DECISIONS UNDER DURESS:
INFLUENCES ON OFFICIAL DECISION MAKING DURING SUPERSTORM SANDY
by
Stephanie Hoekstra
November, 2015

Director of Dissertation: Dr. Burrell Montz

Major Department: Coastal Resources Management

During impending storms, emergency managers and politicians are tasked with the difficult decision of whether or not to issue evacuation orders for their area. This study uses Superstorm Sandy as a case study and investigates how emergency managers (EMs) and politicians made these critical evacuation decisions. Within this larger research question, this study aimed to accomplish five objectives: determining 1) the weather information sources used; 2) the chain of communication among emergency managers and politicians; 3) the situational and cognitive factors that influenced decisions made; 4) how the uncertainty and changing weather information influenced EM perceptions of risk and decision making; and 5) the relationship between and roles of EMs and politicians. Literature on decision making has focused almost exclusively on the publics, yet it is vital to understand how these officials make decisions in order to achieve a more cohesive and interconnected network of hazardous weather preparation and response among all involved parties.

A total of twenty five in-depth interviews, a focus group, and a newspaper analysis were conducted in New Jersey and New York to help answer the question of how emergency managers and politicians made decisions during Superstorm Sandy. Including different locations added a geographical and socio-economic context, which enhanced the overall understanding of the

decision making process both temporally and spatially. Grounded theory, a qualitative data analysis method, was used to determine the various factors influencing decisions.

A major contribution of this research to the hazards field is the creation of a decision making model fitted specifically to the role of emergency managers. This model highlights the complexity and individuality of decision making by illustrating the wide variety of factors, including those of the municipality itself, individual EM, and Sandy's uncertainty, that influenced evacuations decisions. How decisions were influenced by these factors was not uniform across geographic regions. Many factors, such as prior storm experience and knowledge of the town, proved to be more influential in the decision making process than was weather information, such as forecasts. This model further distinguished between making a decision and actually taking action, exploring the different triggers associated with turning a decision into action.

The decision to evacuate is far more complex than simply providing available weather information. In a similar vein to studies that examine public response to hazards, this study considers emergency managers as individuals who often rely on a variety of non-weather sources; this recognition is key to identifying opportunities for improved response. It is vital that forecasters and other tool developers understand that the weather information they provide plays only a small part in how EMs make critical evacuation decisions. Placing emergency managers within the context of the complex, geographically-based networks in which they reside and recognizing that one size does not fit all are significant contributions that this research brings to the hazards field and to future studies on this under researched group of officials.

DECISIONS UNDER DURESS:
INFLUENCES ON OFFICIAL DECISION MAKING DURING SUPERSTORM SANDY

A Dissertation

Presented To the Faculty of the Department of Coastal Resources Management

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Coastal Resources Management PhD

by

Stephanie Hoekstra

November, 2015

© Stephanie Hoekstra, 2015

DECISIONS UNDER DURESS: INFLUENCES ON OFFICIAL DECISION MAKING DURING SUPERSTORM SANDY

by

Stephanie Hoekstra

APPROVED BY:

DIRECTOR OF
DISSERTATION: _____
Dr. Burrell Montz, PhD

COMMITTEE MEMBER: _____
Dr. Scott Curtis, PhD

COMMITTEE MEMBER: _____
Dr. Jennifer Brewer, PhD

COMMITTEE MEMBER: _____
Dr. Christine Avenarius, PhD

COMMITTEE MEMBER: _____
Dr. Graham Tobin, PhD

CHAIR OF THE DEPARTMENT
OF COASTAL RESOURCES MANAGEMENT: _____
Dr. Sid Mitra, PhD

DEAN OF THE
GRADUATE SCHOOL: _____

To my Grosi, who has taught me that the little things in life are what matter most. You are always in my heart.

ACKNOWLEDGEMENTS

I would first and foremost like to express the deepest appreciation to my committee chair, Dr. Burrell Montz. Her dedication to and passion for the social sciences within the field of meteorology is awe-inspiring. This dissertation would not have been possible without her continual support, confidence in my abilities (even when I didn't see it), and witty sense of humor that kept me at the edge of my seat.

I would also like to thank my committee members, Dr. Scott Curtis, Dr. Christine Avenarius, Dr. Jennifer Brewer, and Dr. Graham Tobin for their words of encouragement, helpful resources, and enthusiasm for my work. They are stellar role models for successful integrated research. I am also grateful for the two Directors of the CRM program during my time as a student, Drs. Hans Vogelsong and Sid Mitra, for their support and commitment to student excellence.

I would like to give a huge thanks to my fellow graduate students and friends, notably Alyson Lewis and Mary Allen, who together with myself make up a pretty awesome trio. These girls kept me sane during this meticulous, and at times seemingly never ending, process.

I would like to also acknowledge my family, especially my mom for listening to me whine from 3,000 miles away and my dad who never doubted my capabilities. They have been and always will be my rock. I am perhaps the most grateful to my fiancé, soon-to-be Dr. Robbie Munroe. There are not enough words to express my gratitude to Robbie, who was always been there for me whether I needed someone to get me through writer's block or a shoulder to cry on. I owe my successes to him.

Lastly, I am very appreciative to the participants in my study. Without their trust in me as a researcher and willingness to openly share their experiences from this tragic event, this research would not have been possible. I aspire to one day be as successful in and dedicated to emergency management as they all are.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

EM	Emergency Manager
NWS	National Weather Service
NHC	National Hurricane Center
BEMA	[Name of Region] Emergency Management Alliance
EOC	Emergency Operations Center
ESF	Emergency Support Function

CHAPTER 1: INTRODUCTION

1.1 Problem Statement

Extreme weather events often result in loss of life and damage to property and infrastructure. Understanding how people make decisions during extreme weather events can lead to more effective weather products as well as the dissemination of those products, lessening the negative impacts from these events. However, the uncertainty inherent in weather information in addition to the wide range of factors that influence decision making renders it extremely difficult to fully understand why people make the decisions they do. Decision making during weather events is a prominent topic in social science literature, however, a comprehensive scientific model or theory of decision making under uncertainty has yet to be created, especially for officials such as emergency managers (EMs) responsible for making critical decisions. In-depth research on the influences on decision making during extreme weather events is needed in order to create a scientific model of decision making under uncertainty. Using a known theory of public response to hazards and a model of situational awareness as foundations, this project creates a holistic scientific model of emergency management decision making under uncertainty.

With respect to hurricanes, politicians and EMs are tasked with the challenging decision of whether or not to order an evacuation. The process by which they make this decision is relatively unknown. Superstorm Sandy is an interesting case in that it transitioned from a tropical hurricane to a post-tropical storm, which led to the issuance of impact-based warnings (i.e. high winds warning) instead of phenomenon-based warnings (i.e. hurricane warning). This may have influenced how officials made evacuation decisions. In order to measure how the evolution of Superstorm Sandy affected the decisions made by officials, an integrated study involving both a meteorological

analysis and a behavioral analysis of EM decision making during Sandy is necessary. The physical characteristics of the storm set the context in which EMs made decisions. EMs are responsible for a unique area, and thus must make different decisions regarding their specific locations based on their experience and knowledge and the information received about the storm. The overall goal of understanding the influences on EM and politician decision making regarding evacuations can only be accomplished through an initial understanding of how the storm evolved from a physical perspective. This research thus involves both a physical analysis of Superstorm Sandy's evolution and a behavioral analysis of decisions made, as a way to understand how the impacts of the storm's physical characteristics influenced emergency management behavior.

1.2 Research Objectives and Questions

The overall goal is to assess the influences on decisions made by EMs under extreme conditions, using Superstorm Sandy as a case study. The specific objectives and subsequent research questions are:

1. to determine the weather information sources EMs used, as well as why they used those sources.
   - Q1 What sources did EMs use to gather weather information?
   - Q2 What factors were most important to EMs regarding weather information sources?
2. to determine the chain of communication among EMs, politicians, and the National Weather Service (NWS).
   - Q3 With whom did EMs communicate prior to and during the event, and why?
3. to determine the situational and cognitive factors that influenced decisions made.

Q4 To what extent did factors specific to each municipality, such as location and size, influence EM decision making?

Q5 To what extent did factors relating to the individual EM, such as previous experiences and knowledge, influence EM decision making?

Q6 Who/what was most influential in EM decision making?

4. to determine how the uncertainty and changing weather information influenced EM perceptions of risk and decision making.

Q7 To what extent did the changes in Sandy's physical characteristics over time influence EM decision making?

5. to determine the relationship between and roles of EMs and politicians.

Q8 To what extent did politicians rely on their local EMs?

Q9 To what extent did EMs trust their politicians and vice versa?

Q10 Did EMs or politicians issue evacuation orders?

Q11 Are there "breaks" in the response model hypothesized below (Figure 1.1)?

1.3 Research Hypotheses

The relationships among the variables in the research objectives above, including changing weather information, communication, experiences, and influencing factors to decision making are illustrated in a theoretical model (Figure 1.1) by Tobin and Montz (1997) that has been adapted to incorporate several of the researcher's hypotheses. Tobin and Montz (1997) discovered that there are different levels of connections between various factors and response: dashed lines represent direct connections between the factors and response, dotted lines suggest that the various factors in each set interact to affect response, and the solid arrows illustrate a continual exchange between

the two sets of variables, with each set affecting the other. The situational and cognitive sets include external factors, such as weather information, as well as various psychological and attitudinal factors.

Several modifications were made to the Tobin and Montz model (1997) in order to incorporate the various hypotheses of this research. As seen in Figure 1.1, perception is added as a precursor to response since it is hypothesized that an individual's perceptions may not automatically lead to a direct response. For example, an EM may not be able to respond or make a decision based on how he/she perceives the risk due to political and economic constraints (Figure 1.1). A "break" was thus inserted between perceptions and response to symbolize this hypothesized discontinuity. Similarly, a politician's perceptions may be influenced by his/her reliance on information from EMs and the NWS. However, despite their general lack of weather knowledge and subsequent reliance on EMs and NWS employees, politicians still respond (make a decision about evacuation) based on their designated responsibilities and roles within society (Figure 1.1). The "break" between situational factors and perception is therefore added. These hypothesized "breaks" within the response model are included in Q11.

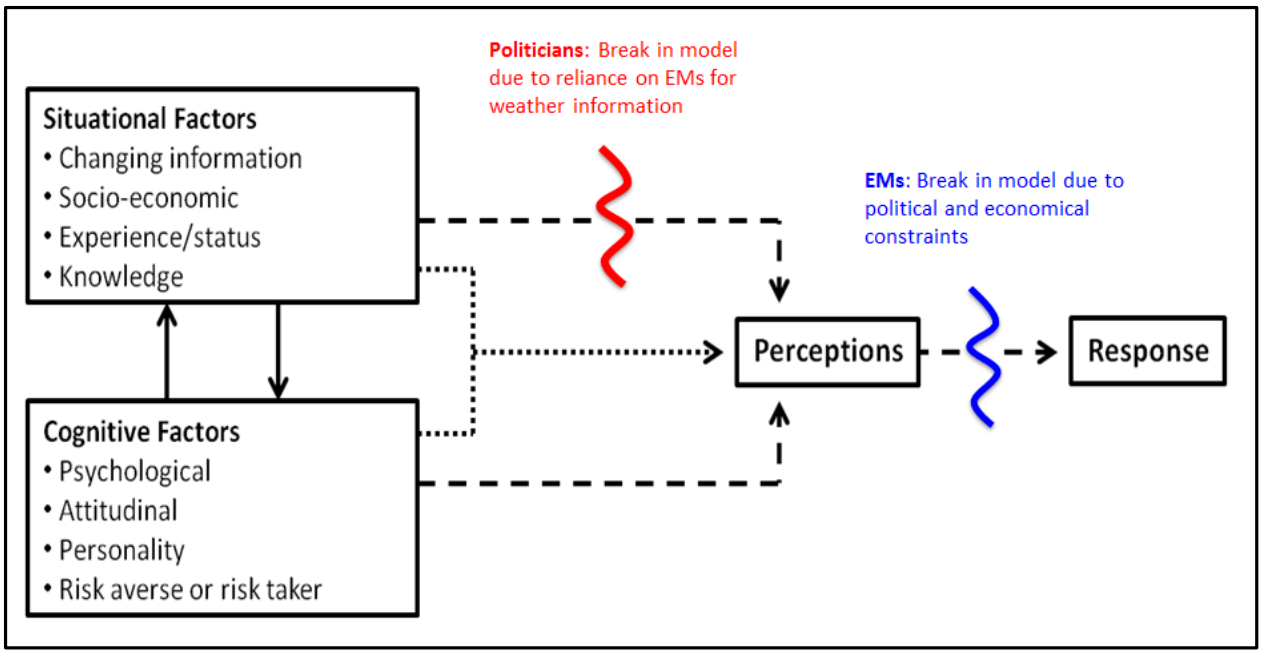

Figure 1.1. Theoretical response model illustrating the relationship among the hypotheses (adapted from Tobin and Montz 1997).

1.4 Overview

This dissertation consists of seven chapters following this introduction. Chapter 2 provides a background and literature review. Chapter 3 discusses the research design and methodology of this study. Chapter 4 explores the findings relating to research objectives 1 and 2, providing the context for EM decision making. Chapter 5 focuses on objectives 3 and 4, describing the model addressing the factors influencing EM decision making and the impacts of uncertainty on decision making. Chapter 6 helps to fulfill the 5th research objective on the role of politicians in evacuations. Lastly, Chapter 7 briefly summarizes the study, discusses its application to real-world practices, and makes suggestions for future research.

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

2.1 Superstorm Sandy Background

2.1.1 Sandy as a Historic Event

Superstorm Sandy was a particularly unprecedented event in a number of ways, not the least of which are the magnitude and spatial extent of damage it caused along the eastern seaboard. The storm transitioned from a tropical to a non-tropical event prior to landfall on October 29, 2012. This storm kept its hurricane inner core while taking on extratropical characteristics, which led to further strengthening at abnormally high latitudes. Sandy combined the strength and unfavorable trajectory of a land falling hurricane with the long duration, vast size, and slow motion of an extratropical storm. Strong winds, flooding, and surge were the major impacts felt along the coast. Superstorm Sandy's pressure bottomed out at 945 mb, comparable to a category 1 or 2 hurricane. Maximum sustained winds were clocked at 80 mph with an 820 mile diameter of tropical force winds (Stewart 2013). To put this in perspective, Hurricane Katrina, a large hurricane and storm in its own right, had tropical force winds of 460 miles in diameter (Fritz et al. 2007). Superstorm Sandy's extremely large, strong, and slow moving characteristics over open water provided the perfect recipe for a storm surge disaster.

To further add to the severity of the surge, the storm made landfall perpendicular to the coast, which enhances surge as a result of the funnel shaped coastal geomorphology where New Jersey and New York merge (Colle et al. 2008). The result was record storm surge values of 10 to nearly 15 feet in New York and New Jersey (Robertson et al. 2013). It is important to realize that this also happens to be the most densely populated area in the United States, with large cities located along the coast. Thus, all-encompassing damage estimates exceed $50 billion and continue to

grow, placing it as the second most costly storm to hit the U.S. after Hurricane Katrina (Robertson et al. 2013). In addition, Sandy resulted in 97 direct deaths (Abramson and Redlener 2013) and 147 indirect deaths (Robertson et al. 2013).

The hybrid nature of the storm and potential severity due to its location created difficulties for weather forecasters, EMs, and public officials as they worked to characterize the risk to spur appropriate public response. Specifically, a major communication challenge erupted when the National Weather Service (NWS) decided to use the National Hurricane Center (NHC) forecast of post-tropical instead of tropical as the hurricane merged with a frontal system. This transition led to the issuance of high wind and flood warnings (impact based warnings) rather than hurricane watches and warnings (phenomena based warnings). Although there was consistency with the warnings that were issued, it is unknown as to how a lack of phenomenon-based warnings may have influenced the decisions made by EMs in the affected areas and in turn decisions made regarding issuing evacuation orders (NHC 2013b).

2.1.2 Storm Dynamics and Characteristics: Tropical vs. Extratropical Storms

Since Sandy began as a tropical storm and later transitioned into an extratropical storm, it is important to explain the two types of storms because their characteristics differ substantially (Jones et al. 2003). Tropical cyclones are smaller with strong pressure gradients and strong winds, while extratropical cyclones cover much larger areas and tend to have relatively higher pressures and weaker winds, though with larger wind fetches (Dolan and Davis 1994). These differences can be seen in Figure 2.1, which shows Sandy as a post-tropical storm (left) and as a tropical storm (right). Although tropical storms can induce larger magnitude storm surge in localized areas, storm surge

during extratropical storms can cover a much wider area. Thus, despite their weaker pressure gradients and winds compared to tropical storms, the large areal extent of extratropical storms can make them extremely damaging to the coastline, affecting people in areas that are not used to these storms, which could lead to increased risks of losses (Jones et al 2003).

Figure 2.1. Left: Post Tropical Sandy, 2012. Right: Hurricane Sandy, 2012 (Tutino 2012; McNoldy 2012).

Much of the damage caused by coastal storms is related to coastal flooding and increased storm surge during the months that nor'easters are most active, which is another reason why extratropical storms can be more damaging than tropical storms (Dolan and Davis 1993). As seen in the set of graphs on the right in Figure 2.2, the average daily residual, or sea level height above or below the predicted tide, for the four locations along the East Coast exceeds 0.05 m during the months when nor'easters are active. This storm surge is defined as a sea level anomaly (Sweet and Zervas 2011) and can result in substantial flooding along the coastline (Jones et al. 2003). Other studies have shown that nor'easters result in more annual damage to infrastructure and housing than both tornadoes and hurricanes combined (Zielinski 2002; Sweet and Zervas 2011).

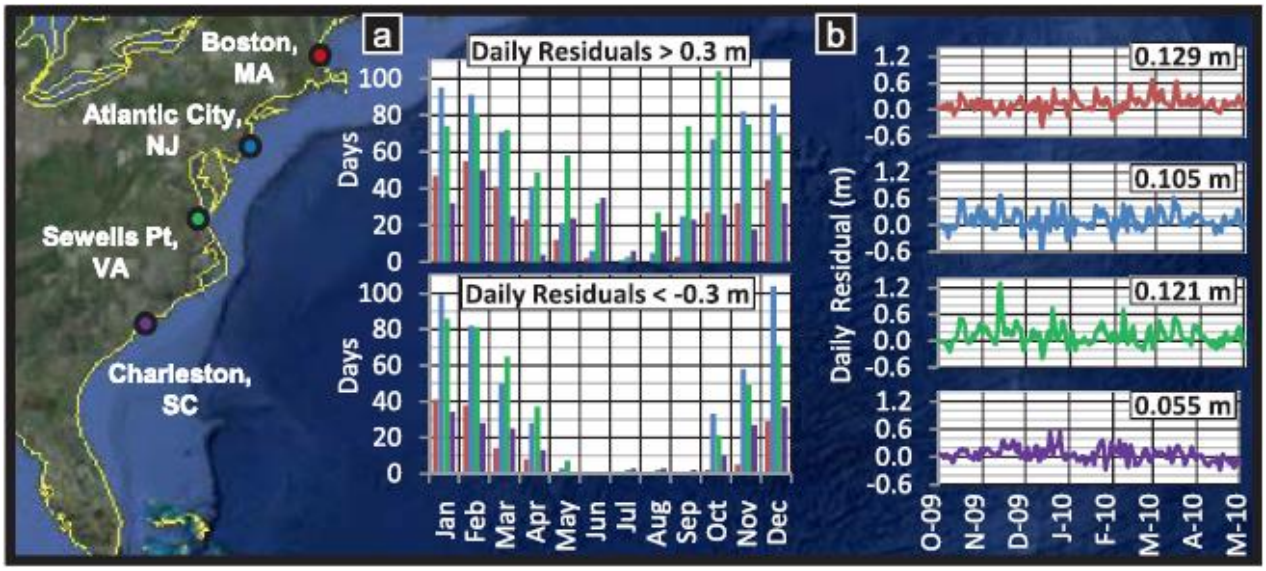

Figure 2.2. (a) The monthly distribution of daily storm surges and setdowns between 1960 and 2010, and (b) Mean of storm surge for a time series from 2009 to 2010 (Sweet and Zervas 2011).

Due to being more spatially expansive, slow moving, and able to strengthen at landfall, extratropical cyclones can have a longer duration than their counterparts, affecting larger populations on the coastline as well as inland (Jones et al. 2003). Additionally, nor'easters can occur in succession, which also lengthens their duration and leaves less time for beach recovery. In terms of formation, the fact that extratropical cyclones do not require warm water for energy means that they strengthen as they move up the coast to cooler waters as opposed to tropical cyclones, which tend to weaken with increasing latitude. For this reason, along with the fact that nor'easters extend much farther north than tropical storms, people living in the northern coastal states experience nor'easters far more frequently than tropical storms (Jones et al. 2003). As mentioned earlier, nor'easters can strengthen at landfall, compared to tropical cyclones that weaken at landfall since they rely on warm water as their main driving force (Dolan and Davis 1994). Thus, people inland who do not experience tropical storms may experience extratropical storms.

In extremely rare cases, a storm can transition from one type of storm to another. These storms, known as hybrid storms, take on characteristics of both types of storms. For example, the Perfect Storm of 1991, also known as the Halloween Nor'easter of 1991, is a famous example of a hybrid storm that transitioned from a nor'easter to a tropical storm after absorbing Hurricane Grace (NOAA 2008). Conversely, a storm can also transition from a tropical storm to a nor'easter, as in the case of Superstorm Sandy (Robertson et al. 2013). As mentioned earlier, Sandy indeed took on characteristics of both types of storms.

2.1.3 Temporal Characteristics of Sandy

A comprehensive understanding of Sandy's evolution can be gained from the data illustrated in Figures 2.3-2.8. This information is critical in order to fully understand how Sandy's evolution impacted decisions made and actions taken. Sandy formed as an easterly wave off the African coast. By the 18th of October, Sandy began moving toward the Caribbean Sea. As seen in Figure 2.3, Sandy became a category 1 hurricane south of Jamaica late on the 21st of October with peak sustained winds of 85 mph. Sandy then continued moving north, making landfall on Cuba at 0525 UTC on October 25 as a category 3 hurricane with the second lowest central pressure of Sandy's duration, at 954 mb (Blake et al. 2013) (Figures 2.3 and 2.4). Peak sustained winds reached 115 mph near Santiago de Cuba, Cuba (Robertson et al. 2013).

