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Effect of Weather Events on Travel Time Reliability and Crash Occurrence

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Introduction

On average, nearly 5,000 people are killed and more than 418,000 people are injured, in weather-related crashes every year in the United States. Further, about 23% of the non-recurring road delay in the United States can be attributed to snow, ice, and fog. Rain, which occurs more frequently than snow and fog, leads to more traffic delay. In other words, weather conditions such as precipitation, high-speed winds, fog, and other extreme events such as high-volume snowfall, flooding, hurricanes, and so on disrupt the operational performance of roads. They reduce road capacity, travel speed, and safety performance. The magnitude of the effect of adverse weather conditions on road operational performance varies with the type of weather condition and the road characteristics of the studied road links and adjacent links. Therefore, the relationship between weather and traffic is always a concern to traffic engineers and planners, and they have extensively explored ways to integrate weather information into transportation systems. Understanding the influence of weather on operational performance and safety helps traffic engineers and planners to proactively plan and manage transportation systems. The main objective of this research is to evaluate the effect of adverse weather conditions on travel time reliability and crash occurrence, by severity.

Study Methods

The state of North Carolina is the study area of this research. Travel time data, weather data, road data, and crash data were considered in the assessment process. A data-driven methodology is proposed by integrating weather information and travel time data to quantify the effect of common weather conditions like rainfall and visibility on the travel time reliability. The travel time reliability measures such as Planning Time Index (PTI) and Travel Time Index (TTI) were computed for one week before and after (same day of the week and time of the day) under the normal weather condition and compared with those obtained under different intensities of rainfall and visibility. A survival analysis was also conducted to estimate the probability of a road segment reaching an unreliable state under rainfall and visibility conditions. The effect of weather conditions on crash occurrence was assessed using logistic regression modeling. The weather conditions considered in the assessment include rain, snow, fog, sleet, hail, freezing rain, drizzle, severe crosswinds, and blowing sand. Three separate models were developed for each injury severity level, such as severe injury (fatal and injury type A), moderate injury (injury type B and injury type C), and PDO (no injury). A partial proportional odds model was developed to identify factors contributing to the injury severity of crashes occurring during adverse weather conditions.

Findings

Some of the key findings are:

- Poor visibility with different rainfall intensities has the maximum adverse effect on the travel time reliability. The likelihood of reaching a moderately–highly unreliable condition is 8%–15% higher on urban freeway road segments in the case of poor visibility condition relative to the normal weather condition.
- The effect of the weather on travel time reliability was lower in the case of urban arterial road segments when compared with freeway road segments.
- Driving on dark lighted roads or during dusk hours in adverse weather conditions increases the likelihood of severe injury crash when compared to driving on roads in adverse weather conditions during daylight hours.
- Driving on high-speed roads in adverse weather conditions increases the likelihood of moderate injury crash when compared to driving on low speed roads in adverse weather conditions.
- Driving a motor scooter, moped, pedal cycle, or motorcycle during adverse weather conditions is

more likely to result in a moderate injury compared to driving a passenger car during adverse weather conditions.
- Female drivers are more prone to injury when compared to male drivers during adverse weather conditions.

Policy Recommendations

The methodology used in this research requires weather-related information and travel time data, which are readily available from various sources. The results obtained from adopting the methodology are useful for transportation system managers and planners to manage the traffic under different weather conditions.

The findings also help improve the functionality of weather-responsive management strategies such as variable signs to indicate the change in reliability under rainfall and low visibility conditions. The findings from the analysis on the effect of weather conditions on crash occurrence and severity could be utilized to enhance highway safety in adverse weather conditions. Potential strategies for enhancing highway safety during adverse weather conditions include installing more warning signals on selected roads to remind drivers of the need to be vigilant and cautious during adverse weather conditions, using a weather monitoring and warning system that includes pavement surface information, and improving the light conditions on highways.

About the Authors

Dr. Sonu Mathew received his PhD in Infrastructure and Environmental Systems (INES) Program from the University of North Carolina at Charlotte, NC. He is a Postdoctoral Researcher with the IDEAS Center. His current research interests include traffic safety, traffic flow modeling and simulation, ITS, connected and automated vehicles, and spatial modeling.

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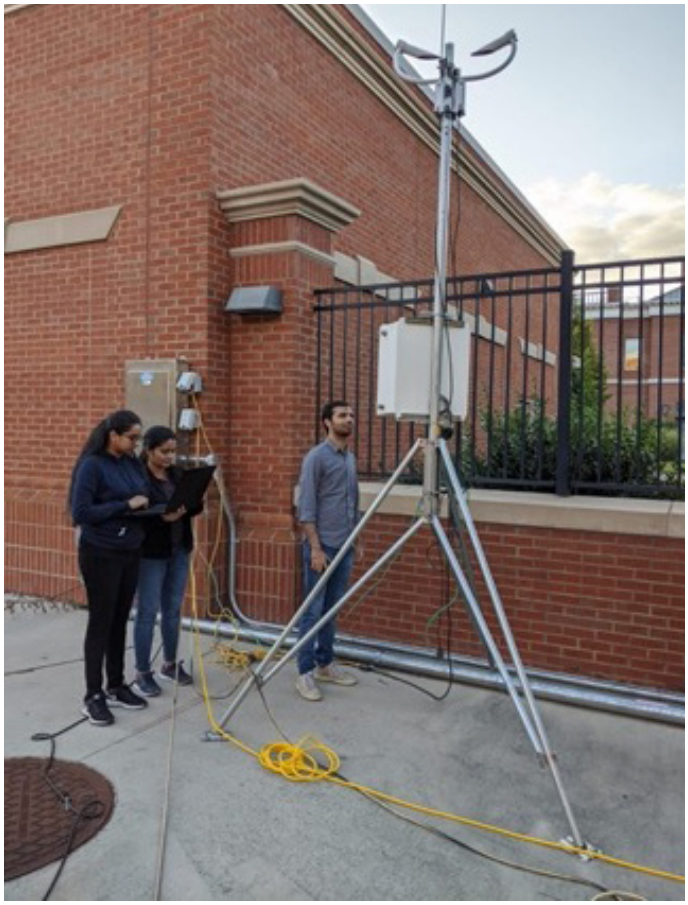

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/2035

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