Southwest Region University Transportation Center
Project Proposal - FY 2012

TITLE OF PROPOSED PROJECT: GULF COAST MEGAREGION EVACUATION TRAFFIC SIMULATION MODELING AND ANALYSIS

STRATEGIC GOAL(S) ADDRESSED: EVACUATION

CONSORTIUM MEMBER: LSU

TOTAL PROJECT BUDGET: $48,893

PRINCIPAL INVESTIGATOR: DR. BRIAN WOLSHON
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HAS THIS PROPOSAL BEEN SUBMITTED FOR FUNDING ELSEWHERE? NO

DID THIS PROPOSAL RECEIVE FUNDING FROM ANOTHER SOURCE? NO (MATCH FUNDING ONLY)

DOES THIS PROPOSED RESEARCH INVOLVE THE USE OF HUMAN SUBJECTS? NO

WILL THIS PROPOSED RESEARCH INVOLVE OTHER ORGANIZATIONS AS PARTNERS?* YES (ROBERT HARRISON – UT AUSTIN)

PROJECT MONITOR NAME, ORGANIZATION, ADDRESS AND TELEPHONE NUMBER:*
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STEPHENSON DISASTER MANAGEMENT INSTITUTE
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ABSTRACT OF PROJECT:
Over the past decade, there has been a growing consensus among long range climatological forecasters that the earth is experiencing significant changes in its climate. These climatological changes have also been suggested to be linked to a rise in ocean sea levels as well as the likelihood for an increase in the strength and frequency of catastrophic tropical weather systems like hurricanes. When this is coupled with enormous population growth along the coastal regions throughout the world, which are now developing into mega regions, a

significant potential exists for the occurrence of catastrophic disasters of heretofore inexperienced proportions that can threaten millions of people. Work is now underway to begin investigating megaregion evacuation. The Transportation Analysis and Simulation System (TRANSIMS), an agent-based travel simulation system designed to meet State Departments' of Transportation (DOTs) and Metropolitan Planning Organizations' (MPOs) needs for more accurate and more sensitive travel forecasts for transportation planning and emissions analysis, will be used for model construction. In the project the goal will be to create megaregion evacuation traffic scenarios to examine the creation of and recovery from traffic congestion.

Gulf Coast MegaRegion Evacuation Traffic Simulation Modeling and Analysis

by:

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Gulf Coast MegaRegion Evacuation Traffic Simulation Modeling and Analysis

PROBLEM STATEMENT

Over the past decade, there has been a growing consensus among long range climatological forecasters that the earth is experiencing significant changes in its climate. These climatological changes have also been suggested to be linked to a rise in ocean sea levels as well as the likelihood for an increase in the strength and frequency of catastrophic tropical weather systems like hurricanes. When this is coupled with enormous population growth along the coastal regions throughout the world, which are now developing into mega regions, a significant potential exists for the occurrence of catastrophic disasters of heretofore inexperienced proportions that can threaten millions of people.

CURRENT LITERATURE AND RELATED STUDY

Traffic simulation modeling has become a useful tool for evacuation traffic analysis since the late 1970's. The accident at the Three Mile Island nuclear power plants triggered an urgent need to study the time needed for people to evacuate from endangered areas. The first simulation model for evacuation, NETVAC, was developed by Sheffi [1], which is a macroscopic model for simulating the traffic patterns during an emergency evacuation. It was used to estimate the evacuation clearance time for different nuclear power plants. NETVAC is sensitive to network topology, intersection design and control, and different traffic management policies. However, as it was the first model developed for evacuation analysis purposes, the model is unable to handle large networks of greater than 1500 links. Also, the model can only be used for design and planning purposes rather than descriptive analysis. Since then, evacuation time estimates (ETEs) for nuclear power plants has become an interest to researchers. The Nuclear Regulatory Commission conducted research on techniques for estimating evacuation times at nuclear power plants [3]. This analysis, together with work by Federal Emergency Management Agency contractors, became the basis for the ETE guidance [4]. However, ETEs are only one way to analyze evacuation planning under emergencies. ETEs were not capable of facing the complex situations with evacuation scenarios even though evacuation clearance time estimation is of critical importance to the public authorities until now.

With the realization of the importance of evacuation planning for mass population, developing pre evacuation plans for nuclear power plants [5], man-made crises, and natural disasters has become a popular research area since the 1980s. In the 1990's, after a number of catastrophic hurricanes hitting the coast line of the U.S., more researchers have shifted to hurricane evacuation modeling and the behavior of evacuees under such scenarios. E.J. Baker studied the hurricane evacuation behavior based on the sample surveys following approximately 12 hurricanes from 1969 to 1989 in many states from Texas to Massachusetts.

He found that risk areas and actions by the public played the most prominent role in affecting public response [9]. During the same time frame, Frank Southworth developed a five step process for regional evacuation modeling [10]. The process involved vehicle trip generations, trip departure times, trip destinations, and trip route selection modeling.