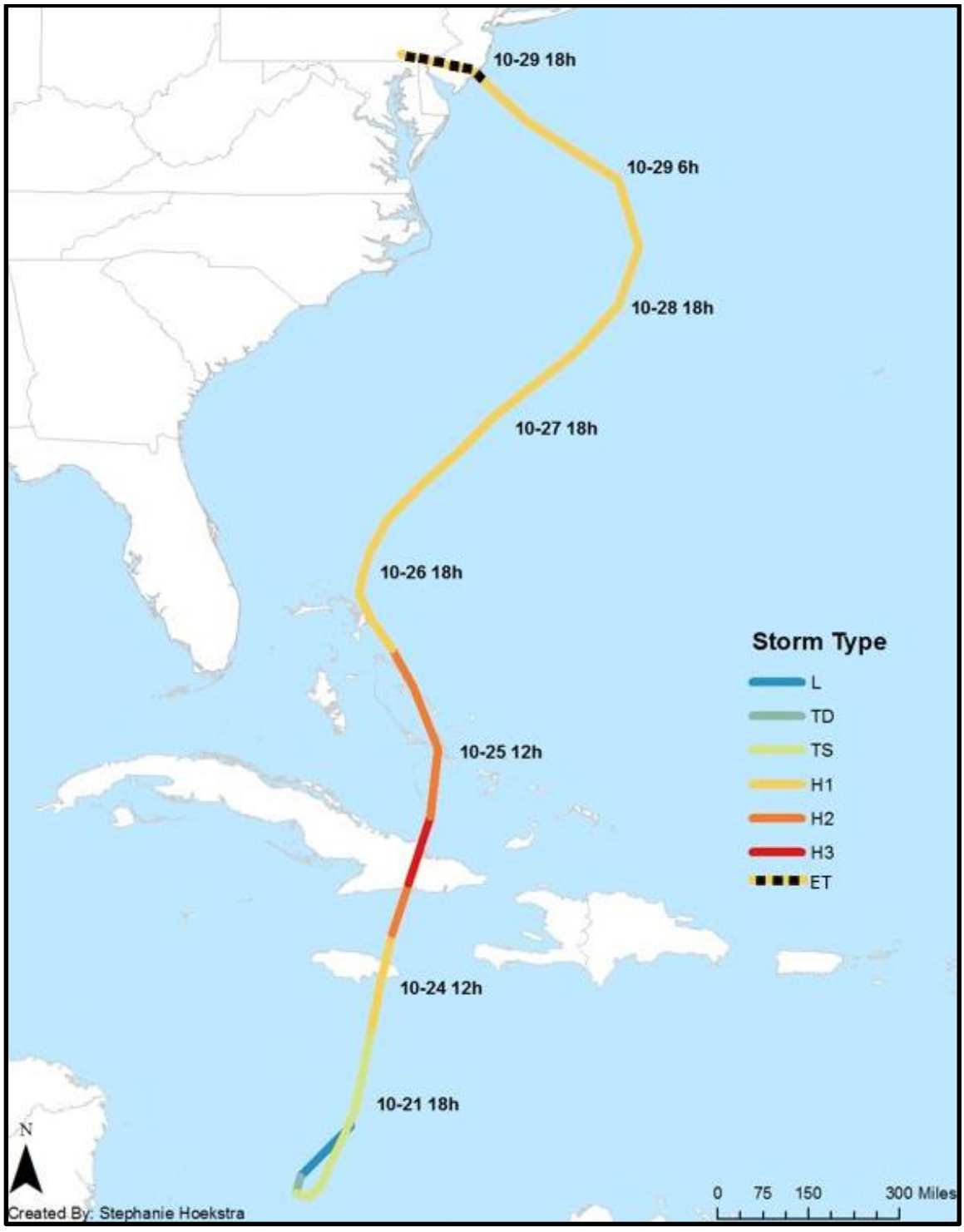

Figure 2.3. Superstorm Sandy's storm type from October 21 at 6pm until after landfall. Storm type was determined using wind speed (mph). The storm became classified as post-tropical right before landfall, even though it had hurricane-force winds.

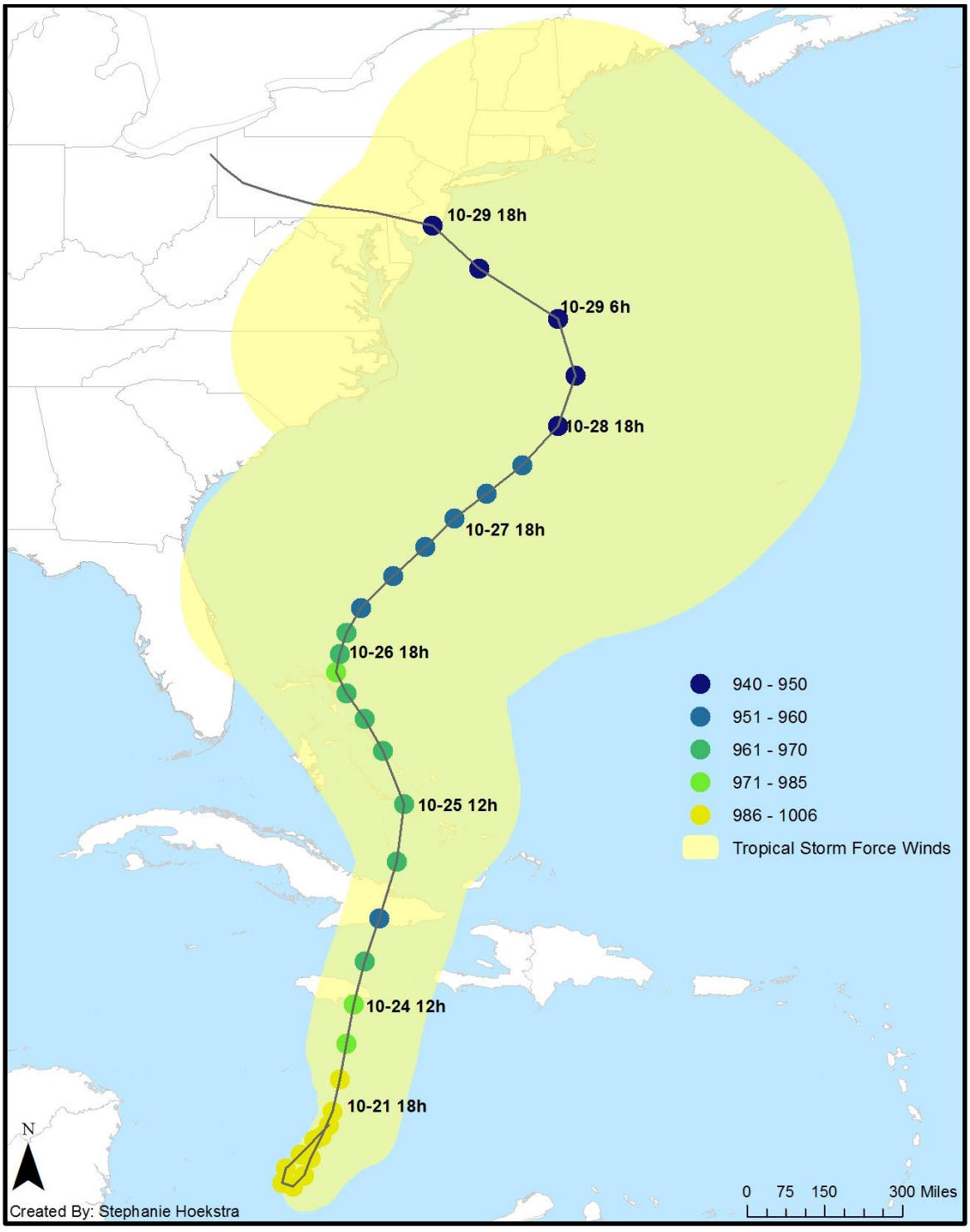

Figure 2.4. Central pressures (mb) and tropical storm-force winds of Superstorm Sandy from October 21 at 6pm until after landfall.

After it passed over Cuba, the storm interacted with the first of two frontal systems. Around 0000 UTC on October 27, Sandy's structure significantly changed as it met an upper-level tough. This decreased its intensity, increased its central pressure, and substantially increased its wind field (Figures 2.3, 2.4, and 2.5). Additionally, Sandy began moving northwest due to this upper level trough and a western Atlantic ridge. It was in this area that Sandy confronted continental air, helping to strip it of its tropical characteristics. While it transitioned into its hybrid and post-tropical states, the size of tropical storm force winds approximately doubled since landfall in Cuba (Blake et al. 2013; Robertson et al. 2013) (Figures 2.5 and 2.6).

Sandy interacted with the second of two troughs that moved into the southeastern US early on October 29, which enhanced both the non-tropical and tropical aspects of Sandy by creating the opportunity for temperature gradients and a decrease in vertical wind shear. The interaction with this trough re-intensified Sandy early on October 29, reaching 85 knots at about 1200 UTC. The decrease in central pressure and increase in size around this time is shown in Figures 2.3, 2.5, 2.7, and 2.8. The lowest central pressure of 940 mb occurred just off the coast of New Jersey (Figure 2.4). From the interaction with the first trough onwards, Sandy could be considered a hybrid storm with characteristics of both types of storms; this is illustrated by its strong inner core and large size (Figures 2.5 and 2.8). Following its interaction with the second trough, it can be argued that Sandy lost all of its tropical characteristics (Figures 2.6 and 2.7).

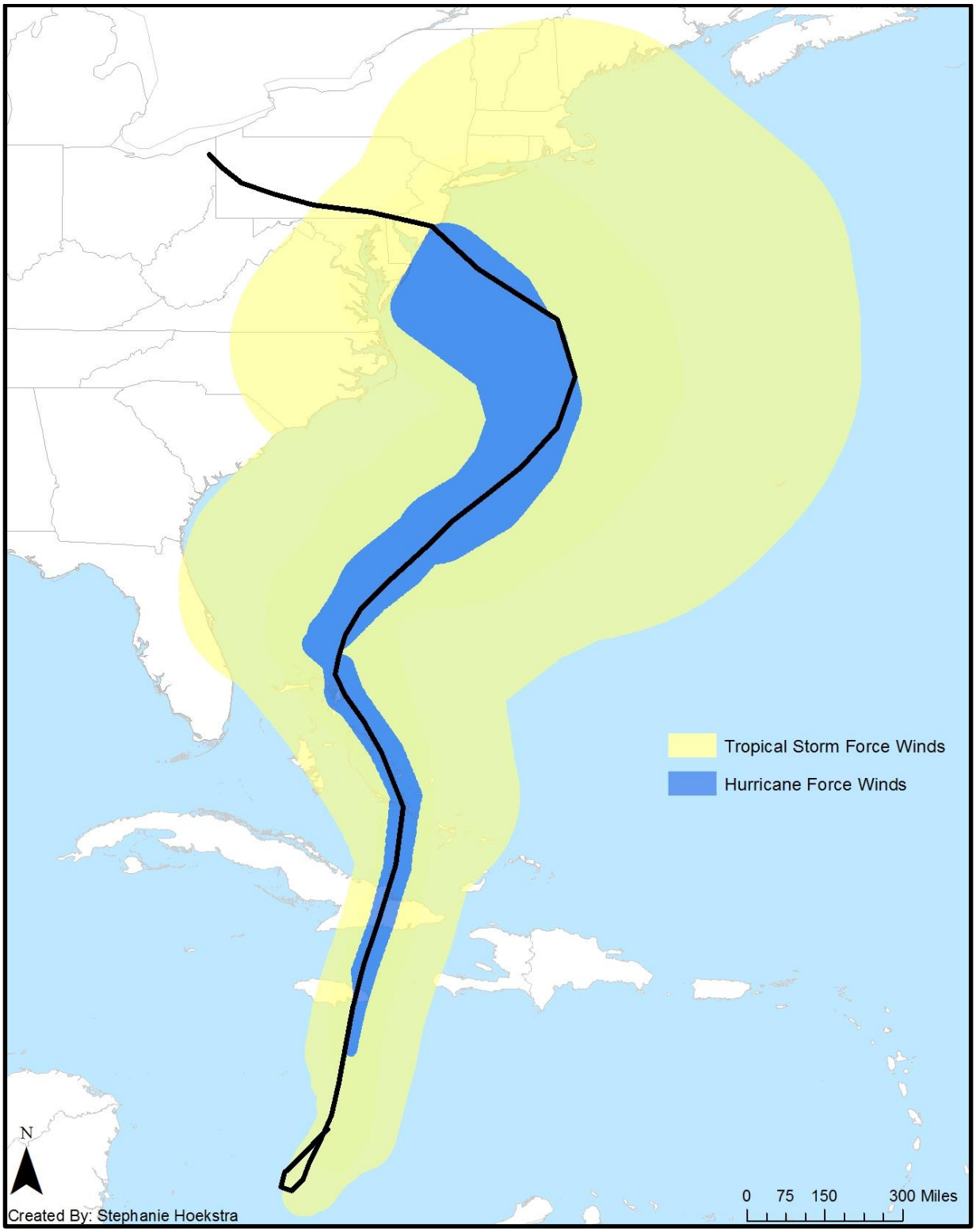

Figure 2.5. Extent of tropical storm force and hurricane force winds of Superstorm Sandy from October 21 at 6pm until after landfall.

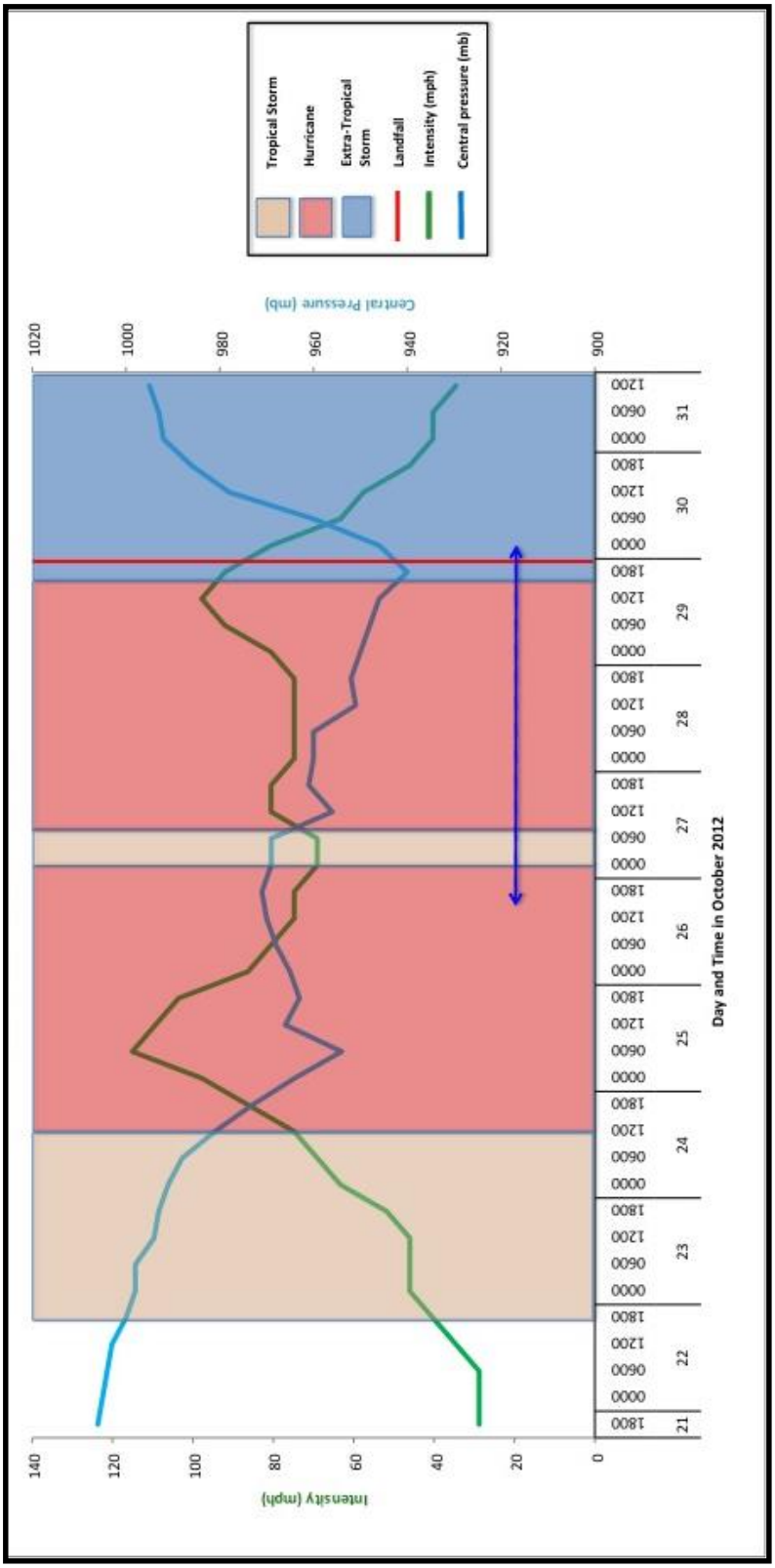

Figure 2.6. Storm classification through its evolution. Blue arrow represents the period of time that impact-based warnings were being issued. Created by Stephanie Hoekstra.

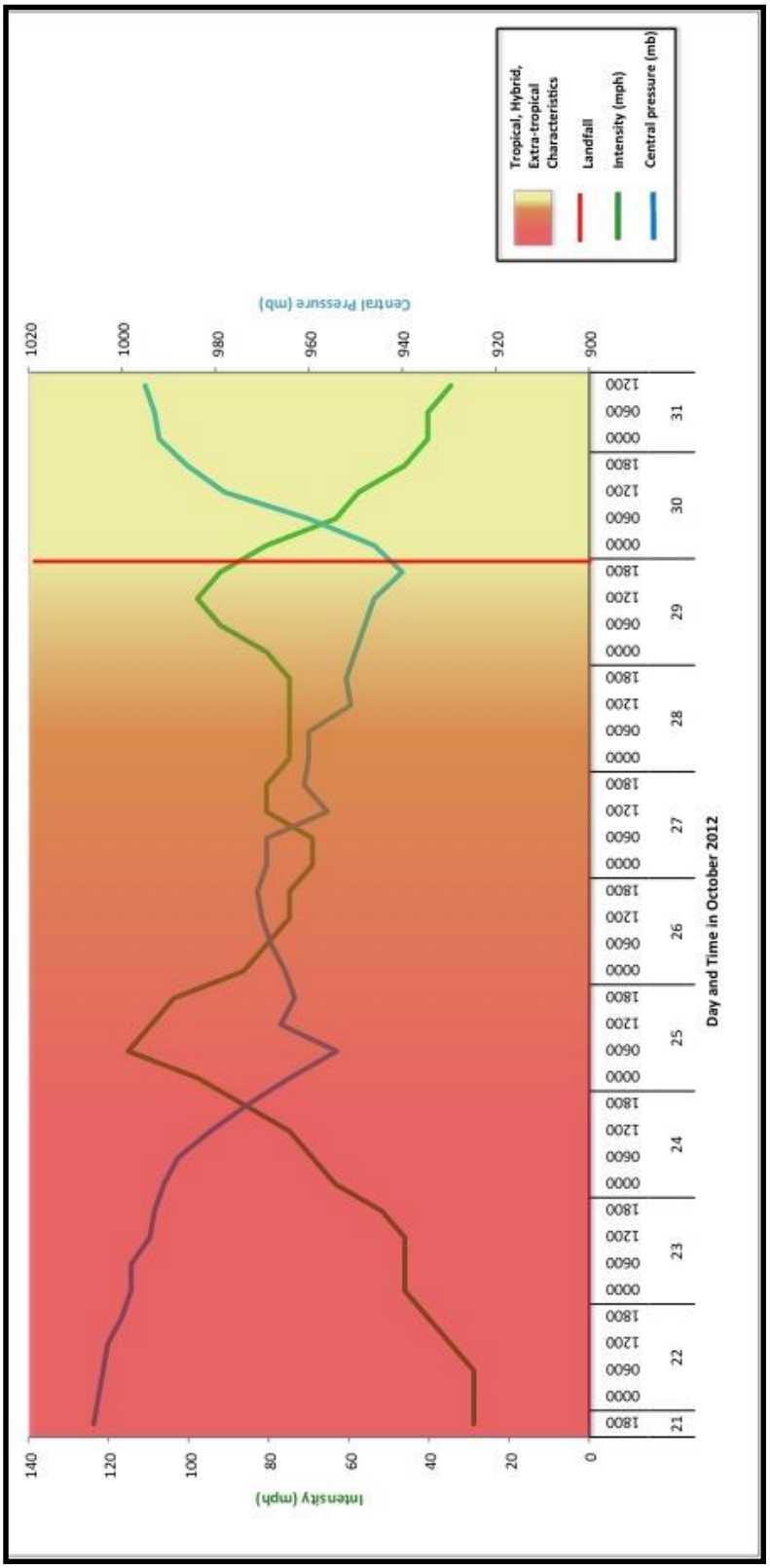

Figure 2.7. Wind speeds (mph), central pressure (mb), and transition characteristics through Superstorm Sandy's evolution. Created by Stephanie Hoekstra.

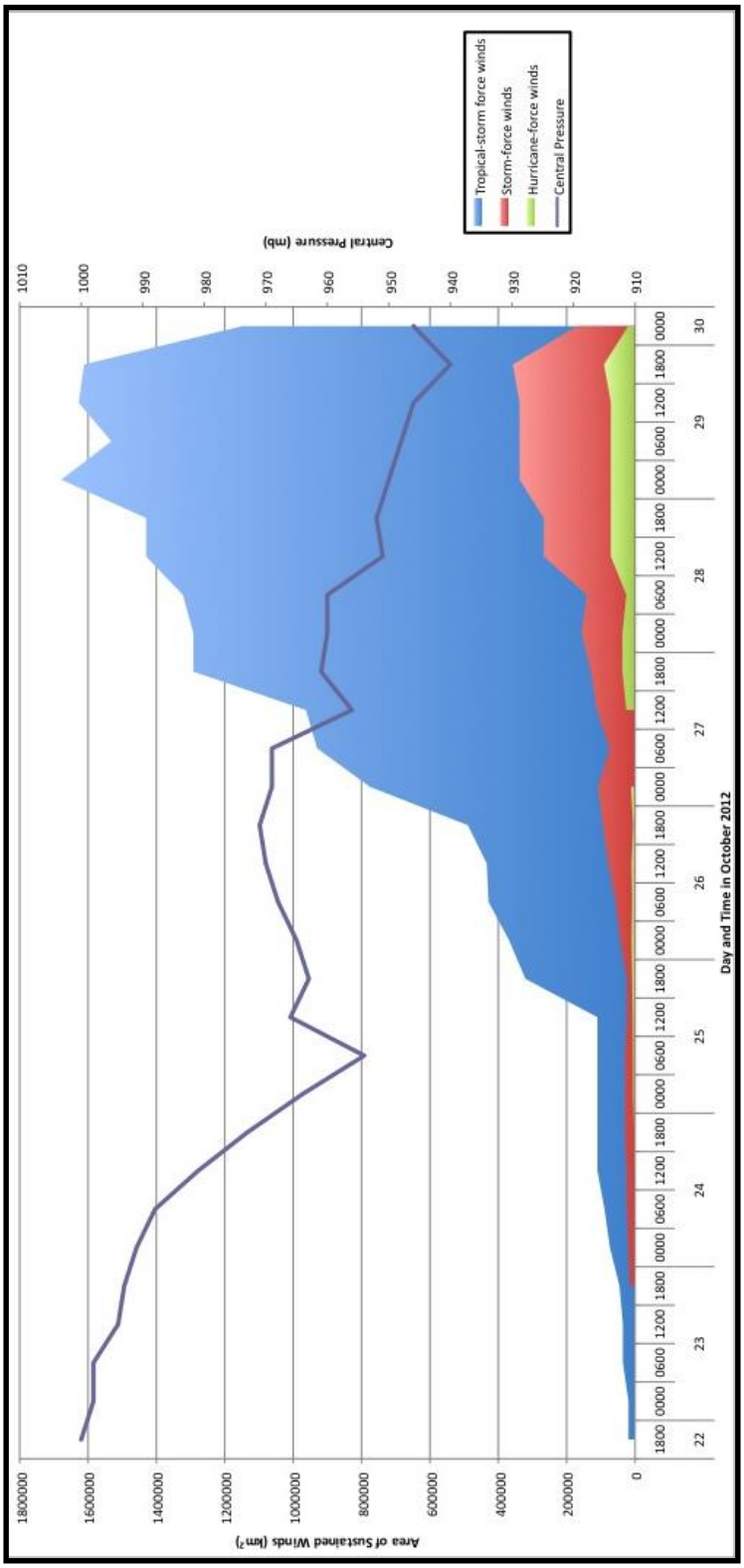

Figure 2.8. Superstorm Sandy's central pressure (mb) and total area of sustained winds (km2), including total area of tropical-storm force winds (34 knots), storm-force winds (50 knots), and hurricane-force winds (64 knots) from October 22-October 30. Created by Stephanie Hoekstra.

