

Analyzing Transit-Based Evacuation Demand in Hurricanes

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Center Name: Center for Equitable Transit Oriented Communities (CETOC)

Research Priority: Preserving the Environment

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Project Description: Large-scale evacuation events have become the norm in the Gulf of Mexico Region due to the impacts of climate change. Meanwhile, population growth has pushed more residents into flood-prone areas. Previous hurricane evacuations have seen massive congestion on primary evacuation routes. Additionally, many historically- disadvantaged populations, such as minority, low-English-proficiency, low-income, carless, senior, and/or disabled individuals, have faced difficulties in evacuations. Mass transit and rail have the potential to serve their travel needs during evacuations. What is needed is an accurate estimation of transit-based evacuation demand in hurricanes, so that public transit can be appropriately used to reach those at-risk populations. To tackle this problem, we propose to leverage the anonymized GPS trajectory data (generated from mobile devices such as smartphones and smartwatches), the General Transit Feed Specification (GTFS) and/or GTFS Realtime data, the survey data collected from the disadvantaged populations, and public comments on unmet transit needs to estimate the transit-based evacuation demand during hurricanes. The goal of this research is to study transit vehicles and their use during hurricane evacuation events by collecting, analyzing, and integrating multi-source datasets, particularly focusing on understanding the travel needs of disadvantaged populations. Estimating transit-based evacuation demand (i.e., existing transit use and unmet travel needs) during hurricanes will be a focal point. This proposed research aims to improve understanding of hurricane evacuation process and enhance emergency planning and management with equity prioritized. This research will also help determine how transit services may be improved during such events to facilitate safe, efficient, and effective evacuations, particularly the evacuations of disadvantaged populations. The proposed research will be accomplished via five tasks: 1) Meeting with local stakeholders (state/local DOT, city managers and planners, NGOs, among others) to seek their inputs and feedback for our research design, results, and products; 2) Transit-based evacuation trip inference using GPS and GTFS data, where we will use the individual-level movement data generated from mobile devices (i.e., GPS data) along with the bus schedules from GTFS data to infer which trips are transit travel during evacuations; 3) Survey data collection and analysis, where the survey will be widely distributed through multiple channels to ensure the

representativeness of the sample. Particularly, the PIs will collaborate with the established contacts to reach marginalized communities, and Qualtrics survey panel will also be leveraged to help collect a representative sample; 4) Transit-based evacuation demand estimation by integrating the transit trip inference results from Task 2 and the reported unmet demand from Task 3; and 5) Final report and policy brief. We will use Lee County, FL and New Orleans, LA as the study areas, as they have been frequently impacted by hurricanes and ordered large-scale evacuations in the past decade. Particularly, Lee County experienced significant human loss and damage in the 2022 Hurricane Ian, while New Orleans was severely impacted by the 2021 Hurricane Ida and 2005 Hurricane Katrina. Zhao has ongoing research focusing on Hurricane Ian evacuation analysis and she has established local contacts in Lee County, FL, and Tian has ongoing working relationships with stakeholders in New Orleans, LA. Furthermore, Zhao and Tian are physically located in FL and LA, who are well positioned to conduct local community engagement activities to reach marginalized populations.

Update April 2024: Data collection and analysis are well underway; Preliminary results indicate a heterogeneous spatial pattern of evacuation rates, with significant variations across counties. Lee County, despite being the hardest hit, showed a notably low evacuation rate.

USDOT Priorities: Safe and effective transit responses to hurricanes and other natural disasters is a research area tied to many of the USDOT strategic goals and research priorities. Broadly, this research involves the goals of *Safety*, *Equity*, and *Climate and Sustainability*. Evacuations often affect underserved and disadvantaged populations most severely, and transit-based evacuation is key to making disaster recovery more equitable. Improving these systems is key to the production of communities that are more resilient, and more equitable in their resiliency, in the face of natural disasters.

Outputs: 1. A new methodology to infer transit travel mode by analyzing GPS data and GTFS/GTFS Realtime data; 2. A new survey instrument to assess the historically-disadvantaged populations' travel needs during hurricane evacuations; 3. A new dataset that contains the origin-destination (OD) matrix for transit travel during hurricane evacuations; 4. A final report to summarize the research products and findings; 5. A policy brief to provide potential immediate implementation plans or action items to aid disadvantaged populations in future hurricane evacuation events; and 6. 1-2 manuscript(s) for refereed journal/conference publications.

Outcomes/Impacts: With the findings and products of this research, transit agencies, local governments, emergency management professionals, and nonprofit organizations will have greater knowledge of hurricane evacuation by transit, and thus can effectively and equitably incorporate disadvantaged populations' needs into safety elements of local and regional plans, developing evacuation service programs, and other relevant programs and plans.

Final Research Report: (Link to be provided after project completion).