Emergency Evacuation Route: A Case Study of Irma

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INTRODUCTION

Hurricanes pose a severe threat in the state of Florida every year and Floridians prepare for the worse when there's something on the horizon, since it has a history with massive and powerful hurricanes since the 90s when hurricane Andrew destroyed most of South Florida as a Category 5. Learning from the history of hurricanes in Florida, Floridians evacuated earlier for hurricane Irma. This evacuation is the biggest evacuation the state has ever been in, with the data collected we can prove such things in specific interstates as shown in Figure 1.

Last year, the preparations were very significant in the whole state, through the datacenter from the Florida Department of Transportation (FDOT) we were able to obtain data points of the evacuation. This specific analysis is done for three major interstates in Florida, I-95, I-4, I-75. Comparing these three routes by volume data and level of service (LOS), we are able to make several adjustments for future evacuations.

Figure 1: *Picture from FOX 13 News of the Southbound lanes of I-95 and its evacuation volume*

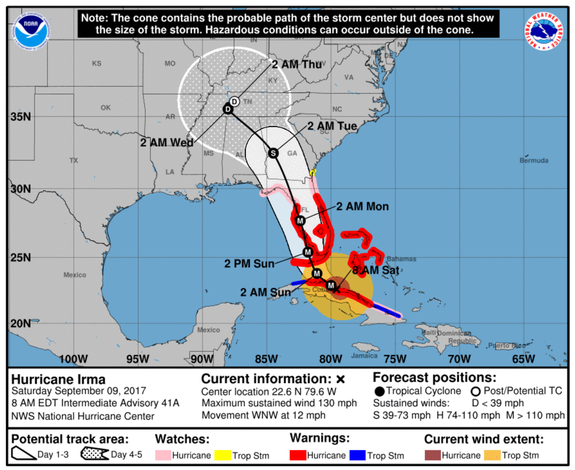


Figure 2: *The real timeline of the hurricane course from Saturday to Tuesday*

As seen in Figure 2, the storm started approaching South Florida the morning of September 9th and it made its way up the west coast of the state. Earlier in the forecast, the hurricane was said to be hitting Florida's east coast and within 24 hours, the hurricane changed course. The evacuation movement started going down from Key West, since in the past it has been the most devastating location in Florida after a hurricane. The evacuation started as early as Tuesday, September 5th of last year. Florida was completely shut down for five days. The data shows the incredible evacuation in many areas across the state.

BACKGROUND

SunGuide program was used to gather data from all the sensory equipment that are on all roads around the state. With this equipment we were able to acquire all the data needed to analyze where the highest volume rate took place in these three evacuation routes. All of the state of Florida is assigned to different evacuation routes and zones, Figure 3 is an example of how the sections within a county is divided by evacuation zones and routes close to those specific zones.

The specific data shows the volume of residents evacuating from every county in different evacuation routes. The analysis done in this study will be only of I-95, I-4 , and I-75. These data points are very consistent and crucial in the state of Florida, since it is used by the emergency management for evacuations routes and zones as shown in Figure 3. Also these three routes make their way North to South and East to West.

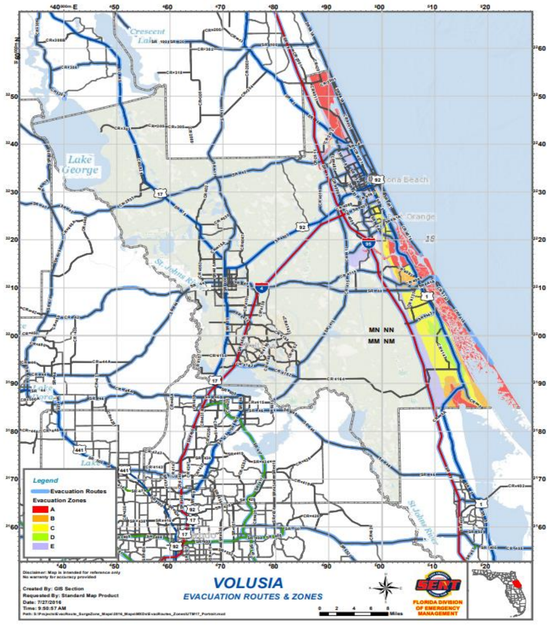


Figure 3: *Evacuation routes and zones for the Volusia county.*

METHODOLOGIES – Intelligent Transportation System (ITS)

There are two methodologies that will be considered in this project: Achieved Data Management Subsystem (ADMS) is when a data is collected and formatted with qualities that define the data source and conditions to interpret the data. The subsystem prepares data products that can serve as inputs to state and local data reporting systems especially during hurricane evacuations. The data that was collected, was from all the different sensors in many different areas of the state of Florida, but our focus is on the three major interstates stated above, which provides a general data warehouse service for a region.

