled who use paratransit service, tourists, and temporary residents. Accumulating data across different surveys through time or using other emerging data collection methods can help solve this issue.

Overall, additional data can help this research to generate more insight on household's joint choice behavior, update the model to fit the ongoing changes of household behavior, and draw more meaningful conclusions for the benefit of emergency managers.