Prospectus

Emergency Management and Underserved Communities: Using Big Data to Improve Emergency Management Preparedness, Response, and Resilience
(Technical Topic)

Analysis of Hurricane Rita in Houston, TX in September of 2005
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

As climate change continues to affect our planet, its consequences could prove to increase risks for people around the world. Holland and Bruyère (2013) explored how climate change could impact the severity of hurricanes, stating that "it is likely that the frequency of intense hurricanes will increase with future anthropogenic climate change" (p. 617). Since the occurrence of category 4 and 5 hurricanes will likely increase in the future, the question that must be asked is "are the current methods employed by emergency managers effective enough to be used against hurricanes in the future?" Emergency managers have an important job already, helping people evacuate or shelter in place during natural disasters, but the issue of climate change could make their role even more significant (Berardelli, 2019). In Virginia, the Department of Emergency Management (VDEM) is responsible for working with other agencies to monitor storms, recommending whether the governor should issue an evacuation order, and if there is an order, getting out the proper information on what to do next (Virginia Department of Emergency Management, 2010). The current evacuation plans that VDEM uses are flawed, as only 48% of Virginia's population plans to leave the impacted area during an evacuation order and many times people state that they do not know where they are supposed to go (Behr et al., 2020). By helping Virginia's emergency managers prepare higher quality evacuation models, they will be able to better support the communities they serve. To address the current oversights in VDEM's evacuation plans, I will propose a new model that will showcase the areas where most people evacuate to and from and the time periods when people evacuate during an order. This new technology will allow VDEM to create better plans, tailored to different regions of Virginia, to address the specific needs of its communities.

While it is important to create evacuation plans based on different regions within Virginia, there are other factors that VDEM must consider in order to create an effective plan like the traffic routes available to that region and the social demographics of those who live in that area. A lack of understanding of these factors inevitably leads to the current problem where people do not evacuate during a natural disaster because they lack the support and resources that they need. This, in turn, could make way for deadly consequences especially as hurricanes become more catastrophic.

To create better evacuation plans and guarantee the safety of more civilians, both the technical and social aspects of this problem must be addressed. Using RStudio, a programming language, and a visualization package within it entitled Shiny, I will design an interactive model that allows VDEM to see the location of residents before, during, and after a hurricane, using data acquired during hurricanes Florence and Dorian in Virginia. Furthermore, since I will build a heterogeneous network with my model for VDEM, I will use actor-network theory to look at the failure of a related socio-technical network. Specifically, I will analyze the failed evacuation that occurred during Hurricane Rita in Texas in 2005 to determine the technical and non-technical actors that can occur when faced with a major hurricane.

Technical Problem

Emergency management teams are responsible for preparing evacuation plans during incoming natural disasters and determining the best methods to relay this information to the impacted areas. Curtis Brown, the state coordinator of emergency management at VDEM, explained that their main job during an incoming disaster is to "coordinate the overall response with the governor's office, state agency partners and localities … everything from logistics, to finance, to public information and resource requests from affected jurisdictions. Should a storm

impact the commonwealth, [VDEM] also coordinates recovery activities" (Stallsmith, 2021). In Virginia, the governor makes the final decision on whether or not to issue an evacuation order, so VDEM provides their office with recommendations on aspects like when the dates of the order should be and which regions should receive it. Such decisions are crucial as thousands depend on emergency managers for survival during a natural disaster.

Emergency management teams use various methods to predict the projection of a hurricane and what evacuation routes the public should use to get out of the impacted area; however, currently VDEM uses a uniform plan and does not include any demographic information in any of their considerations (Smith, 2020). Without understanding how different social groups in different parts of the state react to evacuation orders, VDEM is inadvertently leaving out groups who might need additional resources and/or support during evacuations. Therefore, in a time of emergency certain groups or regions within Virginia might not know that they need to evacuate or if they do, they might be unsure of where to go, putting their lives in increased danger (Smith, 2020).