2.2 Emergency Management Hazard Response and Behavior

The physical component of hurricanes (i.e. numerical weather prediction and weather forecasting) has been studied extensively by a variety of researchers and agencies (Sorenson 2000). However, over the course of the last several decades considerable attention has been directed to social behavior and decision making regarding weather events. Some of the earliest evacuation behavior research was conducted in the 1950s and focused primarily on behavior theory (Pike 1954). A complication exists because studying human behavior is difficult in that people act and interpret information differently depending on hazard type and external factors (Mileti and Sorenson 1990; Sorenson 1991). Thus, despite improvements in warning systems (Sorenson 2000), mitigating against future disasters remains a difficult task given the lack of applied research on a population whose behavior is difficult to measure (Perry 1979; Gladwin et al. 2009).

Since the 1950s, behavior theory research on hazard response and evacuation has expanded, the majority of which focuses on the general publics and on severe weather events (i.e. tornadoes; Pike 1954; Perry 1979; Mileti and Sorenson 1988; Sorenson 1991). Empirical studies on the behavior of EMs and others in leadership roles during tropical weather events (i.e. hurricanes) are less common.

Within the few studies conducted on EM and official decision making (League et al. 2012; Losego et al. 2012a; Losego et al. 2012b; Riley 2012; Call and Coleman 2014; Hoekstra et al. 2014; Montz et al. 2014), one in particular has significantly added to the literature on EM decision making during tropical weather events. Weather for Emergency Management Decision Support (WxEm) was a collaboration between the NWS and the University of North Carolina that aimed to better

understand how EMs used current NWS products and how those products played a role in official decision making processes (Losego et al. 2012b). Using a combination of semi-structured interviews and focus group interviews with fifteen Emergency Support Functions (ESFs) established by the Federal Emergency Management Agency's (FEMA) National Response Framework (2008; Table 2.1), researchers found a variety of significant results. EMs are most interested in knowing the onset time of tropical storm force winds in their particular location. They also want "point of reference forecast" information in order to "have a benchmark to work from," (Losego et al. 2012a, p.4) and uncertainty information on the storm. Additionally, they found that storm surge information tends to not be used in operational decisions due to it being forecasted too late; EMs voiced an interest in surge information prior to 72 hours before landfall, which is when critical evacuation decisions are made. Perhaps the most significant conclusion was that it is important for forecasters to understand that EMs manage risks, not hazards. EMs have found it difficult to find and interpret weather information that provides risk information, since current NWS products emphasize hazard and impact information.

Table 2.1. Emergency Support Functions (FEMA 2008).

#1: Transportation	#9: Search and Rescue
#2: Communication	#10: Oil and HazMat Response
#3: Public Works and Engineering	#11: Agriculture and Natural Resources
#4: Firefighting	#12: Energy
#5: Emergency Management	#13: Public Safety and Security
#6: Mass Care, Emergency Assistance, Housing and Human Services	#14: Long-term Community Recovery
#7: Logistics Management and Resource Support	#15: External Affairs
#8: Public Health and Medical Services	

2.3 General Public Hazard Response and Behavior

Although the few studies conducted on EM decision making are of high quality, they are significantly limited in quantity. Due to this limitation, decision making by other stakeholders can provide additional insights into EM decision making. Understanding how the general public behaves during coastal storms and the factors that influence how they make decisions could be useful when assessing how EMs and politicians behave, since EMs must understand how their residents perceive storm events and respond in order to make critical decisions and disseminate information. Additionally, public decision making literature serves as the most ideal proxy for EM decision making given the abundance of literature on the general publics and the lack of literature on EMs. Prominent research conducted on evacuations has aided in more fully understanding the host of factors on which humans base their decisions regarding natural hazard evacuation (Dash and Gladwin 2007).

Largely before the 1990s, attempts to understand evacuation were primarily descriptive in nature, in that they focused on how warning characteristics (i.e. hurricane warning content, hurricane warning source, etc.) influenced behavior (as referenced in Dash and Gladwin 2007). Slowly, the focus shifted to include more sociological factors in determining decision making behavior (Mileti and Sorenson 1990). Mileti and Sorenson (1990) provided a list of several characteristics of the hazard warnings *and* of individuals that influence behavior. Examples of factors involving the warning include the credibility of the source of the warning, the consistency of the message, how an individual personalizes the warning to one's situation, the clarity of instructions on how to best act, and the frequency of warning dissemination. Examples of individual characteristics include personality, social settings, family size, demographics, psychological attributes (i.e. level of risk

aversion), and prior experience and memories of previous hazards and evacuations (Mileti and Sorenson 1990). These factors are highly interrelated and dependent upon one another, depending on the situation (Nigg 1993; Dash and Gladwin 2007).

Information about both the warning itself and individual characteristics of the recipient is found to greatly influence the process by which an individual makes decisions and takes actions. Mileti and Sorenson (1990) developed a model of public response to warnings that consists of several phases. The first stage is "hearing the warning" (Mileti and Sorenson 1990). There are a growing number of social science research studies that consider *daily* weather information use by the publics. However the samples in these studies are small and therefore not necessarily generalizable (Sink 1995; Legates and Biddle 1999; Lazo et al. 2009). These studies may be considered to set the baseline for more comprehensive research efforts about how people gather information and "hear a warning." The remaining phases of public response are understanding, believing, personalizing, deciding and responding, and confirming the hazard (Mileti and Sorenson 1990). The warning and individual factors previously discussed play an integral role in each of these phases, ultimately guiding the final decision made and actions taken (Mileti and Sorenson 1990).

It is a common mistake among those who create warning systems to assume the publics are simply waiting for instructions and then immediately respond as an official warning is issued from a government agency such as the NWS (Parker and Handmer 1998). This is not the case. Instead, they interact with and respond to the information sent out from the NWS and/or EMs (Parker and Handmer 1998). Additionally, public evacuation behavior is found to be greatly influenced by the media, neighbors, experience and knowledge, and location (Stein et al. 2010). The publics

determine their own vulnerability to hazards based on each citizen's individual situation. The publics' risk, "perceived or real, remains one if not the dominant determinant of evacuation behavior" (Stein et al. 2011, pg. 3) and their perceived risk is highly influenced by their local knowledge, communication, and environmental cues instead of "blanket statements" (Stein et al. 2010 p. 816) from officials (Dash 2002). Because of the inherent need for localized information, the publics often use personal networks and local knowledge to assist in interpreting official messages (Parker and Handmer 1998) from non-weather sources such as family and friends; they may not always rely on the NWS to obtain weather information since official warnings may not include localized information (Tunstall 1990).

Research has shown that people's personal warning system is often greatly influenced by their own understanding of local needs. Meteorologists must understand that the general publics do not only use the information they send out; the publics use unofficial warning systems to interpret the information they hear and make appropriate decisions. This needs to be understood in order for the NWS to provide the types of weather information and products that fit what people need. Unfortunately, the individual is often blamed for not being sufficiently informed about the hazard if his/her risk assessment and that of the NWS' differ, when in actuality, it can be considered the fault of those who create the official messages for not fully understanding the publics' processes of understanding their risk. Mileti and Sorenson's (1990) model portrays public decision making to hazards as uni-directional, not entirely taking into consideration the phase during which unofficial warnings influence their decisions. The impacts of these unofficial warnings on decision making are substantial, making the process of warning communication even more complicated.

Additional theories and models are needed in order to more thoroughly account for public behavior during hazardous weather events when official warnings are not all that is considered.

It is often thought that people make what seem like irrational decisions when it comes to the actions they take when an event is impending. Why would anyone willingly drive through a flooded road, or film a tornado occurring just several hundred feet away? People have always behaved in ways that seem irrational to the onlooker. However, the idea of rationality is complex and requires clarification before claims such as this one are made. Simon (1957) discusses three types of rationality exhibited by decision makers in managerial roles: rational, nonrational, and irrational, and embeds these types of rationality into his definition of the two types of decision making processes that he considers underresearched: analytic and intuitive. A decision maker makes an analytic response when he/she responds systematically to a warning, carefully considering the consequences and gains from each alternative response. Analytic decision making processes are rational responses. On the other hand, a decision maker makes an intuitive response when he/she responds rapidly based on experience and knowledge or, more emotionally, based on stress and the situation. A rapid response based solely on experience is considered nonrational behavior, while an emotional response is considered an irrational behavior. An important distinction that Simon (1957) points out is that, while decision makers use both intuitive and analytic decision making processes, they tend to make rapid and/or emotional decisions first based on their experience and then after the decision is made, they take on the analytic decision making process. Thus, decision makers can make what seem like irrational *and* nonrational decisions simultaneously based on their unique situations and experience levels.

Understanding why people make nonrational or irrational choices in hazardous situations is best captured by several theories and models stemming from a variety of disciplines. These theories highlight the need to include both the information from the hazard itself as well as the characteristics of the individual who receives the hazard information. These theories recognize that behavior is shaped by both sets of factors, ultimately leading to behavior that is rational to the individual, but may not be rational to others looking on. A theory developed by Simon (1987) recognized that "the degree to which decision making is rational seems to be bounded by cognitive limitations" (Lindell and Perry 2004, p. 33). This Bounded Rationality Theory explains how people make decisions when bounded by the law, societal norms, and cultural circumstances. People bounded by factors such as these might act nonrationally from an economic perspective, but feel as though their actions are most appropriate according to their personal boundaries and limitations.

A number of additional models that range from Reasonable Person Theory (Kaplan and Kaplan 2003), linking the environment with behavior, to the Process and Content Model (Kahneman 2003), considering both intuition and reasoning systems, have addressed the processes of decision making and have proposed the various conditions that impact those processes. A particular theory that is relevant to the research undertaken here was put forth by Endsley in 1995 and is known as situation awareness, which can be defined as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley 1995, p. 36). This concept, coming from human factors research, became a focus of study beginning in the 1980's when Endsley (1995) noticed that decisions were becoming more multifaceted. He constructed a model that situates the three levels of situation

awareness, which include perception of the current situation, comprehension of the current situation, and projection of future status, within the larger context of decision-making. Situation awareness, along with other factors including the goals and expectations of the decision maker, experience, memory, and system design and capabilities, influence what decisions are made and actions implemented (Figure 2.9) (Endsley 1995). Individuals have varying levels of awareness of the situation in which they are placed. These different perceptions of the space around them influence how they respond to a situation. This "situational perception of risk" (Mileti and Sorenson 1988, p. 322) is what occurs between receiving the warning and responding to the warning in the Mileti and Sorenson model.

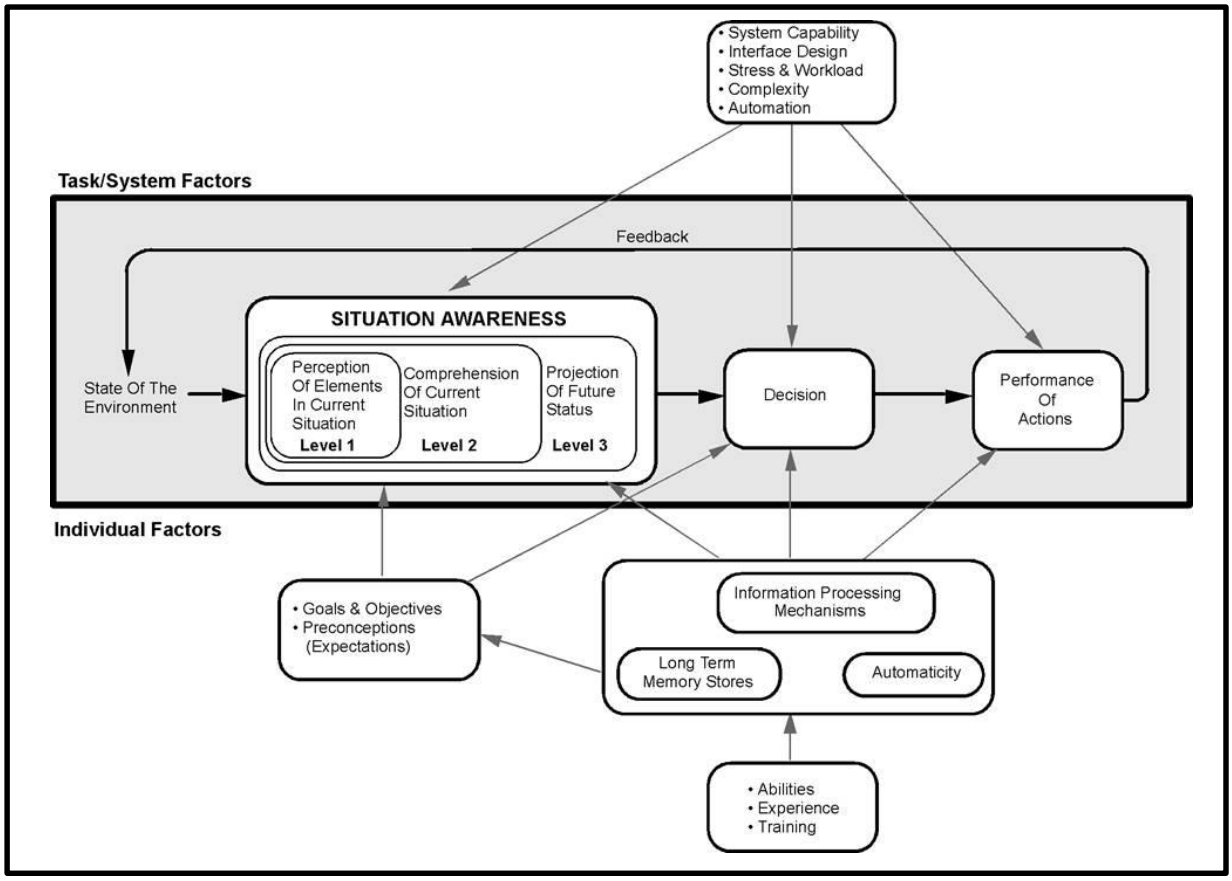

Figure 2.9. Model of situation awareness in decision making (Endsley 1995).

Bounded rationality and situation awareness are inherently incorporated into a hazards response model put forth by geographers Tobin and Montz (1997), which is an effective model for understanding behavior and the framework used for this study (alongside Endsley's situation awareness model). Tobin and Montz (1997) categorize an individual's response to hazards as being influenced by both cognitive and situational factors (Figure 2.10), similar to the process described by Mileti and Sorenson (1990) and Dash and Gladwin (2007). Figure 1.1 is a modified version of Figure 2.10, after having incorporated two of the research hypotheses into the figure for clarification. Cognitive factors include personality characteristics and personal experience that alter an individual's perspective of nature and risk. Situational factors are more externally driven, such as location, income, and weather information, which "complicate an individual's range of choices" (Tobin and Montz 1997, p. 135). An example is someone who owns beachfront property even though he/she is aware of the risk of hurricanes and coastal flooding. To them, the benefits of the location outweigh the risk of the hazard, and the investments in their property and housing are so substantial that leaving seems impractical.

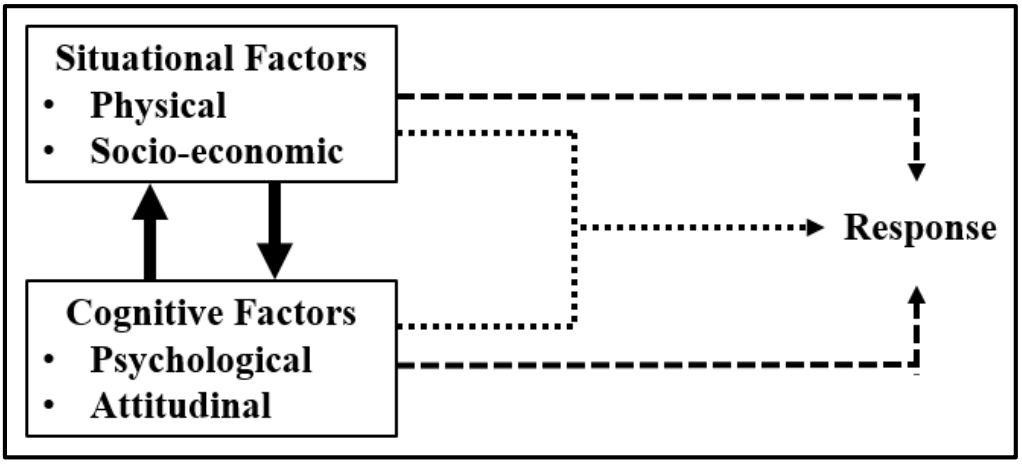

Figure 2.10. Representation of the interplay between various factors and response (from Tobin and Montz 1997). The bullets represent categories of cognitive and situational factors that affect response.

Behavior and response are strongly influenced by the perception of the environment, or cognitive factors, as well as controlled by situational factors. Yet, this "interplay of environment and perception is constantly changing as more information is received and processed, further complicating… attempts to uncover decision-making processes." (Tobin and Montz 1997, p. 141). Over the duration of weather watches and warnings, decision-makers continuously change how they perceive an event as more information is received and processed. This process may even begin long before a watch is issued. Time is a determining factor in how the interplay of the environment and an individual's perception influences his/her decisions. This is a valuable framework to understand what influences behavior since it highlights the importance of the interplay among factors that affect response, indicated by the solid black and dotted arrows (Figure 2.10).

As discussed in the objectives section, this model is useful in that it portrays the possibility of "breaks" in the model as hypothesized in this proposed study (Figure 1.1); certain groups may be constrained by various external (i.e. weather information) or internal (i.e. personality attributes) factors that influence their responses. The responses of EMs and politicians, for example, are hypothesized to differ according to each group's unique and "bounded" role in society (Q7-Q11). This hypothesis has not been tested before, and relatively little research has been conducted on behavior response of the EM and politician communities. The need for a more thorough understanding of decision making by these leaders however is crucial in order to identify gaps in the "end-to-end-to-end" process described by Morss et al. (2005). In this process, the "ends," including tool developers, the publics, and decision makers, all hold influential roles in weather research. Decision-makers need to be incorporated into the application of research and collaborate

with the other two "ends" in the Morss et al. (2005) process, in order to successfully enhance protective decision making during future weather events (Demuth et al. 2012).

2.4 The Politics of Storm Evacuations

The process of evacuating people for a large storm is complex (Urbina and Wolshon 2003). Previously, EMs and law enforcement agencies were responsible for evacuation planning. Currently, hurricane evacuation planning varies largely by state and has become much more political (Urbina and Wolshon 2003). Typically, the majority of states go through a two-tiered process for evacuations. The local level is responsible for planning, response, and recovery, while the state's EMs organize and direct the local EMs, transportation agencies, and law enforcement. Instructions are given by the state EMs while local EMs focus primarily on detailed planning and immediate response (Urbina and Wolshon 2003). Generally, there are three types of evacuation: voluntary, recommended, and mandatory. A previous study has found that people are more likely to evacuate when under a mandatory evacuation order than a recommended evacuation order because they feel a greater sense of urgency with the former (PBS&J, 2000). The majority of officials responsible to make decisions about evacuation use the storm forecasts issued by the NHC, where updated weather information is provided every six hours. However, many decision makers believe that NHC forecasts are not issued frequently enough and/or are not accurate enough several days before landfall (as opposed to one or two days before landfall, when forecasts are more accurate). They have been found to need at least 12 hours of notice in order to successfully evacuate their areas (Urbina and Wolshon 2003).

Generally, governors have the responsibility to authorize evacuation orders. However, in some states, the governor gives this responsibility to local officials, including the mayor, county judge, or sheriff (Urbina and Wolshon 2003). There are two main reasons for this: 1) local officials are much more familiar with the conditions and characteristics of their communities, and 2) state and federal governments try to limit their involvement in evacuations since they are "politically sensitive issues" (Urbina and Wolshon 2003, p. 260). In the case of New York City (NYC), the Mayor is responsible for declaring local states of emergency and issuing evacuation orders. These orders, by New York law, come in the form of "recommendation" or "order," similar to a mandatory evacuation (NYC Office of Emergency Management 2015). Additionally, the Mayor of NYC can issue criminal sanctions for anyone who does not evacuate during an order, or mandatory evacuation (N.Y. Exec. Law § 24(1)(b)). Similarly, the statute also states that "any person who knowingly violates any local emergency order of a chief executive...is guilty of a class B misdemeanor" (Id. § 24(5)), meaning that that person can be sent to jail for a maximum of three months (N.Y. Penal Law § 70.15(2)). With that said, it is rare that the state or local officials enforce these laws. In history, no one has been sent to jail for disobeying this statute. During Superstorm Sandy, Mayor Bloomberg of NYC "assured those refusing to evacuate that they would not face arrest" (Hunt and Varner 2012, p. 1).

In New Jersey (NJ), there are no statutes on not evacuating during a mandatory evacuation order. NJ EMs will not physically remove a person unless they can guarantee harm will come to them if they stay (Urbina and Wolshon 2003). Regarding authority, the Governor of NJ delegates the responsibility to the state EM office or to several local officials, such as the mayor, municipal EMs, or law enforcement personnel.

2.5 Summary

To date, Superstorm Sandy is one of the most destructive storms of all time to hit the U.S. Its unique combination of extratropical and tropical characteristics resulted in its large size, slow movement, and ability to retain strength over land and at higher latitudes. Due to its northward location, Sandy wreaked havoc on areas that have little experience with coastal storms, resulting in hundreds of lives lost and billions of dollars in damage. Superstorm Sandy serves as the case study for this research to better understand the influences on official decision making with regard to evacuations.

Research on decision making and response to hazards has been conducted for several decades. A subfield significantly less researched is that of EM decision making. Only recently have significant strides been made in furthering the understanding of what influences the EM decision making process (Losego et al. 2012a, Losego et al. 2012b). However, the focus of that research is mostly on EMs' use of NWS products in their decision making process and less so on the additional factors that influence how they make decisions, particularly when it comes to issuing evacuation orders. Because of this limitation, it was necessary to consider the theories of general public response and behavior during coastal storms as a proxy for EM behavior and decision making and as a means of understanding the issues EMs face. While a variety of models were considered, the response model put forth by Tobin and Montz (1997) was ultimately selected as the framework for this study due to its consideration of the situational and cognitive factors influencing response.

