

Inter- and intra-regional evacuation behavior during Hurricane Irene



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ABSTRACT

This paper presents findings on the hurricane evacuation behavior during Hurricane Irene, using results from a large-scale phone survey among residents in the Hampton Roads (HR) area. An aggregate analysis of the key determinants affecting the evacuation decision is presented. Unlike related literature, we take on a unique approach by distinguishing between two types of evacuations: intra-regional, in which evacuees leave their homes but stay within the HR region, and inter-regional, in which evacuees leave the HR region. Our analysis revealed a clear distinction between these two types of evacuees, which signifies the importance of examining these two types of evacuations separately.

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1. Introduction

The East Coast of the United States is no stranger to hurricanes. According to the National Hurricane Center of the National Oceanic and Atmospheric Administration (NOAA), since 1950, over 45 hurricanes have made landfall somewhere between Florida and Maine (NOAA, 2013). Moreover, 30% of these hurricanes have somehow affected Virginia, especially the southeast region of Virginia known as the Hampton Roads (HR) area (HR also includes two small counties in North Carolina), (e.g. see Schwartz, 2012). HR encompasses 24 counties and cities Accomack, Northampton, Middlesex, Lancaster, Northumberland, Richmond, Westmoreland, Gloucester, Mathews, James City, Chesapeake, Hampton, Isle of Wight County, Newport News, Norfolk, Poquoson, Portsmouth, Surry, Suffolk, Virginia Beach, Williamsburg, Currituck County, Dare County and York County (see Fig. 1). This area of Virginia represents over 20% of Virginia's population (approximately 1.7 million residents), is home to the United States Navy Atlantic Fleet, houses the third largest port on the U.S East Coast, and is the most vulnerable area to flooding anywhere on the East Coast (Burnson, 2011; Kaufman, 2010).

This paper examines the evacuation decisions among the residents of the HR area during Hurricane Irene and identifies the variables that influence evacuation decision. Hurricane Irene made landfall in the Outer Banks of North Carolina and traveled through HR on August 27, 2011. In this study, we distinguish between two types of evacuations: intra-regional evacuation, in

which residents left their home but stayed in other places within the HR region, and inter-regional evacuation, in which residents left the HR region. One way to think about this distinction is that HR residents were actively informed via local media about the possible paths of Irene in HR in the days prior to landfall. Thus, when the decision is made to evacuate intra-regionally, this likely would indicate that one has decided (for whatever reason) to stay within the danger zone, whereas when one evacuated inter-regionally, this more likely would indicate that one had the intention to evacuate out of the danger zone (although at the end, this might not be the case). It is to be noted that prior evacuation studies do not make this distinction. Intuitively, evacuees that decide to stay within the risk area – the intra-regional evacuees – might decide fundamentally different about the evacuation decision than inter-regional evacuees that leave the major risk area behind. To facilitate direct comparison with some of the major prior studies, we applied correlation analysis to identify the variables that affect the intra- and inter-regional evacuation decisions. These insights will be of importance in understanding and influencing the evacuation decisions among these two distinct groups.

The remainder of this paper is organized as follows: In Section 2, we review existing literature and discuss variables that were found to be significant in the evacuation decision. Section 3 contains information about the collected data as well as discussion of the descriptive statistics of the variables of interest and the analysis results of intra-regional evacuation and inter-regional evacuation behavior. The differences between these two types of evacuation behavior are then discussed. Next, a comparison of the findings with the previous literature is presented. Finally, the last section contains concluding remarks, and a discussion of possible future research directions.

