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Hurricane Evacuation Modeling Package

INTRODUCTION

The Hurricane Evacuation Modeling Package (HEMP) is a computer-based software package that estimates the time-dependent evacuation behavior of households facing an oncoming hurricane. With the exception of the evacuation network, the package operates entirely on data available from official sources and uses models that have been estimated from observed evacuation behavior in past hurricanes. In the package, population is synthesized from census data, storm data is downloaded from the National Hurricane Center, and evacuation behavior is predicted in terms of the number of households evacuating in each 6-hour period, their destination, mode of travel, type of refuge, route, and the resulting traffic flow on the network. A user specifies a past or current storm to be analyzed, the area to be evacuated, if and when evacuation orders and/or contraflow are to be implemented, and the package estimates the consequences of the scenario in terms of average travel time, delay, speed, and degree of migration in each time period.

Figure 1
Damage caused by Hurricane Lili (2002)

OBJECTIVE

The overall objective of this study was to incorporate the LTRC hurricane evacuation models and the data on which they operate into a single, user-friendly computer package. The intention is that the program will provide emergency managers with a convenient means of estimating the consequences of alternative management decisions before they make them, thereby enabling them to select the best set of evacuation decisions.

SCOPE

The scope of this project was to develop a working software package whose operation is demonstrated in an application to the New Orleans area. The emphasis was on establishing a working version of the package, recognizing that it is likely to require improvement, and upgrading as it is run and tested. It is also likely to require extensions to its current capabilities as new requirements are identified.

While applied in the New Orleans area in this study, HEMP can be applied in any area where the model parameters are valid and data on the application area (such as the evacuation network) is provided. The default model parameter values in the package are based on data from past hurricanes in Louisiana, South Carolina, and New York. The default values can be altered if required.

METHODOLOGY

Research conducted on hurricane evacuation modeling at LTRC in the last two decades has involved investigation of the suitability of the conventional urban transportation models in modeling hurricane evacuation demand and the development of models that address incompatibilities between the two. Models estimating the evacuation decision of households in discrete time

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intervals, type of refuge chosen, choice of mode, and the destination of evacuating households make up the time-dependent evacuation demand estimation part of the package. HEMP has integrated these models into the TransCAD software package to benefit from its file-handling capabilities and its ability to synthesize the population of an area. TransModeler uses the time-dependent demand emanating from TransCAD to simulate the migration of the population and dynamic traffic conditions on the network. HEMP is operated through a menu-driven user interface.

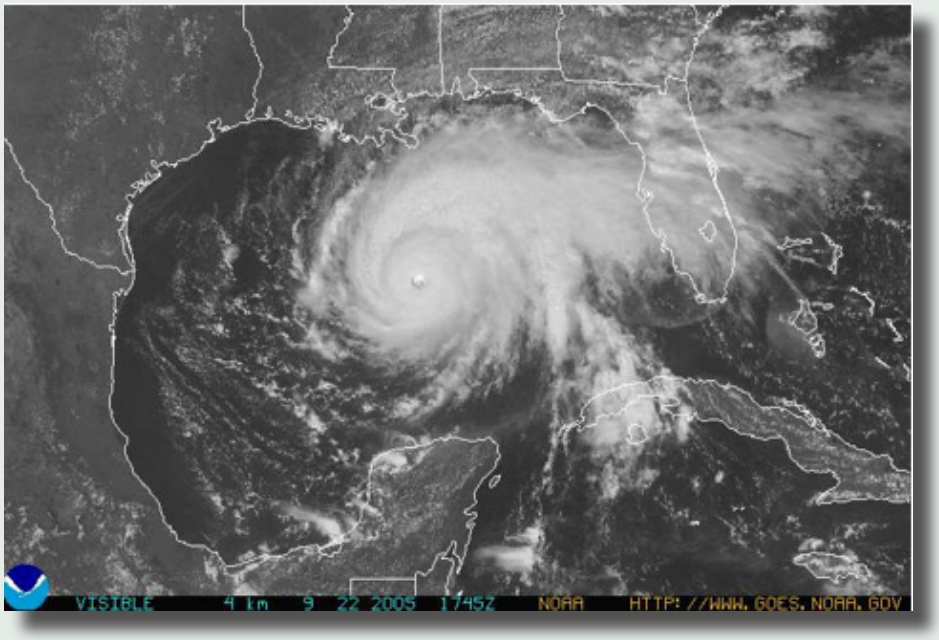

Figure 2
Hurricane Rita (2005)

CONCLUSIONS

The first conclusion drawn from the development of this package and its application in New Orleans is that care must be taken to apply the models in the package in exactly the same manner as that in which they were estimated. Specifically, the level of aggregation, units, and time to which each variable applies must be consistent between the estimation and application environments. Failure to do so will result in false model estimates.

A second conclusion is that coding a network for application can take a large amount of time and effort if the network is to be coded accurately and provide all the network features needed by the models in HEMP. For example, current traffic signal settings must be accurately coded if TransModeler is to simulate traffic on the evacuation network realistically. The probabilistic route choice model in HEMP requires additional network information (such as AADT and the number of gas stations and hotels on each route).

A further finding from this study is that traffic control involving flashing yellow on main routes and flashing red on minor routes is consistently better than keeping existing traffic signal settings in operation during evacuation, particularly during periods of peak traffic. In the application reported in this study, flashing yellow/red resulted in less delay, higher speeds, shorter travel times, and less total travel than evacuation conducted with current traffic signal settings.

Traffic assignment using the route choice method included in HEMP resulted in similar traffic flow estimates to that achieved using shortest path assignment in TransModeler. This may indicate that travel time is the most important consideration in route choice even in evacuation. However, the two methods do produce results that are up to 450 vehicles per hour different at certain times in certain locations. Further research into the application of the route choice method in TransModeler is needed to verify the integrity of the method.

Further work is needed to streamline the application of HEMP, ensure input data is correctly submitted, and verify the package is operating correctly. Repeated runs of individual components, testing the sequential operation of models, and assessing the plausibility of alternative scenarios is needed to verify the integrity of the package. Beside this "debugging" operation, attention should be given to improving the output generated by the package. In particular, the statistic "clearance time" should be added since emergency managers use it to determine the latest they can issue an evacuation order without having evacuees exposed to gale force winds as they evacuate.

RECOMMENDATIONS

The following recommendations are made based on the conclusions of this study: (1) test HEMP to identify any bugs in the package; (2) incorporate instructions in the running of HEMP that will ensure input data is correctly specified; and (3) review the application of the route choice method in TransModeler.