CHAPTER 3: METHODOLOGY

3.1 Research Design

3.1.1 Overview

To fulfill the overall objective of understanding the influences on EM and politician decision making, an exploratory study was conducted using semi-structured interviews with EMs and to a lesser extent, with politicians. The exploratory interview was both cross-sectional and retrospective in that the participants provided a narrative of what occurred during a single hurricane that took place in the past (Spradley 1979).

The research spanned from January 2014 through August 2015 and consisted of two parts. The first is the physical analysis of the storm included in the background and literature review section above. This physical analysis of the storm provided the context needed when evaluating EM decision making. The second part consisted of designing and implementing the semi-structured interview questions incorporating the research objectives and the model of situation awareness in decision-making by Endlsey (1995) and response model by Tobin and Montz (1997) as a guiding foundation for the interview questions. Factors, such as experience/training, expectations, and perception were used as elements of the interviews (Figures 2.9 and 2.10).

3.1.2 Emic and Etic Approaches

This study takes both the emic and etic approach to research (Morris et al. 1999). Both of these approaches are housed in the field of anthropology and represent approaches to understanding culture. An emic approach takes the “inside” perspective, learning about the culture directly from the native. On the other hand, the etic approach is the “outside” perspective, comparing cultures

with each other based on an external norm. Incorporating both approaches is suggested for gaining a full understanding of a culture or group, in this case EMs. Since the interviews conducted were semi-structured, the participant was free to go off on tangents and discuss what came to mind in relation to Sandy. That allowed for gleaning the perspective of the participant as a component of his/her own culture. However it was also important to employ the etic approach in order to avoid being limited to what they decided to discuss. Guiding questions often reveal the researcher's biases, in this case with specific aspects of the decision making process, thus using the etic approach avoids the trap of applying what was learned about the EM culture to other cultures within the weather enterprise; the EM decision making process is vastly different from other subgroups, and it is vital not to assume their behavior is uniform across the board. Combining the emic and etic approaches when collecting and analyzing the data kept that from happening. Additionally, because a goal of the research is to understand more than just the perspective of EMs, this combination allows for evaluating how EMs fit within the larger weather enterprise and how they compare to external cultures, such as politicians. (Morris et al. 1999).

3.1.3 Integration of Sandy's Evolution

Completing objective 4 is essentially where the physical and behavior analyses of this research intersect; this integration serves as the crux of this research, as it is the true measure of how decisions made by EMs, and to a lesser extent politicians, regarding evacuation were affected by the physical changes of the storm. EM observations and decisions, when evacuation orders were issued, and when meteorological models noted the change in storm track, among other components, were combined on the same graphic to see if there are any correlations. This analytical technique is similar to that used to create Figure 3.1, which is a plot of Facebook likes,

comments, shares, and posts during Sandy on the New Jersey EM Agency Facebook page along with times of track changes (Lussenden et al. *forthcoming*). This integration of the physical components of the storm along with EM decisions and actions taken allows for a comprehensive understanding of several aspects of the storm, in particular how certain decisions coincided with the storm's physical attributes (if at all).

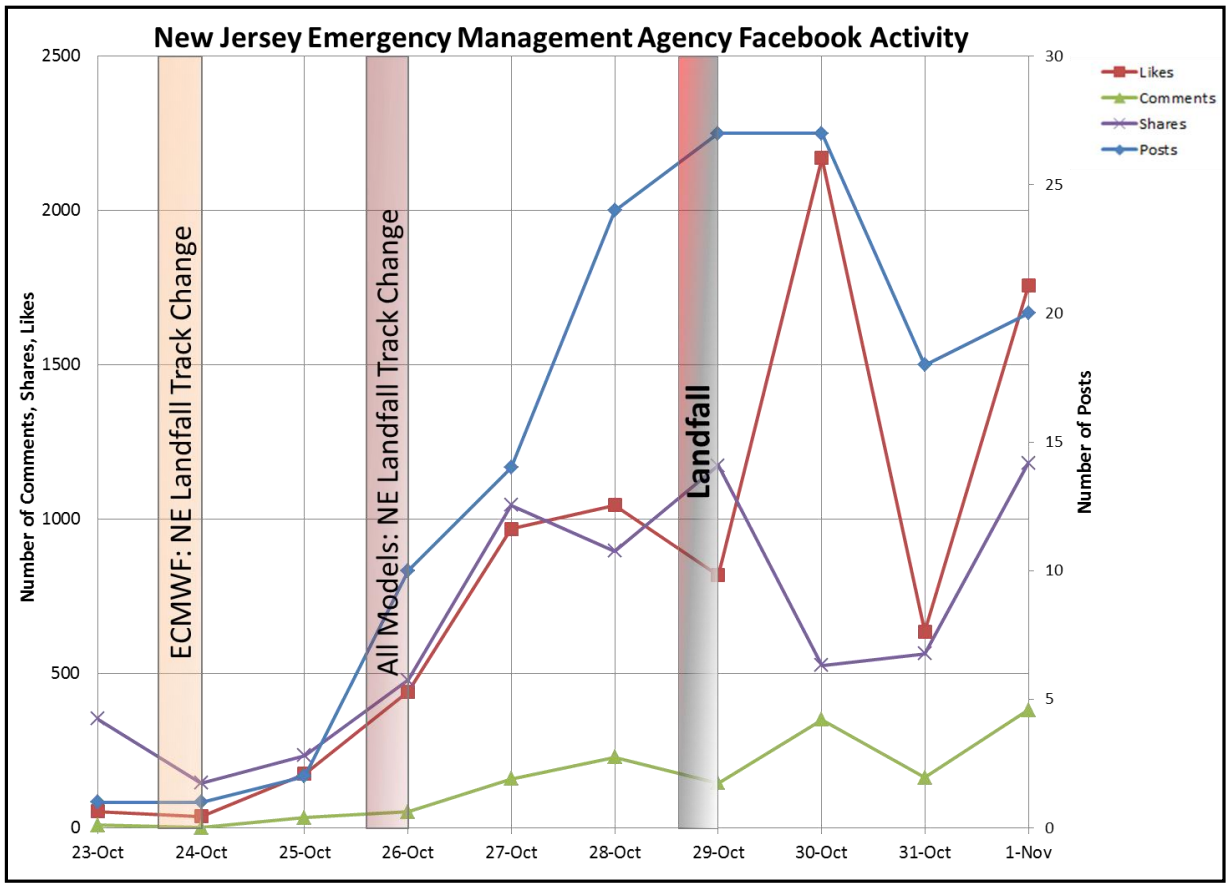

Figure 3.1. Total likes, comments, shares, and posts on the New Jersey EM Agency Facebook page during Superstorm Sandy along with the times of storm track changes (Lussenden et al. forthcoming).

3.1.4 Strengths

This research design has several strengths. First, the exploratory interviews that were conducted in NC ensured successful and valuable interviews during the later interviews (Yin 2003). Second, semi-structured interviews are a useful social science data collection method that allows

participants to guide the interviews and freely express their own views and perspectives; the participant is essentially the teacher (Leech 2002). These ethnographic interviews provided in-depth and detailed stories and descriptions that cannot be obtained from surveys or structured interviews alone. Information gathered from these narratives contributed to the understanding of the decision making process inherent in issuing evacuations, information that is inadequately represented in evacuation literature. Third, this work represents successful integration of social and physical aspects of a hazard in order to better understand decision making behavior.

3.2 Sampling Strategy

A purposive sample of twenty-five EMs and politicians was selected for interviews. The majority of interviews were with one person, however there were a few with more than one person. In total, eighteen in-depth interviews were conducted. The interviews were conducted over a two-week period in June and July of 2014 along the east coast. The locations of the participants are confidential to respect the privacy of the participants and abide by IRB regulations. The majority of participants were EMs in smaller NJ towns. Only five participants were from NYC. All participants were impacted by Superstorm Sandy, though the impacts varied.

Although a purposive sample limits generalization, it is required given the small number of key informants during the hurricane (Bernard 2002). Initially, the researcher contacted the EM in the majority of coastal counties from Delaware to New York via email or phone if his/her contact information was readily available. Some were unreachable, while others were not available or unwilling to participate, for a variety of reasons. A list of all attempts and contacts was not developed, thus it is impossible to calculate a response rate.

It is important to note that under ideal conditions, a roughly equal number of EMs and politicians would have been interviewed. However, it was possible to interview only two politicians (one Mayor and one Deputy Mayor) because many were no longer in office and others were unwilling to participate. Thus there is limited information from politicians. Fortunately, interviewing primarily EMs sufficed given that they communicate with a wide range of decision makers and publics and have varying experiences. They contributed to developing an understanding of the role of politicians in the decision making process, albeit from their point of view.

Snowball sampling was used to gather additional key informants. Snowball sampling allows for the collection of a wider spectrum of participants involved in the decision-making process (Biernacki and Waldorf 1981). This was performed by asking the initial group of participants to identify anyone they consider to be a vital decision-maker or an influence on decision making during the event. Snowball sampling is a preferred method for exploratory and qualitative studies aimed at obtaining information on sensitive topics from difficult to reach participants (Biernacki and Waldorf 1981).

3.3 Data Collection

3.3.1 Interviews

EMs in eastern North Carolina (NC) were interviewed initially to better understand the language used by these decision-makers and the concerns that should be addressed in future interviews. These exploratory interviews substantially enhanced the effectiveness of the interviews with participants in the study sites by providing a more thorough understanding of how to phrase interview questions and converse with EMs and politicians (Yin 2003).

Once the interview questions and protocol were revised based on the results of the NC work, interviews with EMs along the east coast were conducted. The interviews allowed the participants to retell their stories, or narratives, of the event, while ensuring that certain questions were asked and topics addressed (Leech 2002). The interviews elicited information regarding the process and complexity of decision making, gathering both explicit and tacit (inherent to the participant) information that contributes to the understanding of what influences decision making (Spradley 1979). The severity of the events included in this study allows for sufficient information to be retained by the interviewees over a long time period (Cappelletto 2003).

3.3.2 EM Focus Group

Parallel to this research was a project entitled, *"They Had the Facts, Why Didn't They Act?: Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts"* (Carr and Montz 2015), funded by the National Sea Grant College Program as part of NOAA. The main objective of this project was to assess how residents and EMs along the New Jersey coast understood and valued coastal flood forecasts and warning products issued by the NWS during Hurricane Sandy. In focus groups, residents and EMs were led through a storm scenario based on Sandy's actual path. Participants were presented with a variety of NWS products, including briefing packages, and were asked to comment on how they interpret and value each product. Surveys were also given to the participants before and after focus group discussions to obtain additional comments and statistical comparisons. Findings from the focus group conducted with EMs are compared to the findings from the semi-structured interviews with EMs to provide additional context, confirmation, and statistical information on EM decision making.

3.3.3 Newspaper Statement Analysis

Given the small number of politicians interviewed, articles in newspapers were also analyzed in order to better understand the perceptions and statements of politicians. News articles were collected from two newspapers in north and south NJ, *The Star-Ledger* (located in Newark, NJ) and *The Press of Atlantic City*, respectively. Both newspapers were recommended by a lead forecaster in NJ. All articles were obtained using the ECU Joyner Library newspaper database. For each newspaper, articles that included the search term, "Sandy," were compiled for the critical evacuation period for EMs of October 27 to October 29, 2012. A total of seventy-four articles (thirty-nine in *The Press of Atlantic City* and thirty-five in *The Star-Ledger*) were analyzed.

3.4 Data Analysis

3.4.1 Data Entry

Interviews were transcribed using Dragon Dictate for Mac 3. This speech recognition software uses either voice or audio files from digital voice recorders to create and edit text. The interviews were dictated into a head-microphone that Dragon Dictate then converted to text. This software quickened the transcription process, however, much editing needed to be done during the voice-to-text conversion.

3.4.2 Grounded Theory

The qualitative approach used in this research is embedded in Grounded Theory that starts with the collection of data and results in the construction of a theory. An advantage to using Grounded Theory as an analysis method for behavior research is that "it can be used to uncover the beliefs and meanings that underlie action, to examine rational as well as nonrational aspects of behavior,

and to demonstrate how logic and emotion combine to influence how persons respond to events or handle problems through action and integration" (Corbin and Strauss 2015, p. 11). Thus, it provides explanation and rationale for behavior without the researcher biasing or limiting the data with preconceived ideas.

When using Grounded Theory, it is important to distinguish between description and theory. Where "description tells about an event or happening," a theory "offers explanations for why events or happenings occur" (Corbin and Strauss 2015, p. 12). This research not only aimed to find out *what* decisions were made regarding evacuations, but more importantly, it strived to discover *why* and *how* those decisions were reached. Thus, this research contributes to behavior theory, not description. With that said, description is necessary to fill in the details of the theory (i.e. sources used, timing of decisions).

3.4.3 NVivo

After transcribing the interviews, the texts were uploaded into NVivo, a workspace for qualitative analysis of raw data. The data was then "grounded" by being separated into various categories and sub-categories, or codes and subcodes, that later simplified the analysis. NVivo facilitates this coding process by allowing users to sort information as well as examine relationships between various data sets. During the transcription process, categories that were repeated became evident and were used as the initial codes. Initially, twelve main categories or codes were created. For example, the researcher noted that many communication statements were made and thus made "communication" one of the initial 12 codes. See Appendix D for the remaining codes. Using NVivo, sections of the interview files were distributed into each of these primary codes. Once all

interviews were examined, subcodes were created to further break down each code. For example, within the communication code, several subcodes were created, including conference calls, EOC, and avenues for communication. This coding protocol of beginning with the main categories and subcategorizing from there keeps the researcher from having to go through all finished interviews when additional subcategories are created. For example, anything that dealt with communication was coded as communication. After all interviews were coded in this manner, the data in the communication code was further separated into additional codes that the researcher considered appropriate after having gone through all of the interviews. The researcher was then able to identify trends and provide the necessary evidence to support those trends. Additionally, the construction of theories, which is a large component of Grounded Theory, was made possible through coding the data. The data was also coded according to the position type of the participant (i.e. municipal EM, politician, etc.) and location of each participant (North Jersey, South Jersey, NYC). The newspaper article analysis was similar to the interview analysis. Codes were created and data from the articles was categorized into these different codes. See Appendix E for list of codes used.

3.4.4 Participant Narratives: A Timeline of Events

To gain a better understanding of how the physical characteristics of the storm coincided with decisions made and actions taken, a model of EM narratives that visually displays the entire event as experienced by each participant was built (Daiute and Lightfoot 2003). After all narrative models were created, a general model for EMs was created by merging all the models together using common themes and behaviors noted in the majority of the narratives. When integrated with the physical characteristics of the storms (i.e. storm forecast information), the timeline of actions aided in understanding why, when, and how certain decisions were made, taking into account the

uncertainty or inherent potential error in weather information. These generalized models of EM narratives also illustrate the differences between local EMs and politicians (Q8-Q11).

CHAPTER 4: CONTEXT OF DECISION MAKING

Following a description of the roles of the participants, this chapter addresses the context in which decisions are made including a temporal description of decisions made and actions taken, the information sources used, the chain of communication, and the politics of evacuation orders. It is vital to understand that this research is entirely qualitative. Discussion focuses on individual perspectives and experiences that the participants shared during in-depth and lengthy interviews. The crux of this research is to understand the *why* and *how* of decision making.

4.1 Description of Participants

A total of 25 officials was interviewed over a two-week period. All but three participants were EMs, with the remaining three being a forecaster, a Mayor, and a Deputy Mayor. Not all of the participants' job titles were "Emergency Manager," however their job description was that of an EM. The majority of participants were middle-aged to older European American males who have worked in some aspect of the emergency services field for numerous years, many for more than ten years. The majority of participants, 20 of the 25, were EMs in smaller towns in New Jersey. These EMs tended to be volunteer and held other jobs. The five participants from New York were paid full-time employees.

Because the majority of participants were municipal EMs, the models and diagrams included in this chapter are based on the EM perspective. How the forecaster and politicians differed from municipal EMs is discussed only through text. There was not enough data to confidently generalize politician and forecaster decision making.

4.2 EM Role

EMs plan, prepare, and respond to natural and man-made disasters. There are various levels of EMs, ranging from the municipal level to the federal level. Depending on the town/city, the EM may be a part-time volunteer fire chief or a full-time paid EM in a large organization, such as FEMA. EMs tend to be able to adapt to new environments and perform well under pressure. One county EM in NJ said,

> "because everything… is thrown at you you have to be able to counter measure… you always have a contingency, that's the world that we live in, contingency plans, plans, being able to multi-task, you have to adjust. You're going to get something thrown at you and you got to be able to duck or swerve. You can't just sit back and throw your arms in and say 'oh you know what? I don't know what else to do'."

EMs work throughout the year to prepare for natural and man-made disasters, even volunteer EMs. It seems to be a common misconception that EMs only work when there is an impending disaster; this could not be farther from the truth. As one county EM from NJ states,

> "it [the role of an EM] is 365 days a year. Before Superstorm Sandy hit, after Superstorm [Sandy] hit, even this morning, we had a meeting… It's a constant, we are always doing planning and looking at lessons learned from incidents… to make sure that we are ready."

Throughout the year, EMs conduct drills, prepare educational pieces, provide information on their websites, write and re-write plans, and undertake a host of other preparations. EMs, along with the other ESFs, make preparations throughout the year and respond during impending hazards. Typically drills are for car accidents, HPV1 outbreaks, and other events, not usually for hurricanes given the rarity of this event in this study area. The schedule of an EM is not constant; it is not a typical full-time job, especially since most EMs have unrelated day jobs and attend to EM duties in the evenings or weekends. For example, one county EM in NJ "may go for a month and not do

anything, and then… may go for like 3 weeks and be working a couple days a week. And forget about Sandy, it was like a full time job." The role of an EM is "24/7 as needed."

The EMs interviewed for this project tended to err on the side of caution, since "regardless of what [you] were feeling or thinking, it's always better to be overcautious." More often than not, the EMs stated that they tended to over-prepare. Preparations prior to landfall were extensive in some cases, from clearing creeks and sewer drains, to clearing streets of debris, to even removing any items that had the potential to move when exposed to water. As one EM in a small town in NJ stated, "we knew it would be [a big deal]," and because of that "it's always better to be overcautious."

4.3 Timeline of Decisions Made and Actions Taken

Figure 4.1 illustrates the timeline of events by municipal EMs alongside the evolution of Sandy through time. For this section, the focus of discussion is on the municipal EM; more information on politician decision making is discussed in a later section comparing politicians to EMs.

4.3.1 First Heard about the Storm

All municipal EMs interviewed first heard about what would become Superstorm Sandy between one and two weeks before it made landfall. They found out about it via a variety of sources, including the TV, fellow and neighboring EMs, social media, emails/conference calls with the county, and a meteorologist working in the EM office. These five sources are shown in red in Figure 4.2, which displays the pushed and pulled weather sources that municipal EMs used before and during Superstorm Sandy. The size of the circles designates the importance of that product in EM decision making; the largest is most important and used by the majority of EMs, the second

tier is still important but used by fewer EMs, and the third and smallest show the least used sources mentioned. Obviously, all of the sources that alerted the EMs of the storm were pushed to them and three of the five alerting sources were in the top six most useful sources to EMs. At this point, the storm was over the Caribbean and very few models indicated any shift towards the east coast.

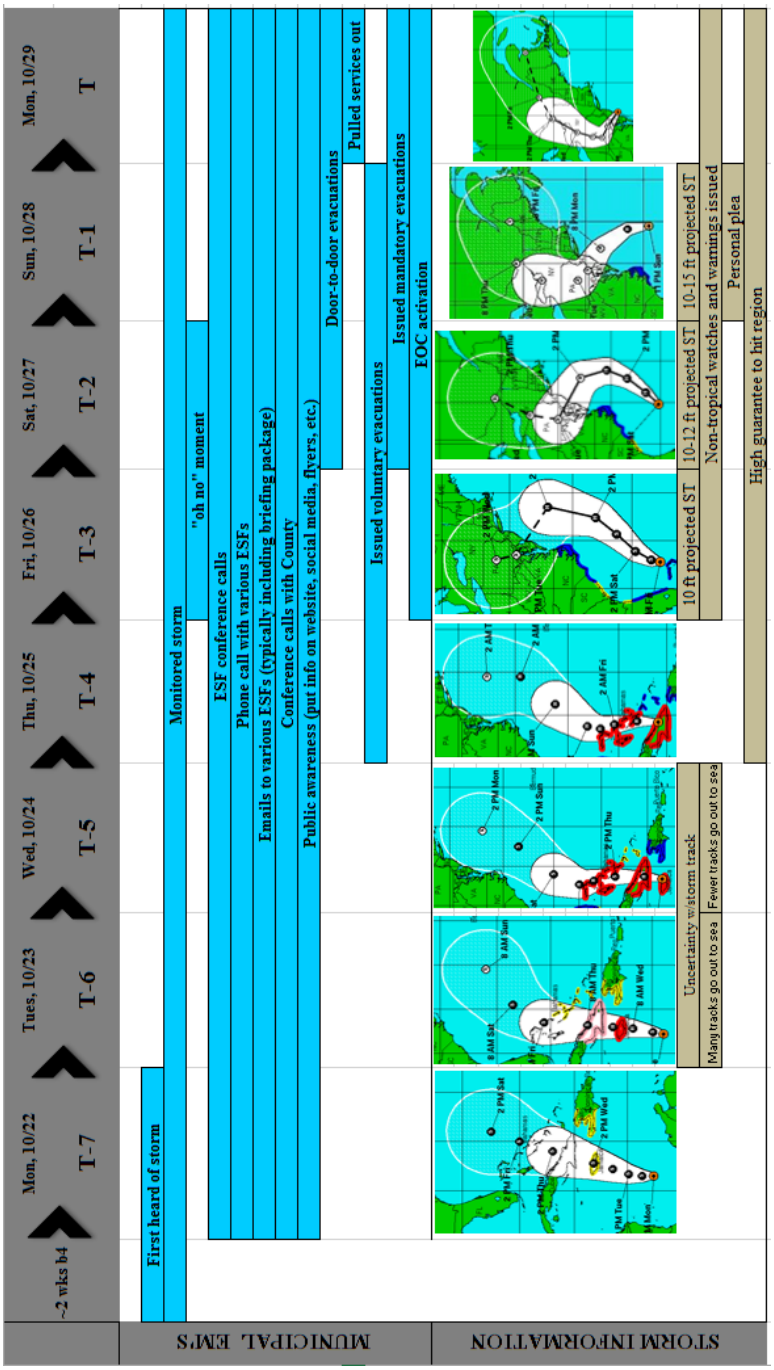

Figure 4.1. Timeline of decisions made and actions taken by municipal EMs during Sandy, along with an illustration of Sandy's track.