Since the September 11, 2001 attack in the U.S., mass evacuation due to terrorist invasions is getting more attention. Due to other events such as the tsunamis and otherwise-caused floods in Japan; the wild fires in Australia; and the earthquake in China, evacuation in these countries typically focuses on specific types of evacuation only. For instance, rising sea level and the low elevation line in the Netherlands has led to research about flood evacuation research and applications [11]. In the U.S., the vulnerability to hurricanes for the Gulf Coast region, Texas and Louisiana has prompted research in hurricane evacuation modeling and traveler behavior.

OBJECTIVES OF RESEARCH

The objective of this project is to take the initial steps toward investigating mega region evacuation. Over the two decades there have been numerous traffic simulation models used or developed specifically for evacuation analysis. These have ranged from macroscopic to mesoscopic and microscopic and each has inherent strengths and weaknesses relative to evacuation analysis.

In this proposed effort, the Transportation Analysis and Simulation System (TRANSIMS), an agent-based travel simulation system designed to meet State Departments' of Transportation (DOTs) and Metropolitan Planning Organizations' (MPOs) needs for more accurate and more sensitive travel forecasts for transportation planning and emissions analysis, will be used for model construction. With careful use and development, it can be adapted to create traffic scenarios which can be applied to mega region transportation simulation and evacuation analysis.

At a minimum, the following tasks will be completed to satisfy the research objectives:

1. Literature and State-of-the-Practice Review
2. Data Analysis
3. Development of TRANSIMS model
4. TRANSIMS calibration
5. Final Report

METHODOLOGY

The process below outlines the proposed steps necessary to develop the model.

Step 1 – The development of networks in the Houston-New Orleans megaregion such as routes, connectivity, control, etc. See Figure 1 below.

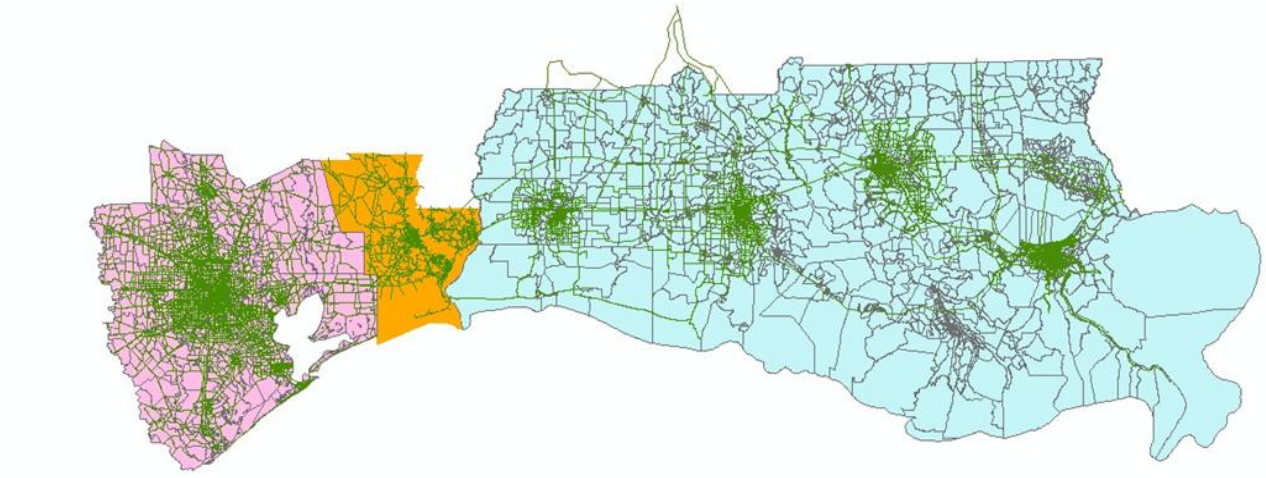

FIGURE 1: Houston-New Orleans mega region network

Step 2 – Temporal and spatial generation of evacuation traffic demand based on the population data shown below in Figure 2, past research and field observation on the behavioral response of evacuees in this region, and the hypothetical scenarios developed in this research.

