Impact of Precipitation on Motor Vehicle Fatalities in the Carolinas

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Introduction

Motor vehicle accidents (MVAs) are among the leading causes of injury death in the United States across all age groups ([1]Xu et al., 2016). The presence of adverse weather can exacerbate this, as deteriorations in road condition and visibility can increase the likelihood of collisions.

The introduction of a high-resolution, high-frequency precipitation estimate, coupled with a database of fatal motor vehicle accidents, allows us to identify the occurrence of precipitation at very nearly the exact time and location of a fatal crash.

By comparing the frequency of rain-associated crashes with the climatology of rain in a given area, we can assess the impact of rainfall on the incidence of fatal accidents.

Data and Methods

Fatal accident data are taken from the Fatality Analysis Reporting System (FARS[2]), which has cataloged fatal MVAs since 1975. The time and location of each crash are provided, along with notable risk factors such as excessive speed or alcohol involvement.

Rainfall estimates are taken from the National Mosaic and Multisensor QPE Re-analysis (NMQ/Q2[3]), which provides radar-based precipitation estimates on a scale of 1 km, every five minutes over the period of 2001-2011.

To examine the frequency of rain-associated MVAs, the rainfall estimate is extracted for the time and location of each crash, and a simple ratio is calculated to determine the percentage of crashes in a certain region which occur during rain. This is compared against the overall frequency of rain for that region, calculated from the same radar estimates (Figure 3).

An "**impact score**" is defined simply as the ratio of fatal MVAs which occur during rain divided by the climatological frequency of rain. A number significantly higher than 1 suggests the presence of a relationship.

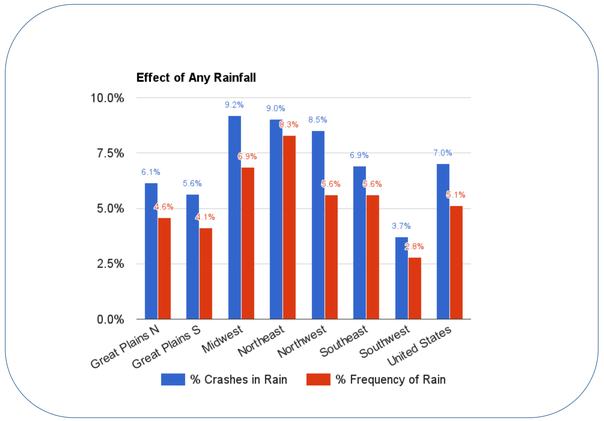

Figure 1: Comparison of rainfall frequency (any intensity) and percentage of fatal MVAs associated with any rain by region of the United States

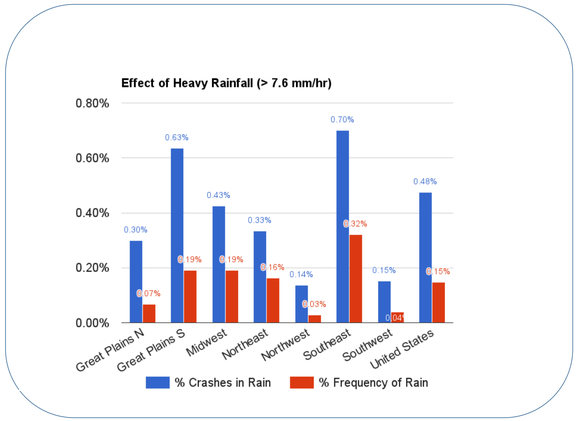

Figure 2: As Figure 1, showing only heavy rain (> 7.6 mm/hr)

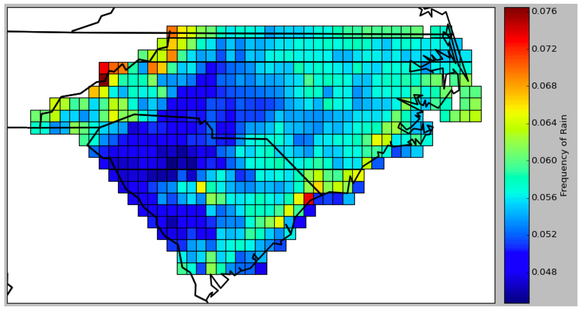

Figure 3: Radar-based frequency of rainfall (any intensity) across North and South Carolina

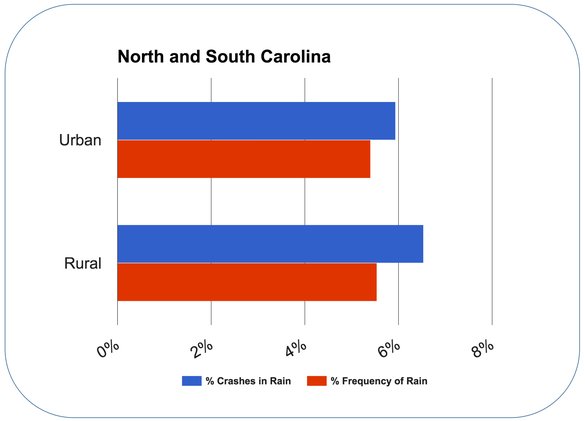

Figure 4: Comparison of effects of rain in urban vs. rural counties of North and South Carolina

Results

Across the United States, the proportion of fatal MVAs which occur during rain is 37% higher (impact score = 1.37, Figure 1) than would be expected in the absence of any relationship. This effect is greatly amplified in heavy precipitation (Impact score = 3.24, Figure 2). While the exact number varies, this holds true across all climatological regions of the US, and in 40 of 45 examined states.

The Carolinas stand out as noticeably less affected, with North and South Carolina having impact scores of 1.06 and 1.16, respectively. While these are still significant, they are considerably lower than the national average and most other states.

When examining these two states on a county level, it becomes apparent that there is a difference between urban and rural counties (Figure 4). Looking at only the 10 most densely populated counties in North and South Carolina, it appears that the impact of rain is greater in rural counties than urban, although both are statistically significant departures from the null hypothesis.

Discussion

It seems clear that there exists a relationship between the incidence of rainfall and the frequency of fatal crashes, with precipitation increasing the likelihood of a fatal crash in nearly all areas. This effect increases with increasing rainfall intensity, becoming far more pronounced in all areas during heavy rain.

There appears to be a difference in urban and rural areas, which can possibly be attributed to better road conditions and/or slower (less fatal) speeds in urban environments due to traffic volume, particularly at the times of day which typically experience the heaviest rainfall. Nationwide results (not shown) concur, showing an inverse relationship between population density and impact score.

References

[1]Xu JQ, Murphy SL, Kochanek KD, Bastian BA. Deaths: Final data for 2013. National vital statistics reports; vol 64 no 2. Hyattsville, MD: National Center for Health Statistics. 2016.

[2] http://www.nhtsa.gov/FARS

[3] http://nmq.ou.edu/

cicsnc.org
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