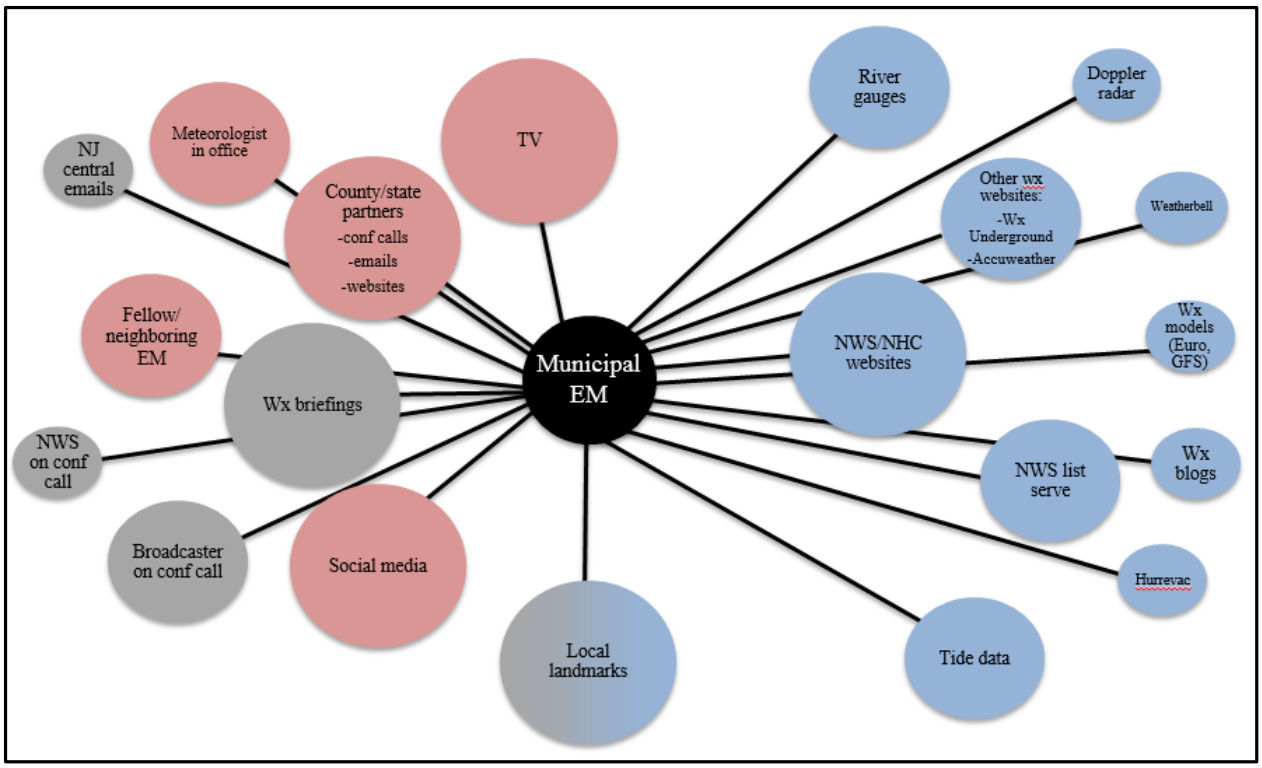

Figure 4.2. Pushed (left) and pulled (right) sources of weather information mentioned by the participants. The five light red sources indicate how EMs initially became aware of the storm.

4.3.2 Monitoring the Storm

From the moment they found out about the potential for a storm until landfall, municipal EMs monitored the storm using a variety of sources (Figure 4.2). The sources used fell into two main groups: pushed and pulled sources. Pushed sources are those that were provided to the EM via other sources, such as in an email from their County EM. Pulled sources, in contrast, are sources that the EM searches for independently. The most useful pushed sources were social media, weather briefings, county partners via conference calls and emails, and the television. Local landmarks are a significant source of information for EMs because many rely on direct observations of how far into their communities flood waters reach, for example, when making evacuation decisions. This source is considered both a pushed and pulled source of information since some EMs are provided with local information simply by looking out their window, while

others actively search specific parts of their community for flood waters. The second tier of sources that were pushed includes fellow and neighboring EMs, meteorologists in the office, and broadcasters on conference calls. The least used sources are emails from NJ Central, an electric company, and having the NWS on conference calls. Very few EMs communicated with an NWS employee directly.

Overall, pulled sources were less used by the EMs than were pushed sources. Only one of the top six sources used, accessing NOAA websites (NWS and NHC), was pulled by the EM. Although this source was used by and relied on by all of the EMs, the five pushed sources that were most used were more influential in their decision making process; pushed sources tended to have a greater weight in determining how the EMs made decisions. The second tier of pulled information includes river gauges, other weather websites such as Underground and AccuWeather, email listservs from the NWS, and tide data. Tide data was very influential but only for a few participants. Those participants mentioned they could not live without tide data, especially during Sandy, which was particularly impacted by high tides. The third tier and least used sources include Doppler radar, Weatherbell, weather models (Euro, GFS, etc.), weather blogs, and Hurrevac. Only one or two participants mentioned these pulled sources.

As they monitored the storm using the variety of sources listed above, the majority of EMs shared information with the publics. Public awareness campaigns started occurring on Monday, October 22nd, one week before landfall. EMs updated their websites with information, posted on social media, and distributed flyers.

Starting on Tuesday before landfall, the forecast began showing model tracks veering left towards the east coast. From Thursday on, there was a strong understanding that Sandy was going to shift westward and make landfall along the northern east coast. Beginning Friday, non-tropical watches and warnings were being issued by the NWS.

4.3.3 Chain of Communication

Communication took place primarily between the municipal EM and the county EM, and between the municipal EM and the other ESFs and politicians. Beginning one week before landfall, county EMs typically initiated conference calls with the municipal EMs from the various towns within the county. Generally, the county EM presented information to the municipal EMs that they obtained from higher levels, being either state or federal sources or from the NWS (Figure 4.3). One NJ EM felt that the county was not helpful "with this stuff because of their level of expertise. They are just relaying stuff from the Weather Service typically to us later than the Weather Service puts it out so we don't really rely on them a whole lot." The information trail is top-down, starting with higher EM levels and ending with municipal, or local, EMs. Little discussion is initiated by the municipal EMs on these conference calls, besides brief questions, which is indicated by the dashed line from municipality to county. In a few cases, the county and municipal EMs met in person.

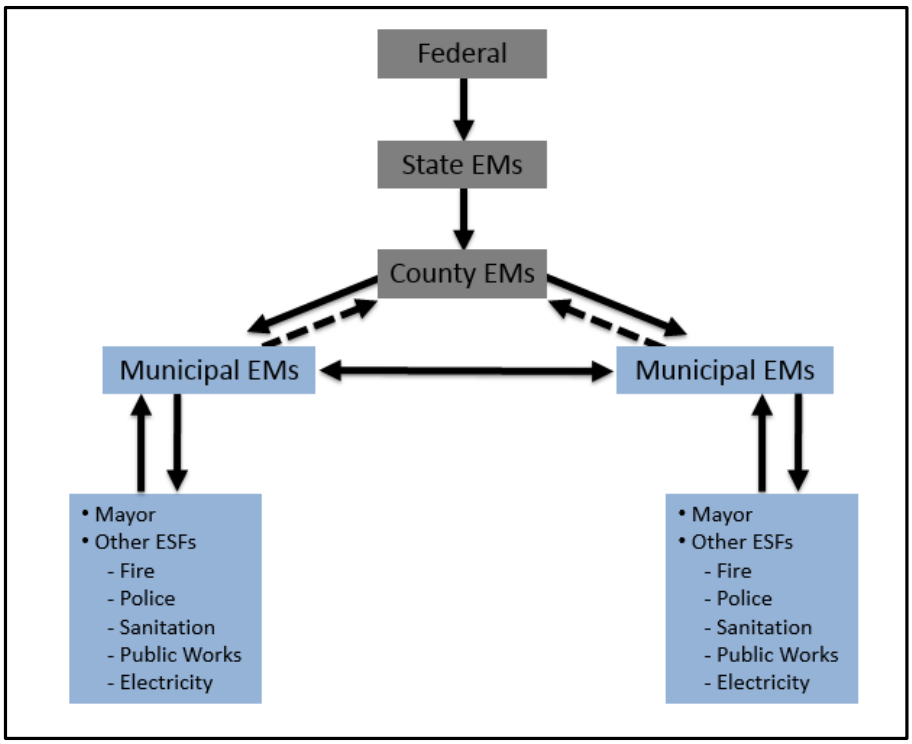

Figure 4.3. Chain of communication between federal EMs, state EMs, county EMs, municipal EMs, and other local ESFs. Solid lines indicate active communication while the dashed lines indicate minimal communication.

The majority of EMs then passed along the information they obtained from higher levels to the various ESFs in their town either via in-person meetings or conference calls (Figure 4.3). These meetings tended to begin one week before landfall on the 22nd of October. From Monday to about Wednesday, the in- person meetings and/or conference calls occurred once daily. From Thursday on, it was typical for an EM to initiate a local meeting and/or conference call twice daily, once in the late morning and once in the early evening. These meetings also involved the local politicians, if they were available. In the meeting, the EM would present the weather information that they either found themselves via several of the sources listed above, or would go through the briefing packages that they received via an email from the county EM. After the presentation, the ESFs, politicians, and any other members were welcome to ask questions about the storm. Typically, discussion broke out among the group. One NJ EM stated that he doesn't "hold any punches with

the emergency services. The emergency services know exactly what [he's] doing." Even though these meetings were primarily led and dominated by the municipal EMs, they seemed much more two-way than were the county-municipality meetings.

Aside from conference calls and in-person meetings, phone calls and emails were two other useful and effective means of communication before and during Sandy. Those out in the field relied heavily on radios or cell phones which were also the most used communication tools as the storm evolved. A few EMs mentioned that emails were the primary means of initial communication. The convenience of emails is that many municipal EMs would simply forward the briefing packages that they received from the county EM to the various ESFs. The briefing packages are an example of an important weather information source that travels down the ranks. In most cases, the EM did not alter the briefing package before forwarding or presenting it. In some cases, the EM tweaked the package to be easier to understand by the ESFs. One EM in particular who tweaked the packages was a weather enthusiast and felt comfortable modifying weather content.

Most EMs activated their Emergency Operations Center (EOC) or another form of an EOC between Friday, three days before landfall, and Monday, the day of landfall. This made communication more convenient as most of the critical players were all together in the same room, facilitating meeting scheduling and accelerating decisions. One EM in particular was especially thankful for having his EOC since power went out and he had six functional phones and internet using cell service in his EOC. In the NYC EOC, "everyone flooded in from all over the Country" as the storm evolved.

4.3.4 Timing of Evacuations

Voluntary evacuations began as early as Thursday, four days before landfall on October 25th, and lasted until Sunday, the day before landfall. Typically, if a voluntary evacuation was issued, which was not always the case, it was issued on Friday or Saturday, a few days before landfall. The EM who issued it on Thursday was responsible for a town of approximately only 200 year-round residents. Mandatory evacuations began being issued on Saturday, two days before landfall, and continued until the day of landfall. Several EMs mentioned that they pulled out their emergency service personnel from the field on the day of landfall for safety reasons.

4.4 The Politics and Communication of Evacuations

4.4.1 Who Can Issue Evacuation Orders?

Who issued the various evacuation orders depended largely on location. In NYC, the Mayor has full control of whether or not an evacuation is ordered. The opinions of the EMs hold no stature and are not always considered by the Mayor when making his/her decision. In NJ, on the other hand, designating the person who makes the decision is more ambiguous. In the majority of cases, the Mayor gives full responsibility to the municipal EM to make the decision, and the Mayor simply goes along with his/her decision. Generally, however, only the Mayor needs to sign the Emergency Declaration, which is a document that allows the Mayor "to spend without consent of committee, without the consent of his or her peers" (NJ Mayor) and is always signed before issuing an evacuation. It can be thought of as a "framework where if [you] have to do something [you] have the ability" (NJ Mayor). Thus, in the majority of the NJ municipalities, the Mayor signed the Emergency Declaration and Evacuation Orders based entirely on the EMs' recommendations. The mayors place a great deal of trust in their local EMs, and this trust is respected by the EMs.

In a few cases, both the Mayor and the EM need to sign the Declaration and evacuation orders before they become active. One municipal NJ EM gives his reasoning for doing so:

> "We kind of set ours up so there is a little check and balances. God forbid you have some crazy OEM coordinator or vice versa… Ultimately we have the power to do whatever we have to, it's just it should be a joint decision no matter what because the Mayor is going to take some responsibility even if he doesn't sign the document. If it goes wrong, then why did you let these guys do it?.. And we don't rule with an iron fist. Everything that we do is always put out there, pros and cons, because no decision is perfect."

In other cases, if the state or county issues a state-wide evacuation order, the municipal EMs do not need to order their own since the state- or county-wide evacuation blankets their municipality. One NJ county EM clearly describes this process:

> "Once a county declares a state of emergency, it automatically umbrellas all of the municipalities. Whether they're impacted or not, they get umbrella'd under that. Same thing with the state, when the state declares and the state issues any emergency proclamation, all 21 counties get umbrella'd under that."

The municipality can still issue its own if officials so desire. There is no law against issuing a more localized evacuation order. For example, one EM gave the example of a municipal law stating that one must be 17 years old to drive, even though the county law states one can drive at 16 years. You must abide by county laws, but can have more localized and stringent municipal law. With that said, having more than one evacuation notice can cause confusion among the residents. Because of this, one NJ county EM asked that his municipal EMs tell him if they chose to issue their own evacuation order so he was aware and could act accordingly.

Based on these findings, it is important to note that the hypothesized model included in the objectives section illustrating the breaks in response needs to be modified to take into account the fuzziness of who actually issues evacuation orders (Figure 4.4). In the original model, politicians

were thought of as the issuers of evacuation orders with little perception or understanding of the event, while EMs understood the event but did not have the political power to issue such orders. According to these findings, most EMs issued evacuation orders on their own account. Thus the break between what they perceive and how they respond, in this case ordering an evacuation, is actually much more permeable than originally thought (Figure 4.4). This is significant to understand for future events, especially in NJ, where EMs are given full responsibility and granted the necessary power to both communicate weather information and order evacuations.

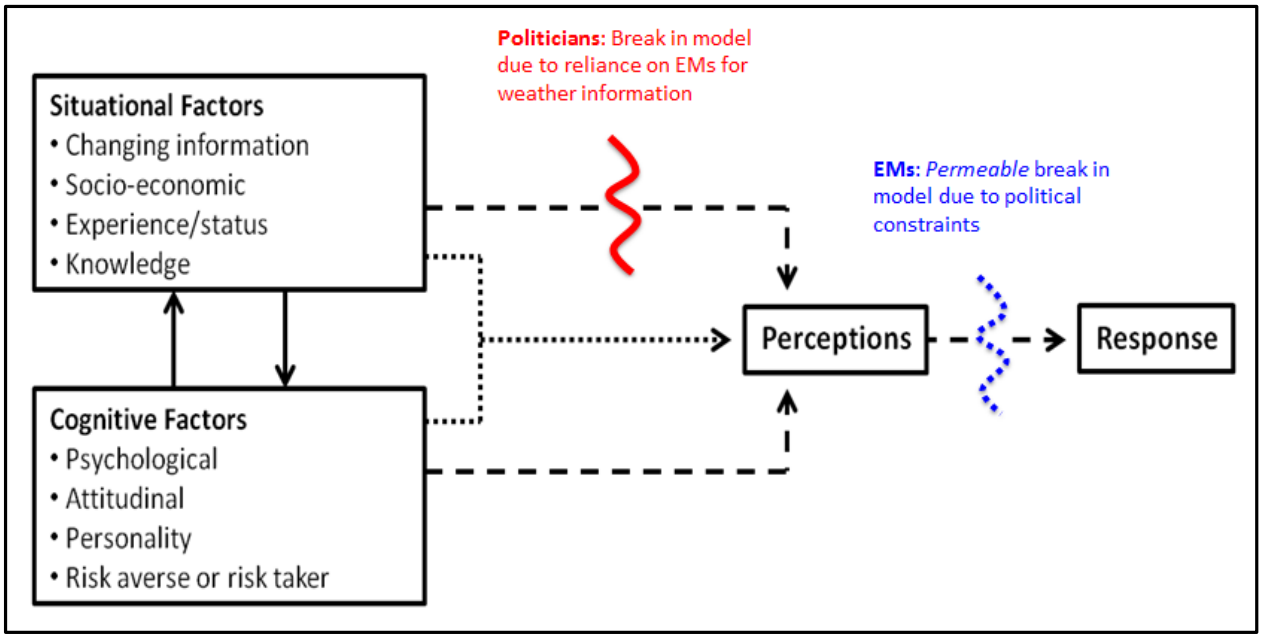

Figure 4.4. Modified theoretical response model illustrating the relationship among hypotheses (adapted from Tobin and Montz 1997).

4.4.2 How Evacuation Orders are Communicated to the Publics

Evacuation orders were communicated to the publics in a variety of ways (Figure 4.5). As discussed earlier, information, typically in the form of briefing packages, was passed from the county/state EMs to the municipal EM. Little information is sent or communication directed to the county/state EMs by the municipal EMs, which is indicated by the dashed line. The county and state EMs have two-way communication with NWS and NHC personnel, while the municipal EMs

and Mayors tend to only obtain information from the NWS and NHC websites as opposed to speaking with an actual person. The municipal EM has two-way communication with the media, detailing the necessary information to media sources to display to the publics, generally via text bars at the bottom of the TV. There are a variety of more direct forms of communication with the publics as well. Almost all municipal EMs mentioned using reverse 911, also known as code red, to disseminate information to their residents. This is a service that is typically paid for by the town and distributes weather information via text, phone, or voicemail to the residents who must sign up for this service beforehand in order to receive the messages. Municipal EMs also updated their town websites with weather information as well as posted information on social media, most notably Facebook. Some smaller municipalities conducted door-to-door evacuations starting on Saturday, three days before landfall (Figure 4.1).

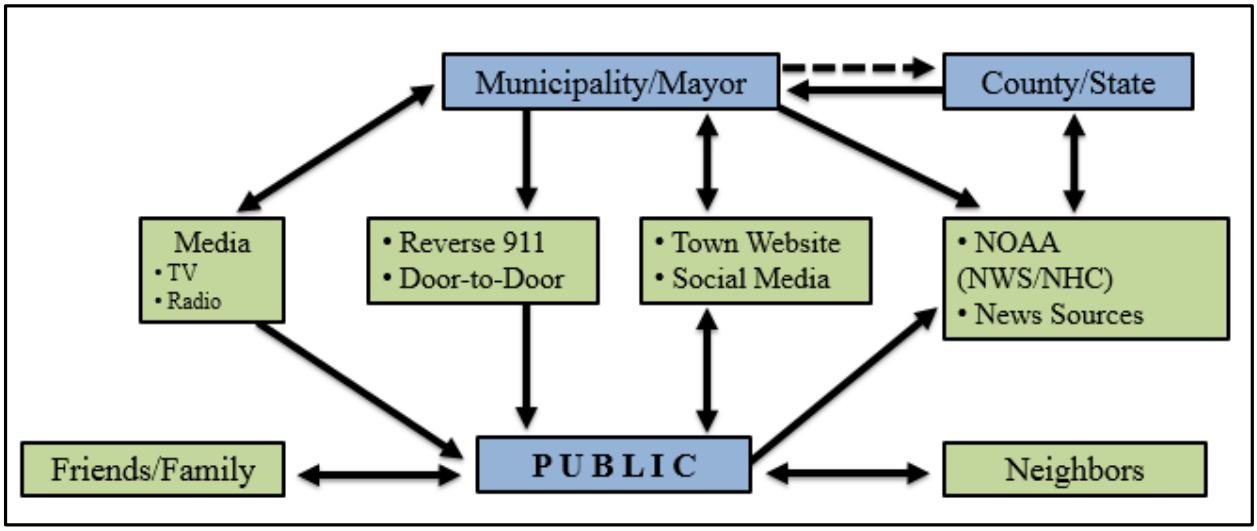

Figure 4.5. How information regarding evacuations is communicated to the publics from various sectors and sources.

Communication via social media was two-way between the municipality and the publics because it allowed the publics to comment and ask questions to which the municipality EMs then responded; information in this sense goes back and forth between the groups. Beyond notices from

the municipal EM and TV sources, the publics also received weather information from news sources (i.e. NWS, NHC), friends/family, and neighbors.

CHAPTER 5: DECISION MAKING MODEL

The previous chapter discussed *when* certain actions were taken and decisions made, as well as *who* can make those decisions. What remains missing is a thorough exploration into *why* they made the decisions that they did and why they took action on those decisions when they did. This chapter delves more deeply into answering this question, which is vital to understanding what influences decision makers during coastal events. Figure 5.1 is a model that illustrates the many factors that influence the decision made, in this case to order an evacuation during Superstorm Sandy, as well as the factors that affect when the action is taken, that is actually issuing the order. The three components that influence the decision made include characteristics of the municipality, factors involving the individual EM, and weather information and storm characteristics.

Once the evacuation decision is made, the participants took one of two paths. First, they issued the evacuation order quickly based on several "accelerators," including the personal plea issued by a Meteorologist-in-Charge (MIC) at one of the NWS offices, the tone of forecasters and gut feelings of the EMs, and/or the visualization of the storm tracking left towards the coast. Secondly, the large majority observed their surroundings, waited for signals such as water reaching a certain level in their towns, and verified the severity of the event before ordering the evacuation. Each of these components is discussed in more detail in the following subsections.

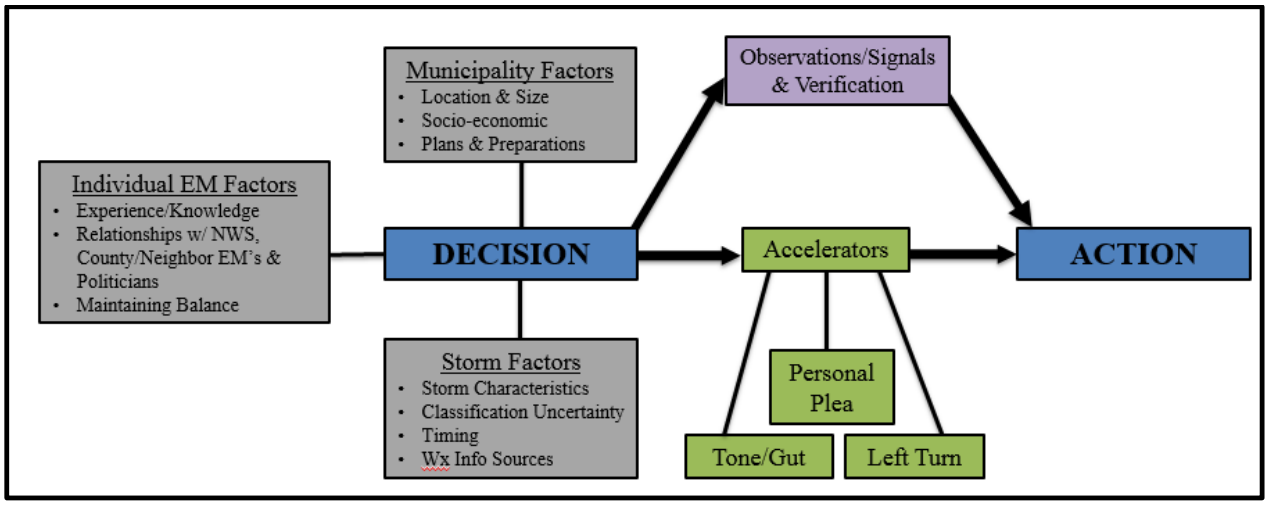

Figure 5.1. Model of factors that influenced decisions made and actions taken by municipal EMs. The model is not time-dependent.

