LOUISIANA TRANSPORTATION RESEARCH CENTER

Technical Summary

LTRC Report 704

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Testing the Hurricane Evacuation Modeling Package (HEMP)

Introduction

Researchers from various disciplines have worked to estimate several evacuation demand models over the last decade. Louisiana Transportation Research Center (LTRC) is one of the major research groups focused on evacuation demand modeling. All of the modeling components developed by LTRC were assembled in a computer package called Hurricane Evacuation Modeling Package (HEMP) between 2017 and 2020. HEMP allows the estimation of evacuation traffic depending on storm characteristics and decisions made by emergency managers. HEMP has been set up to operate in the New Orleans, Louisiana, metropolitan area and was tested using data from Hurricane Katrina in 2005.

A graphic user interface was created to make HEMP easily accessible to emergency managers, who may not be familiar with the traffic simulation tools running in the background. Emergency managers are only asked to enter their decisions, such as phased evacuation orders, through the developed user interface. With other inputs provided in the background, HEMP automatically generates outputs, such as average travel time, to help emergency managers evaluate the impacts of their decisions.

Objective

This project tested the developed HEMP computer package to determine and improve its accuracy, usefulness, and running time before it is released for practical use. The project team made the following improvements to the HEMP package:

- Input data were examined to ensure models were applied in the same way they were estimated.
- Simulation outputs were compared with observed data, such as survey responses and traffic counts, to improve confidence in HEMP's prediction ability.
- Several changes were made to improve HEMP's fitness for actual emergency management operations in Louisiana.
- HEMP's computation speed was improved to provide reliable outputs in a shorter amount of time.

Additionally, this project sought to identify other enhancements that could be made to further improve the computer package and better support emergency management in Louisiana in an era with digital twins, which are "digital replicas of a physical object, person, system, or process, contextualized in a digital version of its environment."

Scope

The project team used Hurricane Ida (2021) as the case study for testing and assumed it was an approaching hurricane for result comparison. The study area included four coastal parishes (Jefferson, Orleans, Plaquemines, and St. Bernard) in the New Orleans-Metairie, LA metropolitan area, which are heavily populated and were severely affected by Hurricane Ida in 2021.

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Methodology

Figure 1 shows the scope and workflow of the study, with an anticipation that the HEMP package could be run in real time in the future. Please refer to the Final Report for a more detailed explanation of each step.

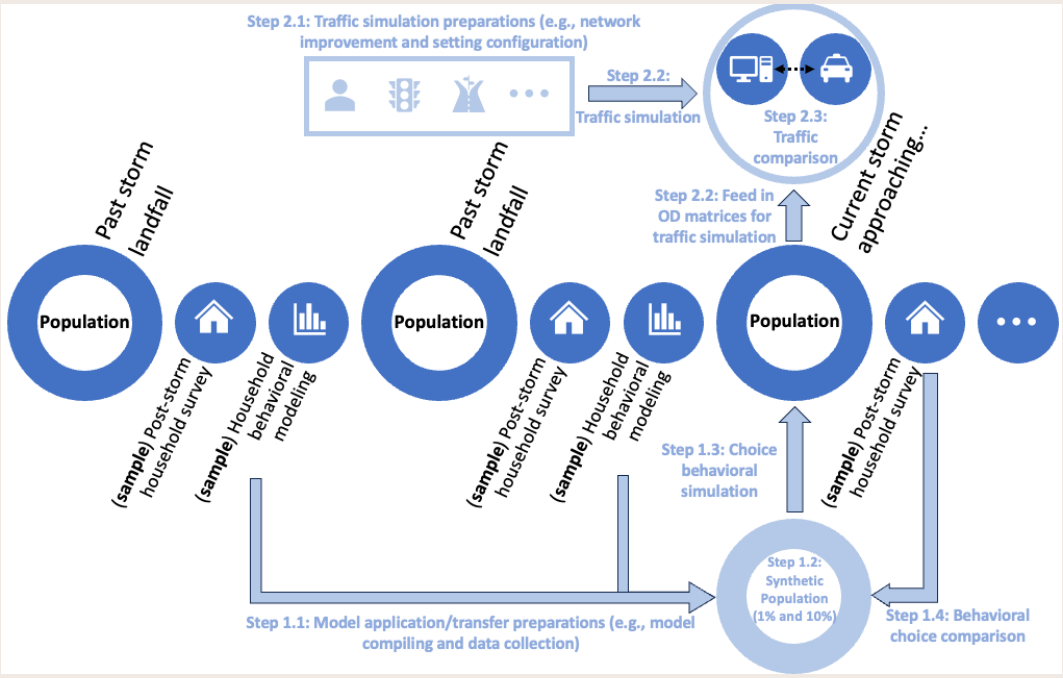

Figure 1. Study workflow

Conclusions

This study highlights the challenges of collecting data to generate synthetic populations, the shift of local demographics in the last decade, the lessons learned in evacuation behavior model transferability, and the updates to the traffic simulation setting with drivers' route choice behavioral parameters integrated. All of the results can be applied to facilitate the upgrade of traditional evacuation simulations to digital twin creation for future storm responses. This process also emphasizes that human components, including demographic profiles and behavior choices, should not be overlooked in the process of creating digital twins to better support future disaster management.

Recommendations

In its current version, the HEMP can provide statistics, such as the number of evacuees and average evacuation traffic speed/time in 6 hour intervals from 72 hours prior to storm landfall, to evaluate when and where to issue an evacuation order and determine when and where bottlenecks exist to support traffic operations for congestion mitigation.

From an academic perspective, advances in communication technologies make collecting and transmitting near-real-time data possible, which makes the concept of digital twins possible in transportation applications.

From an implementation standpoint, computer-generated simulation results should be evaluated, trained, and improved by utilizing the human knowledge, experience, and instincts accumulated throughout years of practice after disasters. Creating academic-public partnerships for tool improvement, testing, and use will require additional resources, such as purchasing computing resources and developing training activities.