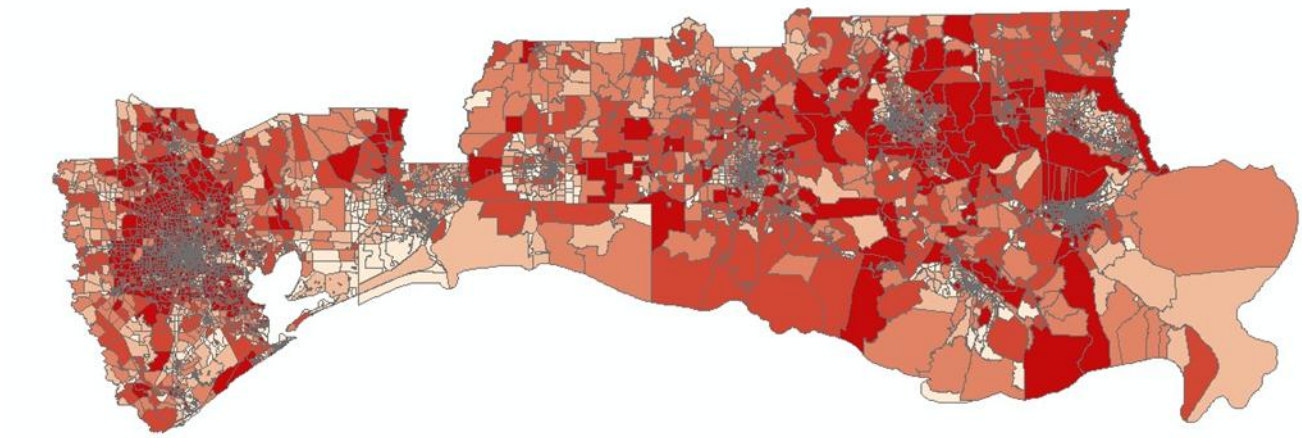

FIGURE 2: Houston-New Orleans mega region household distribution

Step 3 – The temporal and spatial assignment of this demand from their points of origin to appropriate destinations, then to the road network based on logical ad previously observed patterns of travel.

Step 4 – Generation and analysis of results using both transportation and emergency management oriented measures of performance, including clearance time, delay, travel speed, flow volume, and so on. These will be done on various levels of aggregation ranging from the total system to route segments to them movements of individual evacuees and vehicles.

WORK SCHEDULE

It is proposed that the project will be completed within a period of 18 months (June 1, 2012 to December 31, 2013).

Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Lit. Review																		
2. Data Analysis																		
3. Development of TRANSIMS model																		
4. TRANSIMS calibration																		
6. Final Report																		

STAFFING PLAN

The project will be completed under the direction of Dr. Brian Wolshon. Dr. Wolshon is a Professor in the Department of Civil and Environmental Engineering at Louisiana State University, specializing in the field of highway design and traffic engineering. His research covers several areas in highway transportation, most notably issues related to the planning and management of traffic during mass evacuations and in particular the application of reversible traffic operations, the acquisition of road-weather information and the development of regional micro-scale evacuation traffic models of various metropolitan areas.

It is also anticipated that the primary work tasks will be completed by a graduate student and an undergraduate student. The graduate student will be employed to develop models, analyze data findings, and create spreadsheets. It is also assumed that the methods and outcomes developed from this project will also be used to support a doctoral dissertation and a master's thesis. The undergraduate student will assist with data analysis and data input to help with the calibration of the model.

DELIVERABLES

A final report will be prepared to document the entire research effort. The intended end users of the products and deliverables of this project are envisioned to be transportation and emergency management agencies involved in the planning and evaluation of evacuations in the Gulf region. Specifically, these would initially include the Louisiana and Texas Departments of Transportation and the Louisiana Governor's Office of Homeland Security and Emergency Preparedness and Texas Division of Emergency Management. Ultimately, these

techniques and results would be adapted for use in other locations around the U.S. (and internationally) and for other types of natural and manmade hazards.

AMOUNTS REQUESTED BUDGET JUSTIFICATION

The total amount requested to complete the proposed items of work described herein is shown on the attached project budget. It is estimated that all work items will be completed for a cost of $48,893.

PURSUIT OF FUTURE FUNDING

At the conclusion of this project, actions will be taken to extend the research effort. These actions may include examining ways to apply this research to other megaregions around the world. Potential sponsors for the additional research may include Louisiana Department of Transportation and Development or Stephenson Disaster Management Institute.

References

[1] Sheffi, Y., Mahmassani, H.s. and Powell, W. (1980) NETVAC: A Transportation Network Evacuation Model. Internal report, Center for Transportation Studies, Massachusetts Institute of Technology, United States

[2] U.S. Nuclear Regulatory Commission, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, for Interim Use and Comment, NUREG-0654, U.S. Nuclear Regulatory Commission, Washington, DC, 1980.

[3] T. Urbanik, A. Desrosier, M.K. Lindell, C.R. Schuller, Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR-1745, U.S. Nuclear Regulatory Commission, Washington, DC, 1980.

[4] U.S. Nuclear Regulatory Commission, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654 Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, 1980.

[5] Golding, D. and Kasperson, E.R. (1988) Emergency planning and nuclear power -looking at the next accident. Land Use Policy : 19-36.

[9] Baker, E.J. (1991) Hurricane Evacuation Behavior. International Journal of Mass Emergencies and Disasters, August 1991, Vol. 9. No. 2, pp. 287-310.

[10] Southworth, F. Regional Evacuation Modeling: A State of the Art Review. Report. Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.

[11] Pel, A.J., Bliemer, M.C.J. and Hoogendoorn, S.P. (2011). A Review on Evacuation Travel Behavior Modeling and Simulation. Transportation.