5.1.1 Municipality Factors

The municipality factors that affect the evacuation decision that was made include the location and size of the town/township/city, the socio-economic status of the area, and the plans made and preparations taken by the municipality in the time before the event took place.

5.1.1.1 Location and Size

There is a variety of location and size factors that played into the decisions made by the EMs. First, almost all participants mentioned that they felt particularly at risk since Sandy made landfall south of their area. Their location northeast to the point of landfall meant to one NJ municipal EM that "you're getting all that wind and rain and everything first." Similarly, a NJ county EM stated, "for us we knew we are on the worst, we are on that northeast side of it, this is not going to be good for us." An EM from a smaller municipality had a much more theatrical take on it stating,

> "The magnitude of what happened in the stretch from [town name] 4 or 5 miles south was so extraordinary because of that banding and the northeast side being the strongest, when it came into Atlantic City, it hit this area. You look at Atlantic City and you say well the storm hit Atlantic City, yeah it hit Atlantic City, but so what? They had a quiet period. We never had a quiet period… It's just the way it came, we were on the wrong side, and we

were just in the impact zone. Next time if it had just shifted a mile, they'd be in the same conditions."

The majority of participants actively discussed the northeast side of the storm enduring more severe impacts. Most felt extraordinarily vulnerable because of their location relative to the storm. To add fuel to the fire, the location and shape of the bay in between NY and NJ made the impacts even more severe. A forecaster in NJ stated,

> "they know that if you get up to the NY/NJ apex area you funnel stuff, that's a problem…If it [had] gone a little further south, it's not nearly as bad… the surge going up the Delaware Bay probably wouldn't have been quite as great. I think the angle there to focus the waters is probably most effective at that right angle up there in Long Island and NJ."

Second, when it comes to deciding which areas to evacuate, an EM often has to evacuate an area that will not actually flood because emergency services would not have access to that area when bridges and access roads become flooded. This is known as the "island effect." A municipal EM stated that "if [a resident is] going to be stranded in their home, if they're going to be an island now, then I have to evacuate them because I wouldn't be able to get service to them." The same EM further clarified this phenomenon by stating that "[a town] may not be totally flooded and damaged but they would be stranded so they need to be 100% evacuated." Understanding where the island effect occurs in their towns was vital for the participating EMs when deciding which areas to evacuate and when to evacuate them.

Third, it was evident after conducting the interviews that there was a large locational divide among the different regions within NJ and NY with regard to how the municipal EMs perceived their county EMs and how they communicated and collaborated with surrounding EMs. Towns in northern NJ were more likely to fend for and keep to themselves during this event. On the other

hand, towns in southern NJ were much more likely to ask for help from surrounding towns and/or the county EM, even for minimal events, such as a house fire. When discussing these regional differences with a county EM in southern NJ, he summed up the northern municipalities way of life as "isolation." He further discussed the differences:

> " …It's that environment up there, it's different. We joke… the state is divided up into three regions: north, central, and south. So the seven counties in the south, we've always said we're kind of… like our own little group there, and we help each other out and that goes for every municipality within each of those other counties. We'll go help a municipality out in X county if they need it. That's just because again in turn I know I could pick up the phone and call that municipal coordinator and he will send whatever he can to help me… you can't just leave them hanging out there on their own, and that's what we try not to do."

The rationale behind these regional differences seemed to be primarily resource-driven:

> "It's very, I don't know how to put it. It's demographics, it's different in each region, definitely different. I mean we're more urban/rural, you start to get up to the central part of the state it's all urban, and then obviously north Jersey… they're close to NYC so you have that metropolitan type environment and the towns are used to having to do things on their own, work on their own. You come down here, we don't have as many, the other thing for us is we don't have the resources and a lot of the stuff at our finger tips that they have up north so we have to rely on each other, we have to back each other up so that's why you'll see some of that disparity as you go through the state… It depends where you're at. They have more up there. The towns can survive. You go up to North Jersey it would take a lot for a municipality to reach out to the county and say okay we need help. Down here, some of these towns we can have a single house fire and they're calling three or four other municipalities for help plus the county. They just don't have the resources so it varies from one end to the other…"

Interestingly, both ways seemed to work for the respective regions. Their location and proximity to larger cities, like NYC, helped determine the resource availability in each region as well as the overall atmosphere and way of living. It was highly evident that the EMs interviewed in NYC had an abundance of resources at their disposal, while EMs in smaller townships farther south had fewer resources. This significantly impacted how each EM behaved and made decisions.

Beyond resource availability, the varying sizes of the towns also influenced the general way of life of EMs and residents. EMs in smaller towns and townships tended to have a much stronger emotional tie to their communities than EMs in larger towns and cities. This is most likely due to the fact that EMs in smaller communities are very familiar with the town and the residents who live within it. One EM from a very small town in NJ stated,

> "Because this is such a small community and because we all know each other, it snapped to a lot quicker because there is more of a personal attachment. It's not like oh it's a city and it ran through your house. We know everybody's homes. As a police officer, we know it's X's house. It's not 104 X Street. It's Miss's X's house, or it's the Mayors house, it's more personal, or it's the fire captain who lives over here on X Street next to the yacht club…"

These EMs were responsible for a town of about 200 full-time residents. Similarly, another EM responsible for a small town stated, "when I went down to the beachfront, I cried. I couldn't stop crying. What I was seeing, I mean we know these people, what I was seeing I couldn't believe my eyes. It's things you see on TV." This contrasts sharply with a city like NYC, with 8.8 million people at night and up to 17 million during the day. It would be difficult to have emotional ties to individuals in a city of this size. EMs in NYC seemed to follow their plans and guidelines more strictly, while EMs in smaller communities tended to focus on individuals.

5.1.1.2 Emergency Plans and Preparations

The ways in which the EMs incorporated and followed community plans depended largely on the location and size of the towns. Of the EMs interviewed in NJ, less than half mentioned the use of plans or guidelines at some point during the process. Of those, only a few discussed their plans in any detail. For instance, one NJ EM in particular relied heavily on their township's checklist of steps to take during a nor'easter or hurricane:

> "This is [township name] specific… if I know I'm going to get a blizzard or I know I'm going to get a nor'easter or I know I'm going to get any level of a hurricane, then these would be the steps that we'd take…This is our hurricane plan for [township name], which I admit was taken probably ten years ago, initially the core of it was the Miami Dade plan, and we took that and modified [it] to fit our area. But it's undergone like five modifications since then so… it's pretty good for us. But it was pretty much everything. Prior to the storm, during the storm, and then after the storm, recovery, long term recovery. It's all spelled out."

This EM, along with a few others in NJ, mentioned following a plan, checklist, or guideline numerous times. These EMs tended to need organization and order.

Conversely, while there were a few who followed a plan, most never mentioned using a plan or only briefly mentioned using an action plan. It is unknown as to the extent that these EMs followed their plans. During the interviews, they chose to either not discuss a plan or guideline at all, or only briefly. Of those who did mention it briefly, they stated that the plans are typically only guidelines and that they stray from them depending on the event. The plans were ever-changing and not uniform across all types of storms. For example, a few EMs mentioned that once sustained winds reached a certain speed, they would begin evacuating their barrier islands. However, they were vague when specifying a speed at which they would evacuate. One EM for instance first stated "we are going to pull our people off the barrier islands when the winds hit sustained of 55 mph for a period of time." Later, he provided a range, "when [winds] are sustained at 50-55 mph." Although a speed at which to evacuate was specified in their plans, the speed when they actually evacuated did not coincide with the specified speed. Every event is independent of every other event, and other factors came into play when deciding when to evacuate beyond sustained wind speeds. As one local Mayor stated, "we adapted the plan based on condition. And I think that helped us to meet the needs extremely well."

The EMs interviewed in NYC on the other hand had a variety of extensive plans, most notably a Coastal Storm Plan and a Hazard Mitigation Plan. Additionally, the NYC EM office includes various operations, from transportation to health management. The EMs interviewed from NYC followed their plans intently, and relied heavily on their plans when discussing the process before and during Sandy. More specifically, at 120 hours prior to landfall, they convened their coastal storm task force steering committee. This was done according to their strict time frame. The size of the NYC area is so expansive that these EMs felt as though they were required to actively follow their plans. Also, following a timeline allowed for more collaboration and order among the many employees in the NYC office.

5.1.2 Individual EM Factors

The individual EM factors that influenced decision making include the experience and knowledge of the EM, EM relationships with the NWS, county/neighboring EMs, and politicians, and maintaining balance with regard to the allocation of resources.

5.1.2.1 Experience/Knowledge

The majority of EMs interviewed have worked and/or lived in their respective communities for numerous years, many for more than a decade. Having experience with natural hazards such as hurricanes and flooding has several positive and negative impacts on how an EM perceives and responds to a natural hazard. An overview of the positive impacts of experience is discussed first, followed by the negative impacts.

First, all EMs interviewed had a general sense of the areas that flood within their towns, and to what level. An EM in a small NJ town stated the following about herself and her colleague: "I've been here 18 years, he's been here 30 years, just being here so long. I grew up in the town before I started working here and I've been here my whole life so we know where the areas are that flood… It's just familiarity with the town." This EM takes it a step further adding that "this is your home and you have to know."

In some cases, the EMs were so familiar with their town that they could list where everyone in town lived and could describe down to the last detail when flooding will occur, where, and why. For instance, an NJ EM stated,

> "I think we were more prepared [for Sandy] in a lot of ways because we are used to flooding. Here in [town name] there are streets where if you have an east wind for three days, a moderate east wind blowing 10-20 and you get a full moon, you are going to have a foot of water in the street… that's just how it is. And so we have streets in town that are under a foot of water 20 times a year. We live with flooding; we are used to it. We have been through enough storms that we know basically what to do."

This EM was so familiar with his town that he knew what type of storm characteristics are needed to flood his town by one foot. Another couple of EMs in an average-sized NJ town believed they could tell if there would be inclement weather leading to flooding just by "sniffing" the air:

> "We've been through a lot. We've been through hurricanes. It's funny, [EM colleague] and I sometimes went out and we went to the beach. And we sniffed the air, we looked at the wind, looked at the tide and said lets go home. And we were right. We're going to get a little wind and a lot of rain tonight, let's go to bed. Most of the time we were right."

They continued discussing the impacts of Sandy, stating "but this I have never seen anything like it." It is interesting to hear these EMs talk about how familiar they are with their towns and the reliance they place on techniques such as "sniffing" the air to forecast impeding weather.

Additionally, beyond living in an area for a long time, many EMs had several different jobs within the town that allowed them to become familiar with it through many avenues. For example, a NJ EM stated, "I've lived here since 1987, so being here for as long as I have, being a former fire chief, being a former police officer here, we know the areas that flood." This EM was a fire chief and police officer before becoming the EM coordinator for his town. He was able to witness flooding first-hand in the field, and now uses that knowledge when making decisions in the office when disseminating orders.

Many EMs who were interviewed mentioned using points or locations within their towns as a way to compare current water levels to past levels. For example, one NJ EM mentioned "when I see water starting to accumulate here I know we're going to have a problem. So I've got these points where I can go and actually take a look." Another EM of a very small town said,

> "For us, you can tell. Once water hits a certain spot, it's time to go. That's the way I run. Once water hits a certain spot, I have landmarks, our flood zones, once water gets to a certain landmark, okay let's go! Because I know I have an hour or I have 20 minutes to evacuate people."

These EMs carefully monitored certain locations within their town to determine the severity of the storm. These locations became very beneficial in their decision making processes regarding ordering evacuations. For instance, similar to the above quote, another EM mentioned that once water gets to a certain level at a certain location, he knew it was time to take action:

> "And when we knew that it was going to be that the water had not gone out, and I still had water in the street in four or five hours to go before high tide. Now you know that's going to be a problem. See? So at that point, that's when we started moving people. And when we told them we told them move out of [town name]. Out!"

Similar to using specific locations to compare water levels, several EMs also used previous storms

as “benchmark storms” to communicate the storm severity to the publics. The nor’easter in 1992, described by one EM as the “ass kicker,” and Hurricane Irene in 2011 were the two storms most discussed. When presenting information to the ESFs, many EMs compared forecasted surge levels for Sandy to observed surge levels of past storms, such as the ’92 nor’easter. One NJ EM stated,

> “Our presentations evolve into that because we show the direct effects of the storm surge, actual forecasted storm surge, and then I would compare it to previous storms so that the department heads know ‘listen they’re forecasting 9.4 feet. Our storm of record is 9.2 feet.’ So it kind of gives them a benchmark…”

Comparing water levels to past storms gives the ESFs a visual image of what the potential storm surge levels could be for their area. If the area flooded during the benchmark storm, then in all likelihood the area will also flood with a higher forecasted crest. Similarly, another NJ EM used a similar technique when communicating the severity of Sandy, stating, “if the number is 9 in [town], I know I am going to get crushed…I’m basing it from the ’92 storm… so I know if I’m over 10 at [town], I’m going to get flooded as bad as the ’92 storm.” When asked to summarize how previous experience played into his decision making, he simply said, “big time, big time.”

Another positive outcome from EM’s experience is that memorable storms prepared EMs for Superstorm Sandy in several ways. First, EMs were made aware in past storms of the need to be self-sufficient during the storm and for several days post-storm. They understood because of their experience with previous storms that they need to adequately prepare and sustain for a certain length of time and that they could not only rely on resources from the county. For example, one EM stated,

> “The blizzard also was… a huge help for us, 2010, because in each one of these cases we activated shelters, we did evacuations, we recognized the need to be self-sufficient. Everybody promises you[re] going to get the national guard, state police, county resources, you’re going to get all this, stuff is going to come in. It doesn’t come in for

> days and days and days, in some cases, weeks. So we recognize now well we have since the 90's, that we need to be self-sufficient. Everyone says 72 hours, we figure a week."

Secondly, past storms led several EMs to modifying or in some cases completely revamping their emergency plans. When asked if Irene influenced what they did during Sandy, one EM from NYC stated,

> "…Absolutely! We changed our complete way, not completely, we revised it, we learned a lot of things from Irene. There is no EM who is going to tell you that we had a disaster [and] after we had nothing to fix. We had tons to fix and we did a ton of work. A tremendous amount of work."

His colleague later stated, "…there is always an after-action. There's always recommendations that you can incorporate, rewrite some of your plans to reflect those." An EM of a much smaller town in NJ agreed that changes are constantly being made to plans post-event. She especially noted significant changes in the preventative measures they take pre-storm stating,

> "It did help us with being better prepared because we sat down and said what do we need to prepare for Sandy, that maybe we didn't do for Irene. And a lot of that was just taking more preventative measures within the town as far as it was cleaning up sewers, creating a storage area for the debris removal, tracking everything"

Additionally, previous experience gained from storms like Irene gave the EMs interviewed the opportunity (in some cases) to issue evacuation orders, which is something they had not yet done. Due to the rarity of landfalling hurricanes in NJ and NY, EMs in this area almost never have to order evacuations. Hurricane Irene, in particular, gave them the opportunity to practice going through the evacuation process. One EM even mentioned that it "helped [them] kind of come through Sandy" since "that was the first time [the county] issued a mandatory evacuation." Beyond issuing evacuation orders, past storms such as Hurricane Irene strengthened the relationship between several EMs and the NWS, NHC, and media sources. An EM in NYC said, "Irene

definitely solidified our relationship with the NHC more directly." Thus, although experiencing dangerous storms has negative impacts, it can also bring positive impacts. One county EM in NJ went as far to say they were "lucky" to experience Hurricane Irene.

Where experience becomes a problem for EMs in the NJ/NY area is the overall lack of experience they have with hurricanes. In general, this area receives very few hurricanes compared to the southeast, and because of this, they tend to either not be prepared for them or do not believe they occur in their area.

Almost all EMs interviewed mentioned at least once that storms never make it that far north. Several EMs described having monitored storms coming up the coast that eventually veered east into the Atlantic Ocean. An EM stated, "and we have had storms in the past, even hurricanes that come up, skated the coast and kind of petered off" and "yeah they all take the same track, it seems." An EM from a NJ town that was especially impacted by Sandy mentioned,

> "This is the scenario for 9 out of 10 storms. 9 out of 10 storms we get this, they come up the coast, they come to Hatteras, and then they start to veer out, because we're in this little cove here so we don't really get direct blows. We get the glances, we get the strong winds, we get the flooding, we get things like that, but we don't get a direct hit, not like Sandy, Sandy was a direct hit."

In this statement, he was making reference to Sandy's track looking very similar to that of Hurricane Arthur, which occurred in early July of 2014 when the interviews were conducted. Another EM compared Sandy's track to Arthur's, stating, "this area we tend to, just like Arthur is doing, the hurricanes come up, skirt or hit the Outer Banks, and peel off northeast." Another EM

stressed that he has “been to this dance before,” and watched hurricane after hurricane steer east from his location.

When discussing how meteorologists forecasted Sandy to keep west and make the left turn into NJ several days in advance of projected landfall, one EM simply refused to believe it saying, “you can tell me that until you’re blue in the face. All we ever see is this [Arthur’s track]. Some come closer, some don’t. We’ve never had a direct hit here.” Thus, it is clear that for this EM, among several others interviewed, Sandy came as a complete shock as they had never experienced a similar storm before. One EM stated with much conviction, “never have I seen anything like this before. Never have I seen it!” while another NJ EM said, “North Jersey gets nothing, we get nothing.” The way these EMs declared their lack of storm experience made it seem as though they were trying to defend how they perceived Sandy, which for some was disbelief even when Sandy was forecasted to make landfall in their area. Even two years post-Sandy, these EMs still had trouble wrapping their heads around the idea of a storm hitting them in their so-called “bubble.”

Having had little experience with storms in the NJ/NY area clearly affected how the EMs included in this study perceived Sandy. Due to this lack of experience, when Hurricane Irene was forecast to hit that area, most thought it was going to be the “big one.” There was “big hype,” according to one NJ EM, and “all the mandatory evacuations” were followed and “all the preparations” made. However, for the EMs interviewed, it ended up being “a dud,” which resulted in “a false sense of security” and concern for “cry wolf” during future storms. A local Mayor stated that Irene was “probably one of the worst things that happened” to them. Storm damage aside, he described how it “lulled everybody into the sense of ‘ehh it’s not going to happen, it’s all a lot of hype’.”

Since "Irene turned out to be a bust," many EMs felt pressured not to order evacuations for Sandy because residents were simply "burned out" from Irene. One NJ EM discussed the challenges he's faced with when making difficult decisions about evacuations,

> "The thing is this. You asked me about Irene. I go through the same process with Irene, prepare your evacuation kit, voluntary evacuation, blah blah blah and then all of a sudden we get nothing. You ever [heard of] the crying wolf? And that's what happens. You tell the people it's time to evacuate, two maybe three times, after a while they say this is bullshit I'm not leaving my house anymore!... That's my position. I'm damned if I do and damned if I don't. You know what? I'd rather be damned if I do. You want to call me an SOB tomorrow? Be my guest. But I can guarantee you tonight your ass is going to be safe. I'm going to be able to sleep."

A NJ EM openly discussed the possible rationale behind the decision made by the NYC Mayor, in which he ordered evacuations later than NYC EMs would have preferred. He stated,

> "For the politicians and even like NYC even Bloomberg they were burnt out from that false alarm, they evacuated most not most but a lot of NYC. They closed the parkway during Irene and there was no need for any of it. So I'm sure they got a lot of pushback from that and so they were reluctant to accept the fact what Sandy was presenting."

Due to this complacency among the publics, EMs believed that Irene would cause problems with the next big storm stating, "we knew that we were going to have some challenges with the next storm… that built a lot of complacency, we knew we were going to be up against that complacency." A NJ EM who felt especially hesitant to issue evacuations during Sandy stated that "I'm not an alarmist. I'm a realist," meaning that he considers the region's history with storms and does not let one storm alarm him. Another NJ EM also felt pressure when issuing evacuations during Sandy, however in this case it is because he "didn't want to panic people again."

When asked if more people would have evacuated during Sandy had Irene not occurred, one NJ EM stated, "oh yeah, sure. Definitely, definitely. And that's just human nature." I believe this EM

brings up an important point: how we react to future events based on previous events is "just human nature;" there is no changing this type of behavior. A local mayor in NJ similarly stated,

> "I actually think [response during Sandy] would've been greater [had Irene not happened]. There is no empirical data that would tell you that, but I actually think people would've because for so long on the Jersey Shore we've heard the big one is coming, the big is going to hit, the big one, the big one, and then Irene was built up to be the big one is here, the big one is going to happen, and it just petered out, and so I think everybody is just like 'gah come on here we go again.' So I think a lot of people did not take it to heart and then when it got into it, it was too late."

Interestingly, just as Irene made it difficult for the public to believe the forecasted severity of Sandy, Sandy on the other hand is hypothesized to entice the public to evacuate during future storms. One county EM stated,

> "I can tell you we are not going to have the same problem now because people who opted to stay… regretted staying, they were scared. And the amount of fatalities. We only had 4, but… you ask them they'll never want to live through that again… because of the horrific fear that they felt staying in that house."

It only takes one experience to drastically change how someone perceives an event such as Sandy. While Irene made the public wary of future storms, Sandy has reminded them of the potential impacts that storms can have, in any area.

Hurricane Irene influenced all the EMs interviewed except one. This NJ EM was knowledgeable in meteorology and weather savvy. He said, "I just do it. I'll be honest with you, I have a pretty high level of confidence in myself looking at this stuff." This EM was not thrown by Irene's change in severity because he analyzed the models himself and knew that there was potential for it to taper off. Due to his confidence in his forecasting, Irene had little impact on his decision making during Sandy.

On another note, having experience turned out to negatively impact one EM of a small NJ town because she felt pressure to have all the answers. This EM had training in various positions and experience with flooding issues in Katrina. Due to her wide array of experience, her colleagues felt as though she would know exactly what to do during Sandy. She stated,

> "I did Katrina because before here I worked for the state police in USAR the urban search and rescue field in [town name] so we went down to Katrina. I'll tell you what, totally where do you even start? I'm down there thinking where do I start and then I get hosed coming up working for a small police department. I'll do my years and I had gained a lot through the state police doing different swift water events and stuff with them, and learning the emergency management system. But then everybody looks at me and goes well you've done this before? No!... Totally different."

5.1.2.2 Relationships

Municipal EMs conversed and collaborated with a variety of people, including neighboring municipal EMs, local politicians, and county EMs, as seen in the communications section. Their relationship with each varies tremendously. The strongest relationship seems to be that between neighboring EMs, which is depended upon by EMs during events. EMs in a small NJ town described how they met in person with several neighboring municipalities to discuss plans and provide aid during Sandy. Because they "are in a like situation geographically," as one EM puts it, there must be a "coordination of efforts" among neighboring municipalities in the case that something were to occur to their bridges and/or evacuation routes/plans. Communication between neighboring EMs is strong, as indicated in Figure 4.3.

The relationship between municipal EMs and the county EMs is not as strong. The majority of EMs interviewed voiced a negative relationship between them and their county for a variety of reasons. First, there was overall a lack of communication and understanding by the county EMs.