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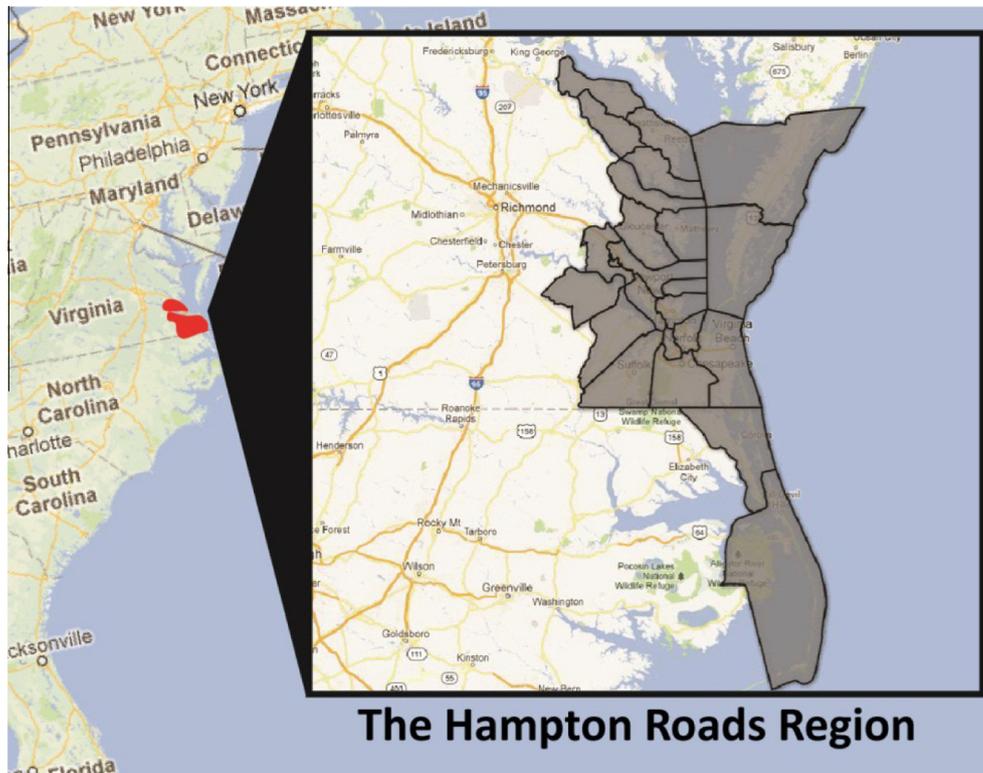


Fig. 1. Map of Hampton Roads. (Source: www.googlemaps.com)

2. Literature review

Various studies in the literature have shown how variables related to socio-economic characteristics, personal experience, expected risk perception and social networks effect the evacuation decision. In this section we briefly discuss these variables.

Socio-economic variables have been identified as one of the important indicators of evacuation decisions by previous literature. For example, income has been identified as one of the variables that significantly impact evacuation decisions by many researchers. Using logistic and ordinary least squares regression on the respondents of Hurricane Katrina, [Elliott and Pais \(2006\)](#) found that people with a high income are more likely to evacuate than those with a low income. A similar conclusion was obtained by [Huang et al. \(2012\)](#), who found a positive correlation between the evacuation decision and the income level using data from Hurricane Ivan and Hurricane Ike, respectively. However, [Whitehead \(2000\)](#) did not find any significant effect of income on the evacuation decision while assessing the data from Hurricane Bonny.

Race has also been identified as one of the significant variables. [Riad et al. \(1999\)](#) developed a logistic regression model based on the response acquired from residents that experienced Hurricane Hugo and Hurricane Andrew for predicting the evacuation decision. Their model showed that the white population is more likely to evacuate than any other racial group. A similar conclusion was obtained by [Whitehead \(2000\)](#) in his study on Hurricane Bonny. Similarly, [Elliott and Pais \(2006\)](#) concluded that the likelihood of whites/Caucasians evacuating is higher than African-Americans.

Female have been found to have a strong positive correlation with evacuation by both [Elliott and Pais \(2006\)](#) and [Huang et al. \(2012\)](#). Being a single adult household or a single parent household were also identified as encouraging evacuations by [Riad et al. \(1999\)](#). Although the presence of children was found to

significantly increase the likelihood of evacuation by [Lindell et al. \(2005\)](#), [Riad et al. \(1999\)](#) concluded that it was not a significant factor on the evacuation decision. On the other hand, home ownership was found to negatively impact the evacuation decision by the several studies ([Riad et al., 1999](#); [Huang et al., 2012](#)).

Personal experience, such as previous hurricane experience has been found to have a positive correlation with evacuation by, for example, [Huang et al. \(2012\)](#).

Risk perception in terms of the possibility of flooding in the household increases the likelihood of evacuation while the chance of burglary in case of evacuation decreases the likelihood of evacuation [Huang et al. \(2012\)](#). This risk perception was also examined in [Baker \(1991\)](#) who found that those that considered themselves more likely to experience damage due to the hurricane were more likely to evacuate.

Several studies have identified the importance of social networks in evacuation decision making process. [Schorr et al. \(2012\)](#) generated a numerical simulation using multinomial logit probability which investigated the influence of social networks in evacuation decision making. They observed that the decision making process of each individual was influenced by the decisions of the other members in their social network. For example, if some members of the same income group choose to evacuate, then the rest would also choose to evacuate. This finding has also been made by [Dow and Cutter \(1998\)](#), who found that residents use information sources such as family and friends to confirm their decision making process.

Based on the above overview, it is clear that no prior study exists that distinguishes between intra-regional and inter-regional evacuation. As stated above, evacuees that decide to stay within the risk area might make behave fundamentally differently than inter-regional evacuees that leave the major risk area behind. This study addresses this gap in our understanding of hurricane evacuation behavior.

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