The Traffic Management Subsystem (TMS) keeps track of and controls traffic and road network by communicating with the roadway subsystem to monitor and manage traffic flow and monitor the conditions of the roadway. That in which coordinates and adapts to maintenance activities, closures, and detours, in this case, of the evacuation. This subsystem also manages traffic and transportation resources to support allied agencies (FDOT, among others) in responding to, and recovering from, incidents ranging from minor traffic incidents through major disasters.

ANALYSIS & CALCULATIONS

When looking for the quality of a roadway or high way depending of the area of where it is, gets to be defined as "A" for the highest to "F" the lowest quality (called Level of Service - shown in Table 1). To define these routes at different days and times, it is required to know the volume, speed, and number of lanes. The following calculation was done to all 8,668 data points, which includes I-95, I-4, and I-75:

$$LOS = \frac{Current\ Average\ Volume\ x\ Average\ Current\ Speed}{Number\ of\ Lanes}$$

Level of Service	Density Range (pc/mi/ln)
A	0-10
B	10-16
C	16-24
D	24-32
E	32-45
F	> 45

Table 1: *Level of Service categories and their density ranges, where the analysis falls into.*

Placing all the data points into a graph to show where we could find the highest volume capacity and the worst quality route between I-95, I-4, and I-75, Figures 4 shown below is a sample. The quality of the three routes vary in locations, whether is rural or urban,. For example, if the highway/road is sited in an urban area, studies from the Katrina hurricane evacuation in Louisiana have shown that it tends to have a higher LOS in these evacuations.

Figure 4: *Historical volume, current volume and level of service summary before, during, and after the storm.*

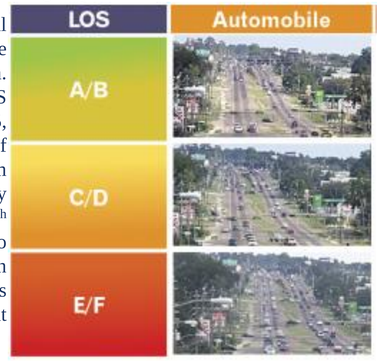
I-95 was mostly used from these three routes on September 9th, 2017 shown in Table 1. On the other hand, to find the highest volume capacity of these major volumes on this exact same day by subtracting the Current Average from the Historical Average Volume, which would give I-75 to be the route mostly used since it is about five times more volume than what is always expected.

LOCATIONS:	I-95	I-75	I-4
County	86	29	75
Site	331	320	130
County Name	Broward	Columbia	Orange
Date	Sep 9th	Sep 9th	Sep 9th
Hour	8:00 AM	10:00 PM	6:00 PM
Direction	North	North	West
Current Volume	8882	4120	6051
Historical Average Volume	7806	785	5583
Current Average Speed	64.48	40.07	62.59
Max Speed (mph)	65	70	60
Level of Service	28	28	32

Table 2: *The highest volume in all three selected routes*

RESULTS

Hurricane Irma had major impacts in the state of Florida since hurricane Andrew. This analysis will help the FDOT as well as educate Floridians how traffic works, especially how the preparations for selecting evacuation routes along the state. These evacuation routes are always done to accommodate the amount of residents in each area for any case of emergency.



I-75 starts from central Florida all the way to the Boarder with Georgia. From Figure 4, the LOS on I-75 is about 65, which is a quality of category "F". The storm hit Columbia county around September 11th and this LOS was two days before the storm. In Figure 5, the LOS is presented by the amount of cars on a highway.

When comparing these three evacuation routes we can see that many Floridians evacuated North instead of East and West. Table 2 displays that many people stayed in their houses on the East coast of the state from the I-4 data and graph as well. I-4 graphs show that there was no low quality LOS, all of the sites along I-4 were below LOS 40. This concludes that the I-4 is capable accommodating that amount of volume during a threat hurricane evacuation.

I-95 has the second highest volume capacity after I-75, this route is stretched all the way from Key West to the Georgia-Florida boarder line. The progression on this route starts Tuesday, September 5th , by the Key West residents. Many of the high capacity volume is not from those specific evacuees, but those who evacuated Thursday, September 7th. The LOS for that Thursday reached to more than 45 with poor quality. This tells us that at those Floridians who evacuated late backed up the traffic going North.

As stated in the previous section, I-75 had the highest volume capacity for people trying to leave the state. With a poor quality of LOS, FDOT can educate residents to take other routes to be able to have a nice flow rate of cars evacuating. This will decrease the travel time and accidents during an evacuation.

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