One municipal EM described the significance of the flood gates in his town, and discussed how the county simply did not understand their circumstances:

> "We have flood gates down there, we don't need to evacuate. We are watching the flood gates… The county when they tell us you need to evacuate, they don't take [the flood gates] into consideration. We tell them we're not going to evacuate and they argue with us, 'you have to evacuate,' 'well no we're not.'"

Even if they technically should have evacuated, the issue brought up by this EM was that he had a difficult time conversing with the county. It was not the issue of evacuating; rather, the county's failure to consider their circumstances was the issue.

Second, there was a great deal of confusion between the municipal and county EMs regarding the type of evacuations ordered, being voluntary or mandatory. For example, one municipal EM said, "they didn't make it mandatory and it was a lot of confusion on that with everybody. The county said to evacuate, well are you making it mandatory or is it voluntary evacuation? There was a lot going back and forth between the county and the towns." In several cases, the county would issue a voluntary evacuation, while the municipality issued a mandatory evacuation, or vice versa. This created confusion among the residents as to which they should follow. This type of unclear relationship was not helpful to EMs when making decisions during Sandy.

Third, the majority of municipal EMs did not receive the resources, aid, or cooperation from the county and was even described as "removed" by two EMs. A deputy Mayor during Sandy said that the county doesn't "really provide anything. You really have to be down and out before they do anything. They're not that forthcoming with stuff. You really have to pry it." The county told EMs "you better be prepared for 72 hours of doing it on your own," despite the limited resources of these small towns. It was well known among municipal EMs that the county was overall not

liked and not helpful, with an EM stating, “some of the towns will say they didn’t get any cooperation from the county. When they told me I needed to survive on my own I knew it. You knew what was going to happen.” The EMs interviewed recognized the need to be self-sufficient, even though the county exists to provide aid to its municipalities. Some EMs “got so fed up that [they] had to react… And [they] basically did [their] own thing.” One NJ EM summed up the municipality’s view of the county perfectly by saying, “we don’t depend on them at all. We don’t depend on the county.”

Due to the lack of cooperation and communication from the county, several municipal EMs interviewed created their own group called BEMA, or [Regional] Emergency Management Alliance. Before BEMA, the municipalities would meet with the county only four times a year, which was not sufficiently meeting the community’s needs. A NJ EM in the alliance stated,

> “We formed a BEMA group because the county would only meet on a quarterly basis and there is just too much going on to meet 4 times a year. So what we did is we took all the X communities and we got together and we set up a meeting and we formed an alliance… We call it the BEMA group… And we meet once a month, to this day.”

Another EM said that “we formed it 10 years ago maybe if that because we weren’t getting the communications from the county at the time so we formed our own little group.” Interestingly, and while laughing, the same EM said that “the county now sends a representative to our meeting” to stay connected and informed on what the municipalities are doing. The Alliance has proved to be helpful to the municipalities “because we get the information out there more. And all the towns that deal with the same stuff, it’s all local.” The county OEM also seems to like it since “if they need to get something to us, they just send it.” However, initially the county OEM felt undermined by BEMA, asking questions like “why are you guys making this organization?” to which those

involved replied, “communications, communications.” The collaboration and camaraderie among the BEMA members was very obvious during the interviews. One EM stated proudly, “BEMA before FEMA!”

On the other hand, the county EM interviewed only had positive comments to say about his municipal EMs. He stated, “it’s actually a personal relationship. I mean we know all the coordinators… We are all on the same team, and that’s the thing, I rely on them as much as they rely on us, believe it or not.” It is important to note here that this is the opinion from one county EM; it should not be generalized to all county EMs. A possible explanation for this discrepancy could be because municipal EMs in central and northern NJ were mostly interviewed, where they are not as close with their county EMs. Perhaps had more municipal EMs in southern NJ been interviewed, they would have had more positive comments to share about their relationship with their county EMs, illustrating the importance of context and location.

The municipal EMs’ relationships with their local politicians was generally positive. Four EMs interviewed discussed the close relationship they had with their Mayor during Sandy, and stressed the importance of making the decision of evacuation together. One EM stated,

> “We brought the entire council. It’s not just a trust thing, they are a partner in this. They sit at the table, roll up their sleeves like the rest of us to help make those decisions. But we brought them and the entire council into the regular meetings starting on Wednesday. It’s better to keep them informed… and they have a big stake in it so they need to have the input into the decisions.”

Another EM set up a “check and balance” to ensure that both the OEM and Mayor had input and that neither was left with the consequences of a bad decision. An additional EM said, “politically, always good to have, and because we have a close working relationship. We never got into a

position where it became an issue. We agreed on it." In this case, the decision to evacuate was made together, the EM signed the evacuation form, and the Mayor made the public announcement to evacuate in order to personalize the message for the residents.

In all the remaining cases in NJ, the EMs made a decision about evacuation separately from the Mayor, and simply informed the Mayor of his/her decision. In general, there was little give and take between the municipal EM and the Mayor and in most cases, the Mayor would heed the recommendation from the EM with no pushback. One assistant EM discussed how the experience with the OEM led to the Mayor listening to his recommendations,

> "They take his word very seriously only because they know with his experience, and his knowledge, and his training, that if he says we need to evacuate, there is no doubt in his mind that that is really what we need to do, so they probably listen to him the most, better than themselves because they are not that familiar with it, so the relationship is very good. They listen. They take our advice and they take our opinions and they listen. So it is good."

Other local Mayors said phrases like, "do what you got to do," and an EM said that his local Mayor just takes "our word for it." The most direct statement from the EMs interviewed would have to be the following,

> "We just did it. We took control. We didn't listen to [the Mayor]. There is a time when you have to do an Alexander Haig. Remember when Alexander Haig stood up and said 'I'm in charge' when Reagan got shot? And everybody said 'okay,' and he took charge. And we just did that. We did the Alexander Haig and we took charge.

The Mayors interviewed have very strong positive opinions about their EMs. Even if they do not communicate on a regular basis, the relationship between them is strong partly due to the respect the Mayors have for the EMs. For instance, one Mayor in NJ said that their relationship is "great. I would hope they would say the same thing! I have the utmost respect for them for what they do,

for literally the time and effort they put into these things, the really selfless aspect that they have that I find absolutely incredible."

The situation in NYC is vastly different from that in the NJ OEM offices. The EMs hold conference calls with the "commissioner, our deputy mayor, and then any other decision makers that we have to include in the conversation," however it is the Mayor who makes the final decision about evacuation. "The Mayor at the end of the day can say 'I'm not listening to anybody, I'm going to do what I want.' That's his prerogative." Just because the EMs give him suggestions as to what to do, "that doesn't mean that they're going to follow it through." When asked if they have a good relationship with the Mayor, one NYC EM stated, "No. We're too low on the totem pole."

The NYC EMs were quite vocal about their opinions of the Mayor's evacuation decision. One EM discussed some of the background to his decision, stating that his department will "advise the commissioner, and the commissioner will talk to the Mayor. But again there is a collaboration, so there were three commissioners there. And a lot of the time the Mayor will prefer to listen to the health commissioner versus the EM commissioner." His reasoning for this is "the Mayor's inexperience." The same EM later reiterated the Mayor's mistake, stating,

> "But listen it falls on the mayor, he's the one who makes the decision. Ultimately, it's [the] Mayor's responsibility. And he made a mistake. He made a critical mistake and I think he didn't know, I think he wasn't experienced enough to make that decision and that's my opinion, that['s] what I think."

Other EMs in NJ also shared thoughts about the Bloomberg decision in NYC. Many EMs were disturbed by the messages he was sending out on Saturday, two days before landfall. An EM stated,

> "[Bloomberg] was like 'well it's not a big deal, it's going to come in fast like a hurricane, the storm surge is slow' and all this stuff. I know guys who lost relatives during that

> storm and I know a guy who barely got out of his apartment, his dog drowned in his apartment. So the fact [that Bloomberg] was putting stuff like that out is absurd."

When asked who Mayor Bloomberg may have communicated with to come to this decision, he responded with "well that's the problem," signaling the lack of communication or misguided communication taking place between Bloomberg and other officials. A forecaster in NJ who was interviewed also voiced his opinion about the repercussions of Mayor Bloomberg's decision. He discusses how the conflicting messages from Mayor Bloomberg and Governor Christie caused the public "to freeze," as he puts it:

> "And the other thing was I was really pissed off, pardon my language, at Mayor Bloomberg in NYC, he really made a bad decision on that Saturday, and I was afraid he was fuzzing the message up. NYC is such a huge media and I was just worried anyone heard what he said, and then anyone who heard what Governor Christie said. To me I go back to when I was doing the service assessments for tornadoes with social scientists, and one of my take-aways from the social science is if you want to freeze people, give them conflicting information: authority figure A says do this, authority figure B says do something different. Now they are in tie-breaker mode. They were going to go seek out additional information anyway but now you've reduced them to saying now I'm going to start looking for C, D, and maybe E to see if I can form which is going to be majority rules here to help me guide me. So I was very very disappointed with that conflicted message…"

The relationship between the municipal EMs and the NWS depends largely on location. In NJ, the EMs have little to no relationship with their local NWS. If anything, they listened to an NWS employee talk about the impending storm on a conference call that the county OEM office coordinated. Otherwise, they tended not to converse with the NWS, aside from monitoring the NWS and NHC websites. The county EMs on the other hand talked regularly with the NWS and invited them to discuss the storm either in person if possible or via conference call. In NYC, the EMs have a strong relationship with the NWS and collaborate during impending weather. Additionally, there is a completely separate weather department of the NYC OEM building that

monitors the weather and provides updates to the other departments.

5.1.2.3 Maintaining Balance

Maintaining balance is a significant factor for EMs, whether that be balancing evacuating versus not evacuating, balancing the allocation of resources, and balancing personal and professional life. With regard to evacuation, EMs must consider the injuries that could occur when the public evacuates before a storm. For instance, a NJ EM stated,

> "There is tradeoffs to everything, like an evacuation in town, just evacuate everybody. But you know people can get hurt or killed evacuating, especially like special need people. God forbid their oxygen runs out or this or that. It's dangerous so you have to [take] these things serious[ly]…"

Additionally, EMs have to consider the "Cry Wolf Syndrome," discussed earlier. An EM said "that's the problem, is coming to the right decision to give the order of evacuation. If you do it too soon, and nothing happens, then the next time people don't believe you." Thus, EMs have to balance the potential for injury and disbelief among the public during future storms.

The allocation of resources is another factor that EMs must balance. More specifically, EMs have to keep the future in mind when allocating resources for a single storm. If they use all their resources for one event, their future may feel the impacts. An EM of a smaller town discussed this balance issue stating,

> "In Irene… after the public evacuation, I was very concerned about that we not lose equipment. Fire trucks are almost a million dollars these days. After the storm, there is going to be fires. It doesn't do us any good to be heroes for three hours and then not be able to respond for 3 months. I ordered basically all equipment to be removed and placed over at X park... Afterwards I did get some blow back from the fire department because they felt that the equipment should've been here."

Another EM said that "you can't go wasting equipment and manpower too much during the [storm]

because you need them afterwards." The EMs interviewed understood the importance of the aftermath of an event and fully recognized the long duration of the recovery phase. Yet, it was difficult to not supply the resources during a catastrophe such as Sandy if they were available. A Deputy Mayor at the time discussed this point stating,

> "That is one of the good things about it, once an emergency is declared you get to buy everything and you only got to pay 10 cents on the dollar. But it costs a lot of money too, because I was going to be the mayor next year and that was only two months away, and so I was like 'oh my god we're spending this much money, we are doing this, we are doing that.' I'm trying to look at my budget for the following year which was impacted."

The politicians interviewed dealt with the issue of maintaining balance between their professional and personal lives. A Mayor during Sandy perfectly described this balance issue stating,

> "But for this one, I had to sign the documents and also I had to leave my own home and building…. As you're looking at this, there is the professional side of you saying here is what I need to do, and there is the personal side of you saying I'm talking about where I live, I'm talking about what I own."

The politicians interviewed discussed this balance frequently. These participants prioritized their personal life much higher than did their EM counterparts. Both politicians interviewed evacuated before the municipal EMs, for either their own safety or to check on their additional properties.

5.1.3 Storm Factors

The storm factors influencing EM decision making include the specific characteristics of Sandy, the uncertainty in its classification type, the timing of Sandy, and the information sources used by EMs.

5.1.3.1 Characteristics

Sandy had "a lot of unique attributes" that made it "so unpredictable." One lively EM in a smaller NJ town said, "there is no scientific word besides the fact that it was a mess!" while a NYC EM called it one "big stupid storm!" With Sandy came a gauntlet of storm surge, wind, flooding, tides, and other hazards that left EMs in complete shock. A county EM perfectly described Sandy, saying,

> "This thing is like nothing we've ever [seen]… this is going to bring almost a little bit of everything. You're going to have wind, and storm surge, high tides, back bay flooding; you're going to have thunderstorms embedded in there, you're going to have snow storms. This thing was like you couldn't fathom what this thing was going to bring! It was nature is just throwing everything at us! Here it comes! Here it comes! Tornadoes!"

Almost all the EMs interviewed were shocked by Sandy's magnitude and seemingly perfect combination of surge, winds, and tide. The same county EM later said that "somebody made Mother Nature… mad! I don't know why, but this is what she threw at us."

When discussing surge or wind, most participants coupled those characteristics with tides. EMs described the impacts from Sandy as a combination of surge, wind, and tides. It was this combination and the timing of events that made Sandy uniquely destructive. A NJ EM talked about "a 39 or 49 foot wave measured off of Sandy Hook," the result of the combination of an astronomical high tide and storm surge.

The largest surprise for the EMs interviewed seemed to be the bay side flooding that occurred. Typically, a storm will bring surge and flooding from the ocean side, not the back, bay or river side. An aspect that made Sandy unique was the combination of winds, surge, and tides that funneled water into the back bay and kept it there, allowing surge and subsequent high tides to

reach farther inland. A county EM voiced his shock stating, “the water is… just moving down the street and you’re going, ‘it’s not supposed to do that!’ You’re supposed to get storm surge from the ocean. We got it from the bay.” A deputy Mayor at the time said that “the water could never get out of our river and that’s what happened. The high tide kept compounding it and a full moon and everything kind of came together. But the tide could never get back out because the wind was pushing so hard.”

Due to the unique combination of wind, tides, and surge, the main issue arose when the second high tide occurred, since the wind kept the inflow from the first high tide in the back bays, allowing the second high tide to add onto it. An EM discussed this phenomenon stating,

> “You got to be careful about the timing and the windspeed, along with the tides. Because once the bay fills up, northwest wind, the bay will fill up at a high tide but it won’t deplete because the wind will keep the water there. The next high tide, 12 hours, that’s when we get in trouble.”

In general, most EMs were concerned about storm surge. In particular, one EM stated that “the main thing we’re worried about is the storm surge and the timing of the storm surge with our high tide cycles,” again demonstrating the combined power of surge and tide. In fact, most EMs interviewed said that the reason for the severe flooding was due to “the timing of it; full moon and the storm surge arriv[ing] at the peak of high tide.” The MIC interviewed also showed concern for surge, stating that “I felt like, if we were going to lose people, it was going to be because of the surge.”

The size of Sandy is yet another characteristic that influenced how EMs perceived the storm. The sheer size of Sandy was unlike most coastal storms. Adding high winds, astronomical high tides, and low central pressure resulted in an extremely large area being impacted. To give a perspective

of its size, according to one participant, Sandy "was bigger than the continent of Europe; it was affecting from as far down south as Virginia all the way to Maine."

Another unique characteristic of Sandy was the snow that fell during the nor'easter phase. None of the EMs interviewed expected snow. The "freezing cold… is one of those things that we never thought about before," said an NYC EM. "Like now we have nursing homes that were without power and freezing. It was pretty scary." Because it was unexpected, EMs did little to prepare for the cold, which was made even more miserable by the lack of power and supplies.

It was obvious throughout the interviews that the EMs did not expect Sandy to be as severe as it was. At the outset, it seemed "very mild," for a coastal storm. As it evolved, however, everything from the storm surge, the flooding, to "the ferocity of the waves" took EMs by surprise. It was especially difficult for them to envision that amount of water being dumped in their towns. Other words used to describe their reaction to Sandy include, "shock," "surprise," stunned", "never imagined," and morbidly, "that was all she wrote for us." Because Sandy was a surprise to most, especially its back bay flooding, this resulted in problems for many EMs. An EM said that "the problem was not the barrier island, the problem was actually on the main land, where we didn't prepare. We didn't anticipate that much water breaking through would come. That's what caused us the most problems." Many assumed that "nobody thinks they're going to get hit. It's like a tornado or warfare. It's always going to be the guy next to you that's going to get hit. I never imagined…"

An additional characteristic of Sandy that was unexpected by EMs was the speed at which the

water flowed in and out of the towns with the tides and surge. “It was like the water came on us and [just] as fast as it came on us, it went right back out. Like you filled the sink and pulled the cork. That’s how quick[ly] it went out.” Others compared it to past storms, stating “I think in the past… I have seen even pretty major flooding here; I never saw it that fast.” Another EM compared the speed at which his town incurred damage to that of fireworks,

> “When we really got the damage was in a short time because when the wind changed it started blowing from the east. When it blew from the east that’s when… like Francis Scott Key could’ve wrote the star spangled banner to it, there were transformers blowing up all over the place. When you look up in the sky, you thought there were fireworks. All the damage in our town happened I want to say within a half hour.”

A somewhat animated EM from a particularly badly hit town retold a story about the speed of the water. Not feeling well, he decided to go home and take a quick shower while his colleague stayed in the OEM building. When he went into his garage to check the water heater, he stepped into two feet of water. Nervous to break the news to his wife, he instead paced around the house contemplating what to do. Forty-five minutes later, he returned to the garage to not a single drop of water. He said with much conviction that he had “never seen anything like that.” (Fortunately for him, he did not feel the need to tell the truth to his wife).

Conversely, EMs in the NY and NJ areas expected more rain than they received. Many considered it a blessing, since “if we got the rain from Irene, if we had the rain that Irene had during Sandy, we would’ve been in a lot worse shape with flooding. But we didn’t get the rain that they expected.” The majority of EMs were far more concerned about the winds, tides, and surge, notably the timing of the tides and surge. Interestingly, the MIC interviewed did not receive the criticism that usually occurs when meteorologists miss their forecasts. He reasoned that the lack

of criticism could be "in part because everything else was so bad… they just kind of took it as a blessing that they weren't dealing with inland flooding as much as they had say with Irene."

With regard to communicating the severity of a hurricane to the public, the EMs in NYC do not believe that the Saffir Simpson scale is appropriate since the numerous characteristics of a storm besides wind speed influence surge height. In fact, they have actually "moved away from that" and started using zones that "are kind of a compilation of the bearing and the intensity of the storm." They considered Sandy to be an excellent example of why delineating a storm by its wind speed does not accurately represent its impacts. Due to their "geographic location on the coastline," they have to consider the angle at which the storm is approaching them; in Sandy's case, the almost 90 degree angle signaled a much higher surge than storms moving parallel to the coastline.

While evacuation zones are used in NYC to communicate areas at risk, a comparison to previous storms is also a helpful tool when communicating a storm's potential damage. A NJ EM described how using previous storms was beneficial:

> "Once it hit 11 feet, which was Saturday, that's when we went to everybody and said this is for real. We compared it to the 92 storm; there were so many people who were… here in 92 and they're still here, and they communicated with their neighbors 'well in 92 I had water in my house. If this is 2 feet more, my whole first floor is going to have water in it,' and they communicated that out."

In addition to comparing to previous storms, several EMs also discussed physically showing residents what a certain surge level looked like in their neighborhood, which helped personalize the risk.

> "We sometimes went out and marked telephone poles and trees and said to people this is 11 feet. So you understand what 11 feet is, this is 11 feet. And we had members of our team go into different neighborhoods and show them what that would be."

Interestingly, no EM interviewed mentioned the storm's pressure as a characteristic of storm surge. In reality, the pressure of a storm is a significant determinant of surge levels (Lee 2006). The focus of discussion was geared almost entirely towards the effects of high tide on surge (which is of course significant). One unusually weather savvy EM mentioned "our ears were popping" since the "barometric pressure was the lowest." The only other instance where pressure was discussed was in relation to Sandy's shift in track. This county EM discussed how he was told by meteorologists that the reason it shifted so far west towards NJ was partly because of the high pressure to the northeast. Even when hearing this, "there was still some doubt… there is just no [way], that's unheard of; no storm comes up and just makes a hard [left]."

5.1.3.2 Classification Uncertainty

A major influence on EM decision making was the uncertainty in how Sandy was classified. As one EM said, "there's still some debate even today, was it a hurricane was it not a hurricane? Did it have characteristics of a hurricane? Some. Did it have characteristics of a tropical storm? Some..." Behaving like a true hybrid storm, Sandy had characteristics from a variety of storm types. This made it difficult for EMs to communicate risk to their residents. An additional controversy was that, as Sandy came closer to the coast, forecasters were faced with the difficult decision of whether they should issue hurricane or tropical storm warnings. As discussed earlier, the decision was made to begin issuing tropical storm watches and warnings while it was still a hurricane, since the time of transition from hurricane to tropical storm would have been right before landfall; switching the warning type then could have spurred additional confusion. In fact, a forecaster in NJ viewed "it as a huge pothole we managed to not hit." For forecasters, the reasoning behind the change in storm type is understood. But to decision makers such as EMs,

there was confusion as to 1) why the classification type changed since it still had hurricane characteristics and 2) how to then communicate this change to the public. This confusion affected the evacuation decisions they made.

A prominent issue was how Sandy's classification altered how EMs planned and prepared for Sandy. A NYC EM said,

> "the hybrid nature of the storm, because it wasn't in essence a true hurricane, that definitely aided in confusion because for us it was a lot of how does this compare to what we've planned for and the modeling that we rely on that is true to a hurricane … There was a lot of confusion and the size of the storm, the movement of it…"

This EM and her colleagues in the NYC OEM office rely on guidelines and plans crafted specifically for varying storm types. The issue arose when Sandy became known as the "Superstorm" with characteristics from multiple storm types. They had no plans in place for a "Superstorm." The question then became, how do we tweak our plans to account for Sandy's unique dynamics? This question was raised at many EM meetings the week before landfall.

Other EMs perceived Sandy differently in that they planned for what Sandy was classified as at landfall, which was a tropical storm. Thinking of Sandy as a tropical storm, several EMs interpreted Sandy's potential severity as much lower than that of a hurricane. With this mindset, these EMs did not expect such severe impacts. A NJ EM stated, "we've been through storms before, and… when it came on land it wasn't even a category 1 storm, it was a tropical storm. Tropical storms here are street flooding, it doesn't do any damage to houses. But this tropical storm brought the storm surge with it." Thus, while the hybrid nature of the storm influenced its impacts, there were still several EMs who thought of Sandy as an entirely tropical storm.

