Research Report Summary

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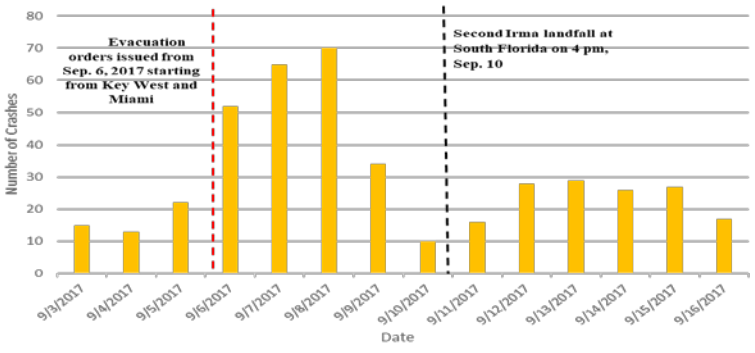
Assessing Crash Risks of Evacuation Traffic

A Simulation-based Approach

Recently, hurricanes have caused major concern for transportation agencies and policymakers attempting to find better evacuation strategies. This was especially evident after Hurricane Irma—a storm that forced about 6.5 million Floridians to evacuate and caused significant delays due to heavy traffic congestion. A major concern for issuing an evacuation order is the high number of crashes that usually occur during the process of evacuation. Though several strategies have been deployed to manage the heavy traffic demand during a hurricane evacuation, current approaches seem to have less impact on traffic safety itself. This project had three objectives: (i) to assess the impact of hurricane evacuation on crash risks; (ii) to identify if there were any changes in traffic flow behavior between evacuation and non-



Number of crashes during Hurricane Irma evacuation

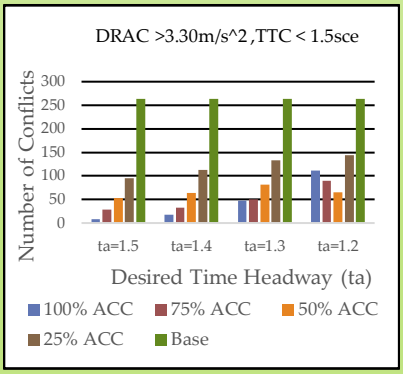
"Ensuring safer mobility for the evacuees"

		Ratio		
Regular Period	cvs_D1	40.08	2.76	0.006
	Occupancy_D1	1.367	1.74	0.083
Evacuation Period	cvs_D3	17.55	2.06	0.038
	Volume_D1	1.004	1.78	0.074

Conditional logistic regression results

Variable	Coef.	z	*p*-value
volume_D1	0.005	4.8141	<0.0001
cvs_D3	0.845	3.6083	0.0003
Evc	0.839	4.0946	<0.0001
constant	-9.493	-47.337	<0.0001

Logistic regression model result (combined data)



Variation of number of conflicts for different values of desired time headway

evacuation periods, and (iii) to assess the impact of an in-vehicle driving assistance system during an evacuation period.

First, we adopted a matched case-control-based approach to assess crash risk during evacuation. After collecting traffic and crash data along a major evacuation route in Florida, we estimated models for three different conditions: regular period, evacuation period, and a combination of both evacuation and regular period data. Results showed that if there is high occupancy at an upstream station and high variation of speed at a downstream station, the probability of crash occurrence increases. We estimated the effect of evacuation itself on crash risk and found that after controlling for traffic characteristics, the chance of an accident is higher during an evacuation than in a regular period. These findings will help us develop advanced real-time crash-prediction models that will work for evacuation traffic conditions and in the design of proactive countermeasures to reduce crash occurrences.

Outcomes

Outcomes of the study

- Created a database that helps us gain insights on crash risk of evacuation based on real-world hurricane evacuation data.
- Reported the influence of evacuation on crash and found the relationship between traffic state variables and crash risks.
- Calibrated a microscopic traffic simulation model that can be utilized to understand driver behavior during evacuations, and
- Provided experimental evidence of potential safety impact of advanced driving assistance systems during hurricane evacuation.

Impacts

Potential impacts of the study

- Drivers can be warned about the impending crash risk and be enforced to reduce speed.
- Evacuation declarations can account for potential crash risks of the evacuation process, and strategies such as phased declaration of evacuation orders can be adopted.
- Researchers and practitioners should adjust model parameters when using micro-simulation tools for modeling evacuation traffic.
- Agencies can recommend the use of in-vehicle ACC system as it can potentially reduce the number of crashes during evacuation.

Second, to understand driver behavior during evacuation and to assess the potential safety impacts of adaptive cruise control (ACC) systems, we developed a microscopic simulation model in SUMO for a road segment on Interstate highway 75 and calibrated it using real-world traffic data from the Hurricane Irma evacuation period. For the calibrated model, we found that the values of maximum acceleration and deceleration were $4.5\ m/s^2$ and $6.5\ m/s^2$, respectively. These values are higher than those in typical car-following models calibrated under regular traffic conditions. Also, higher acceleration and deceleration values indicate abrupt speed variation, the most common scenario for evacuation traffic. To evaluate the safety impact of ACC systems, we adopted two surrogate measures: time to collision and deceleration rate to avoid a collision. Our experimental results showed that during evacuation, about 49% of traffic collisions can be reduced at a 25% market penetration of ACC-equipped vehicles. These findings show the need for better traffic management during evacuations.

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