The goal of this technical project is to create a model to help the VDEM staff see what social groups are more likely to evacuate and what routes these groups typically move from and towards before, during, and after a hurricane. This model will allow our team to create better evacuation strategies for VDEM so they can assist more sectors of the population that have been ignored prior. There are five tasks the team will conduct in order to create this model: 1) conduct interviews with VDEM staff to understand their current decision-making process, 2) create a dataset with information about the evacuation orders (what regions received the order, what are the dates of the order, etc.), 3) collect demographic data of residents in the impacted areas, 4) use Twitter to get mobility data and see where residents were before, during, and after an order was

issued, and 5) create our model to showcase this data and present our recommendations to VDEM. Our project will use and analyze data from several sources: Facebook for general information on evacuation orders, the National Hurricane Center (NHC) for storm data on Hurricanes Florence and Dorian, demographic data from the U.S. Census Bureau, and data from tweets with tagged locations. Combining these sources into one large dataset will enable our team to create our model in RStudio, which is a computer programming language for statistical analysis. We will create an interactive display of the evacuation plans and routes for residents in Virginia using a data visualization package within RStudio entitled Shiny.

STS Problem

In September of 2005, as many residents of Texas and Louisiana were reeling from the destruction of Hurricane Katrina in August, another Category 5 hurricane was forecasted to make landfall -- named Hurricane Rita. On September 22nd, over a million residents in Texas and Louisiana began to leave their homes, many of whom lived outside of the evacuation zones (ABC13 Houston, 2020). Most Houston residents attempted to evacuate via highways, leading to waits on the road that lasted 20+ hours and gas shortages across the city. On September 24th, Hurricane Rita was demoted to a Category 3 hurricane, as it made landfall on the border between Texas and Louisiana, but by that time, most of Houston's residents already left the city. Today, Hurricane Rita is seen as the "forgotten hurricane" as residents of the city do not remember the storm itself but rather the filled roads from everyone trying to evacuate at the same time (Levin, 2017). Typically, emergency managers monitor the forecast of a storm well in advance, making critical decisions regarding an evacuation order at least 72 hours prior to a storm; however, for Hurricane Rita the Texas Governor's Division of Emergency Management (GDEM) "started those plans far too late, leaving a mess on the roads" (Gomez, 2015). Due to the rushed process,

the emergency managers sent out an evacuation order for everyone at once that led to gridlocks for over 24 hours. During the evacuation, there were over a hundred evacuee deaths in transit stemming from factors like car accidents and heat strokes.

Some scholars believe that this botched process was the result of an overreaction to the storm because the city saw the destruction that occurred during Hurricane Katrina only a month earlier (Levin, 2017). But, what this explanation does not address are the numerous flaws in GDEM's decision-making process, their lack of enough evacuation routes, and the absence of proper evacuation plans that existed before hurricanes Katrina and Rita. By making the fear of another Katrina, the sole reason for this incident, the Texas government overlooked these other factors. Failing to account for such factors leads to a lack of understanding for the role other actors played in the evacuation's failure. Therefore, I will argue that the fear of another Katrina along with the existing flaws in GDEM's decision making, hurricane evacuation plans, and evacuation routes worked in conjunction with one another leading to the gas shortages, road gridlocks, and deaths of those attempting to evacuate.

My analysis of the failed evacuation of Hurricane Rita will draw from the science, technology, and society (STS) framework of actor-network theory. Actor-network theory sees systems built by network builders as a complex network of diverse human and non-human actors working together to accomplish a certain goal. It opens up the "black box" of a particular network, examining the different relationships between several points within it (Callon, 1991). Each actor in the network must be accounted for; otherwise, an important element of the overall system might be ignored, allowing for another failure to happen. To support my argument, I will analyze evidence from newspaper articles and interviews of emergency managers and residents

in Houston, which will provide information on the decisions made during Hurricane Rita and the impacts of these decisions.

Conclusion

The technical aspect of this project will strive to deliver an interactive model to predict the routes and locations most evacuees travel to as well as the demographic information of the evacuees in order to support VDEM and improve their current evacuation strategies. Studying hurricanes Dorian and Florence in Virginia, this paper will use data sources from Twitter, the U.S. Census Bureau, and the National Hurricane Center in order to retrieve information studied in the model. The STS research paper will investigate the failed evacuation of Hurricane Rita in Texas in 2005. Using actor-network theory, this paper will inspect the roles that technical and non-technical actors played in the consequences that arose from the failure, specifically the traffic gridlock and rushed decision-making process. The combined results from this technical project and STS research will address the numerous issues surrounding hurricane evacuation, drawing attention to specific problems and things to avoid, and propose a new way to design plans for hurricane evacuation.

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