Another concern EMs experienced with Sandy's classification was how to communicate the storm type and risks to their residents. One county EM mentioned that "if we say… hurricane, the normal homeowner or person visiting… they know, 'oh that's scary we got to get out of here…' They know what to do in a hurricane." He went on to say that "if you tell them well we have this Superstorm coming, what does that mean? What does that mean to the average person? They have no idea what to do." This EM believed there was confusion as to Sandy's classification at both the municipal and state levels. Thus, not only do EMs have to interpret the uncertainty themselves, they need to consider how their publics will understand the information since that is who they are serving.

Confusion aside, the overarching consensus among the EMs interviewed was that the focus should be on the impacts of an impending storm, not on its classification type when disseminating information to the publics.

> "I want to tell them what you're going to see, or what you can expect. I don't care if it's a tropical storm, if it's a hurricane, if it's a tornado, whatever. What's the impact? Me sitting in my living room, what is this thing going to do to me? Am I going to get flooded? Am I going to lose my roof, is my house going to blow over? We gave them the impacts and we told them here is what's going to happen. Here is the tide. Here is the storm surge. Here is what you are going to expect. Here is how long the water is going to lay in the street because it has no place to go, we gave impacts."

The large majority of EMs interviewed shared this opinion. One EM called it "semantics. It's really just semantics." He knew Sandy was going to have significant impacts and the category of it "really didn't matter." Another EM mentioned the insignificance of a name, stating, "how scared can you get from a name of somebody?.. People don't care about what name you're giving it." A NJ forecaster even stressed the importance of understanding impacts, saying "as long as you knew something dangerous is coming and you took protective action, I could care less what you call it."

Another NJ EM critiqued the Saffir-Simpson scale since "it doesn't take into effect the forward motion of the storm… it's just the wind speed." He also considered the location and speed of the storm as "it was right on top of us," allowing its storm surge and tidal influx to continually flow up river with limited backflow. It was important for him to consider not only the hurricane ranking, but also the additional characteristics that made Sandy so unique.

5.1.3.3 Timing of Storm

The days of the week as well as the time of year that Superstorm Sandy occurred also directly influenced EM decision-making. Since the crux of the decision making for Sandy fell on the weekend, EMs were tasked with difficult decisions with regard to casinos, tourists, and staffing. In Southern NJ, EMs had to consider the influx of visitors to the Atlantic City casinos and convention centers for events. They "have to give them the ability to get the conventions out of town, clear the casinos… and again that being on a weekend, you have visitors in town, so we were… hammering out and making these decisions that weekend."

Additionally, the fact that Sandy made landfall the day after a holiday weekend was problematic for some communities where forecasters and/or EMs were off from work. One NJ EM mentioned that as a major issue since it delayed decisions being made and actions taken. Another EM, however, mentioned the timing of Sandy with much less conviction stating,

> "On the 27th, there really wasn't much going on because it was a Saturday and we're not here on Saturdays but we still have access to our email. I don't know I don't remember and I don't think they had any kind of special meeting on Saturday since nobody was really here."

This EM primarily discussed the decision process prior to the weekend and post weekend on the day of landfall. She noted that minimal discussions took place during the weekend. This was not

the case in the majority of cases, however. Most EMs interviewed worked intently during the weekend, with most not leaving their office or the EOC.

The time of the year it occurred influenced EM decision making for two reasons. First, many EMS did not believe storms of that severity could happen so late, being "the last weekend in the season," according to one NJ EM. Second, there are not as many tourists visiting that late in the season. Although this may seem like an advantage, where the issue arises is that vacationers store their boats on land starting in the fall, which then ended up on the water as flooding began:

> "You have to evaluate the time of year, October 29th is not the height of the season, so we don't have all the summer... There are pros and cons to October 29th, a day that late in the season. One pro being our beach community is not as populated as normal. A pro being there are not as many boats in the water because we are a river front community and we have marinas all around us… The con of the boats not being in the water is most of them are stored on land, in an area that floods… they end up on water."

On a daily time scale, understanding when to order evacuations was challenging due to the various tide cycles. Several EMs discussed that the timing of the astronomical high tides during the onset of Sandy influenced how they made evacuation decisions. EMs paid close attention to tidal information since evacuations must be ordered while there is a break in the tides. This becomes a difficult task when this occurs overnight, or is only six hours long. One NJ EM mentioned that he "hate[s] to take people out of their bed at 2 or 3 o'clock in the morning," yet he has to do it because that is when there is a break in the tide cycle. Thus, not only are there seasonal influences when it comes to a landfalling storm, there are also daily considerations when issuing evacuation orders.

5.1.3.4 Weather Information

The source and type of weather information greatly influenced EM decision making in a number of positive and negative ways. In general, the EMs interviewed were mostly satisfied with NWS products and information before and during Sandy. There were several EMs, however, who voiced their opinions about how the NWS is lacking in terms of disseminating weather information. William Pollard once stated that "information is a source of learning. But unless it is organized, processed, and available to the right people in a format for decision making, it is a burden, not a benefit" (Thinkexist 2015). The information EMs received before an impending storm is vital for their decision making process, but this is true only when the information they receive is readily available and, perhaps more importantly, understandable to the EM.

First and foremost, the language used by the NWS and other weather enterprises proved to be too difficult and often times overwhelming to several EMs. This was even the case in the NYC EM office that has full time staff assigned to assessing weather models. One NYC EM voiced her concerns for the smaller towns in NY and NJ with only one EM, asking "how could the part time EM in that community or municipality understand it?" The same EM thought the messaging was confusing during Sandy especially with regard to the severity of the impacts they should expect. She made note that, "we are not meteorologists" and thus should not be assumed to understand the language used by meteorologists. An additional complication is that "everyone uses different lingo," resulting in an added level of confusion when taking into consideration storm surge data, tidal factors, and datums. Several EMs in smaller communities voiced similar concerns, suggesting that the information needs to be simplified in future storms.

Language aside, another complication in terms of weather information is that storm surge and flooding information was disseminated too late by the NHC. A NJ EM stated,

> "[the NHC] got it out to us like the night before the storm. It was too late. They got it out to us on Sunday… we [were] already… under tropical storm force conditions, 30 mph. You can't evacuate! You can't issue an evacuation order that late! I mean you can try. So we don't depend on any of these. If you depend on like the government agencies, they're just going to let you [down]."

He later states that "surge forecasts… [need] to be a couple days away for it to be meaningful." Another EM discussed the issue of storm surge accuracy 72 hours before landfall. The critical time for EMs is about 72 hours; however, the storm surge information at that time is not always accurate, which affects the decision making process. More specifically, this EM stated,

> "72 hours projected flooding levels they projected it would be in the 9 foot range. When it got to 48 hours out, they were talking more like 11 foot surge. When it got to 24 hours, they were talking surges of 13-15 feet. So as you can see, making a decision at 72 hours based on 9 foot surge is much different than making a decision based on a 14 foot surge at 24 hours out… The majority of the town at 9 feet we will get significant flooding… but not life threatening flooding… At 12 feet now it's life threatening flooding. So it's a big difference those 3 feet..."

A NYC EM agreed, saying "that's the hardest thing with all of this is you're making the decisions when the confidence is a lot lower because you're farther out."

Thus, the language used by the NWS and NHC and late surge information resulted in information that was neither available nor in the right format needed to make critical decisions. It is because of these complications that many EMs went to non-NWS sources as either their first source of information or as a way to verify NWS information. For example, several EMs mentioned that their first source of information was actually a former meteorologist who had transitioned to the EM field and now worked in the EM office. Those EMs who had these in-office sources of information considered these sources the most valuable due to the convenience and trust EMs have

in their colleagues. In these cases, the colleagues who have meteorology training were able to sit down with the EM and explain, in lay terms, the meaning of weather products and potential consequences for specific decisions. The information was provided "in a format for decision making," as Pollard said.

5.1.4 Ordering Evacuations

The factors discussed in the previous sections have in some way influenced how EMs made evacuation decisions during Sandy. In Sandy's case, all EMs interviewed came to the conclusion that an evacuation must be ordered. Once that decision was made, EMs were then tasked with the decision of *when* to order the evacuations. The EMs interviewed tended to take two routes when it came to issuing evacuation orders. The first route consisted of verifying impending weather by direct observations, such as rising water levels in town, while the second route consisted of being influenced by one of three "accelerating factors," including gut feelings and the tone of forecasters, the visual shift in track, and the issuance of the personal plea by a lead forecaster in NJ. These "accelerating factors" are discussed in more detail below.

It is significant to distinguish the temporal differences between the two routes. While no actual numerical time information was gathered during the interviews (i.e. the exact time decisions were made and actions taken), it cannot be said with certainty that the accelerated route led to quicker evacuation orders. This model is not dependent on time and is not a temporal representation of EM behavior. Taking the accelerated route did not necessarily lead to a quicker evacuation order than when taking the verification route. Rather, the accelerating factors led to a rapid transition between decision and action, regardless of how late this transition occurred. For example, one of the

accelerating factors, the visualization of Sandy's track turning left, did not necessarily spur earlier evacuation orders in the days leading up to Sandy. Instead, the visualization accelerated the action of evacuating even if that action was taken very late in the week. It is also important to note that while some participants clearly followed one route over the other, the majority of participants followed a combination of both routes. These EMs were influenced by any one of the "accelerating factors" but also verified information by direct observation.

5.1.4.1 First Route: Verification and Observation

The majority of EMs interviewed observed varying water levels throughout Sandy's evolution, influencing when they ordered evacuations. A NJ EM in a particularly badly hit area said that he ordered a voluntary evacuation in between the tide cycles, when the water levels would be at the lowest. Once the first high tide (after Sandy made the left turn) began to recede, he and his colleague ordered the evacuation before the onset of high water levels with the next high tide. This same EM understood the severity of Sandy as well from observing his surroundings. He stated, "when we knew that it was going to be that the water had not gone out, and I still had water in the street… four or five hours to go before high tide. Now you know that's going to be a problem. See? So at that point, that's when we started moving people. Out!" Furthermore, many EMs verified information they received from other sources via observation.

5.1.4.2 Second Route: Influenced by Accelerating Factors

Aside from verifying and observing surrounding water levels, many EMs interviewed were influenced by three factors unique to Superstorm Sandy, which played a vital part in when they

ordered evacuations. These “accelerating factors” include gut feelings and the tone of forecasters, the visual left turn in Sandy’s track, and the personal plea disseminated by a lead forecaster.

5.1.4.2.1 EMs Gut Feelings and Forecasters Tone

The gut feelings of the EMs interviewed played a surprisingly large role in how and when they made evacuation decisions. Seemingly methodical and systematic on the surface, EMs are human too in that they listened to what their gut was telling them and acted on those feelings. Aside from listening to their own gut feelings, several EMs, including a county EM, showed interest in knowing the gut feelings of the forecasters, which helped determine how the EMs felt. In one case, an EM directly asked a forecaster to tell him his gut feelings about the storm. Others associated gut feelings with weather knowledge, with one assistant EM saying, “I think it’s a gut thing. Listening to [the EM coordinator], he is very versed in weather.” This EM coordinator spoke very adamantly of Sandy’s potential damage, which heavily influenced the assistant EM’s feelings of the storm. Another EM voiced a similar opinion stating, “when [the forecasters] started getting concerned, I started getting concerned.”

The tone of the NWS forecasters proved to also be very influential. Several EMs talked about their relationship with the NWS and the fact that they know the forecasters in their local office. During Sandy, forecasters spoke with a tone unrecognized by the EMs. One county EM said, “the tone, the demeanor if you will, between the EM offices and the NWS. We knew something bad, that this was it, this one, that we’ve always worried about.” When another EM was asked why he suddenly become worried about Sandy three days before landfall, he replied, “the tone of the

weather forecasters." One EM in particular shared a very vivid story of the conversation between a NWS forecaster and his EM office:

> "…The mayor and I took a conference call with Governor Christy's office… just kind of a peptalk. This is maybe 4 o'clock in the afternoon on that Monday, and wished everybody the best, prayers. And then he put on a guy from the NWS... And the guy said I will never forget, he said 'folks I don't know how else to say this so I'm just going to say it, the worst case scenario is unfolding right on top of us.' So at that point they knew it had made the hook and the timing of it was it's coming in at high tide, at an astronomical high tide, it really can't get any worse than what's about the hit us. So it was sort of a rude awakening."

EMs like the one who stated the above quote discussed how the tone in which forecasters were providing information was one that they had never witnessed in previous storms. The concern of the forecasters directly influenced their perceptions of the storm and with that, the decisions they made with regard to evacuation.

5.1.4.2.2 Visual Shift in Track

Sandy's track was forecasted to shift left several days before the shift was observed in real time, which occurred primarily on the Saturday before landfall. For the majority of the EMs interviewed, the actual observation that Sandy was turning left into the coast was a critical factor in when they issued evacuation orders. A NJ EM monitored the information and waited until the track began to shift before taking action. More specifically, he said, "the first time that it jogged itself to the left, we ordered… a voluntary evacuation." He later went on the say, "once it made the left, then we knew we were going to have a problem, a bad problem." In order to ensure that this participant did in fact wait until it began turning left to issue an evacuation, the interviewer briefly discussed that it was forecasted to shift throughout the week, to which the EM added, "we waited until we saw it actually make the hook. Once it started to make that hook, that's when we started our evacuation process. And then once it was clearly hooked, that's when we went into a mandatory evacuation."

The reasons for why EMs waited to verify the left turn before issuing evacuations are two-fold: 1) EMs tended to verify information they received during Sandy, and 2) it is extremely rare that storms tracked west to the coast at that latitude, as discussed in an earlier section. It is important to note that although waiting for the observed left turn before ordering an evacuation is considered a type of verification (similar to the first route), this factor is included in the "accelerated" route because once Sandy made the left turn, EM actions were accelerated. This factor accelerated the process of ordering an evacuation, even if this process was started relatively late; this model is not time dependent.

5.1.4.2.3 Personal Plea

On Sunday October 28th, one day before landfall, a lead forecaster included a personal plea in the briefing package provided to EMs. In this message, he urged the public to take Sandy seriously and heed all warnings (Figure 5.2). The forecaster decided to include this personal message for two reasons. First, it seemed to him that although evacuations were being issued on Saturday, there were "some signs of kind of a sluggish response on the part of some conversations with EMs," and "a stickiness in terms of people leaving." Although he attributed some of this response to Hurricane Irene, he believed that including such a blunt and serious statement would induce more willingness to evacuate. Second, as discussed earlier, this forecaster was disappointed in how certain politicians were handling the situation: "And the other thing I was really pissed off [about], pardon my language, at mayor Bloomberg in NYC. He really made a bad decision on that Saturday, and I was afraid he fuzzing the message up." Due to NYC's influential media, this forecaster felt the need to counter Bloomberg's poor response using the personal plea. He believes the best way "to

freeze people" is to "give them conflicting information." He hoped the personal plea would illuminate the true impacts Sandy will incur along the coast, despite poor political decisions.

This addition to the daily briefing package was discussed in over half of the interviews. Those who brought it up in conversation believed that it played a major part in when they ordered evacuations. A county EM stated, "when he put that in there to please please heed the warning, I'll tell you what, that's all it took for us. That was enough… we all knew that this is going to tear us apart." This EM partly attributed this reaction to the fact that he knows the NWS forecasters on a personal level, and "[they] know what [they're] doing, and I value and I give him all the credit. We trust those guys and so when that comes out… you damn well better listen to what he's saying."

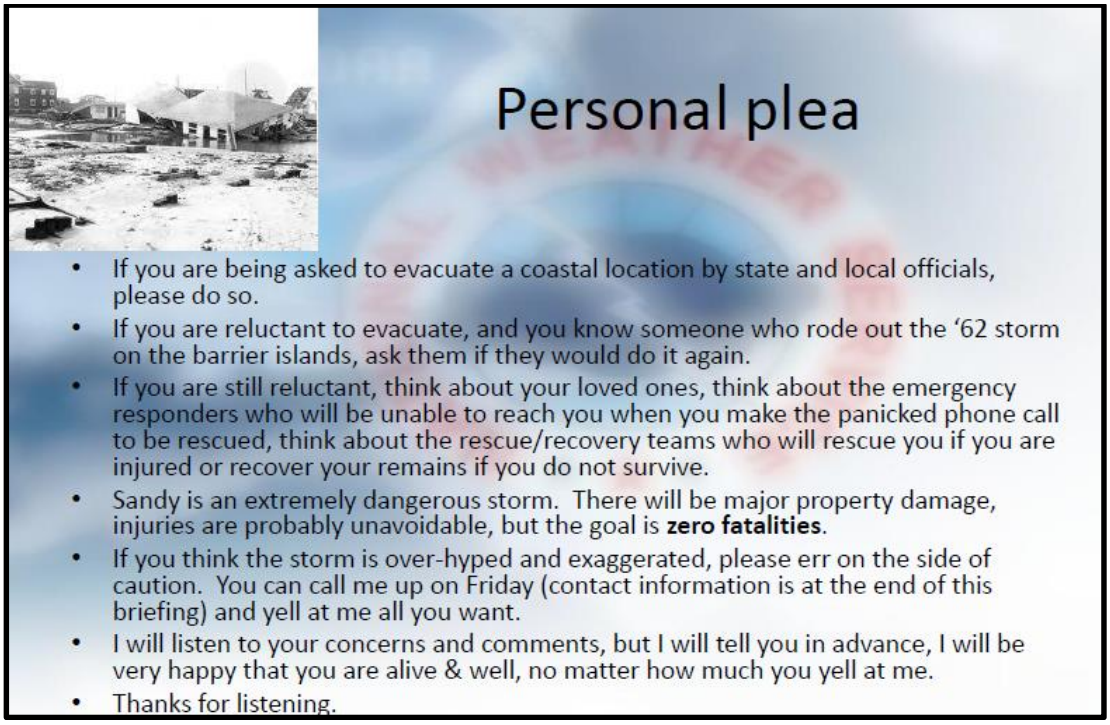

Figure 5.2. Personal plea included in briefing package on Sunday, October 28th.

The same EM believed that had that personal plea not been included, Sandy's impact would have been much more severe:

> "And I'll tell you, that in itself probably engaged more people in emergency management who probably were like 'meh,' that did it, 180 degrees. That changed their minds and it ramped up… I'm gonna tell ya, if it wasn't for him putting that in there, you'd have had a lot of people downplaying this and it would've gotten worse. It would've been a whole lot worse than it was, no question. I'll retire, I'll go to my grave and that's the God's honest truth, you would've had a lot more people downplay this and we would've had a lot more serious injury and death had he not put that in there."

This EM later discussed the moment when the forecaster read his personal plea on a conference call with county and municipal EMs. He recalled,

> "You got shivers… you had 21 counties on there, there was probably like 60-70 people on that conference call. You could've heard a pin drop in anybody's office on that conference line; it was just dead silence because that was it that set the tone. And we knew this is going to be bad, this ain't nothing like Irene, this is going to be bad."

Clearly, the inclusion of this personal plea drastically influenced EM decision making regarding evacuations. EMs who experienced this personal plea, along with the visual confirmation of Sandy's left turn, the tone of forecasters, and EMs gut feelings about the storm, tended to be more adamant and confident in their evacuation decisions.

5.1.5 Summary of Decision Making Model

The EMs who were interviewed perceived and responded to Superstorm Sandy in a multitude of ways; each EM has a unique decision making process and is influenced in different ways by different factors. This seemingly obvious yet significant finding was proven by dissecting the various factors that influenced EMs during Sandy (Figure 5.1). The decision to order an evacuation was influenced by factors regarding the municipality itself, such as location and size, factors regarding the individual EM, such as their experience with storms and relationships with other entities, as well as factors of the storm itself, such as its characteristics, inherent uncertainty, and storm timing (i.e. onset of high tide). The level of influence each of these categories has on EMs

differs, with some EMs being influenced more by their experience than by the weather information received, for example.

After the decision was made that ordering an evacuation was necessary during Sandy, the EMs were faced with additional influences that in some cases accelerated the action of ordering an evacuation. In other words, these accelerating factors, including the personal plea, tone in forecaster's voices and EMs gut feelings, and visual observation of the shift in track, acted as confirmation that Sandy was in fact going to be a severe storm and led to rapid evacuation orders being issued. It is important to note that exact minute-to-minute details of the event were not collected, and thus it cannot be said with certainty that evacuation orders were issued sooner for EMs who were influenced by one or more of these accelerating factors compared to those who were not influenced by these factors. Instead, these accelerating factors merely quickened the action of evacuating regardless of when this action was taking place. This significant distinction is evident in the factor of visualizing the track shift left. Although this factor elicited immediate response, this response was late, and thus in this case there was a greater amount of time between decision and action regardless of the influence.

The decision making model created from the interviews is not meant to describe each EM's decision making process, as some EMs might not be influenced by all the factors included. Rather, it is a holistic and comprehensive model of factors that influenced any or all of the EMs interviewed in this study. This reiterates the point that each EM is different and each dealt with a unique set of influences during Sandy. Similarly, this model is mostly unique to Superstorm Sandy;

EMs who experience storms in the future may be influenced by a different set of factors, particularly the accelerating factors, or a different combination.

5.2 EM Focus Group

Supplementary data was collected during a focus group comprised of approximately ten EMs employed during Superstorm Sandy in Ocean or Monmouth Counties, NJ (Carr and Montz 2015). The primary goal of this focus group was to assess EM understanding of current NWS products, most notably the briefing package, and gather recommendations from the respondents on how to make the products more useful in the future. The findings from this focus group supplement and verify the findings of the first objective of this project. More specifically, it helps to answer the first two research questions: Q1) what kinds of weather information sources did EMs use? and Q2) what factors were most important to them regarding weather information sources?

With regard to Q1, the briefing packages were found to be extremely important and used by the large majority of participants (86%). All those who rated briefing packages in the surveys conducted after the focus groups rated them as either valuable or highly valuable. Additionally, most EMs relied primarily on briefing packages as a type of weather information and identified them as a necessity during future storms.

Other sources used by EMs included the Internet and smartphone apps, with 100% of participating EMs using each of these sources during Sandy. A majority of participating EMs also relied on television and radio (86%). When compared to the focus groups conducted with public residents,

EMs were found to be more likely to use the internet and much more likely to use smartphone apps than were residents. The reliance on television and radio was similar between the two groups.

Within the focus groups, a total of nine different NWS products was discussed (products listed in legend of Figure 5.3). All EMs were familiar with the NHC Hurricane Cone and rated it as either valuable or highly valuable. The primary reasoning for use of the cone was the inclusion of the 66% uncertainty range; focusing in on the area of highest potential for impact is significant to EMs. Surge information was also valued by EMs, with 80% being aware of the surge forecast. Figure 5.3 illustrates the percentage of respondents using the cone and surge products, as well as the additional seven NWS products. Surge information, precipitation information, and the cone were used primarily early in the week, while temperature information and the briefing from a forecast office were used primarily later in the week (after T-5 and T-4 respectively).

With respect to Q2, EMs voiced the need for clear and easy to understand information. A major issue noted by EMs in the focus group was that NWS forecast and warning tools were too confusing and technical in both content and presentation. This finding aligns with what EMs interviewed in this study mentioned. Third, EMs stressed on several occasions during the focus group the importance of localized information compared to national information. Many of the maps and products offer more national scales, and participating EMs voiced a need for more local, regional assessments. One EM said, “localize, localize, localize.” This parallels the interview findings in that EMs wanted impact information specific to their communities.

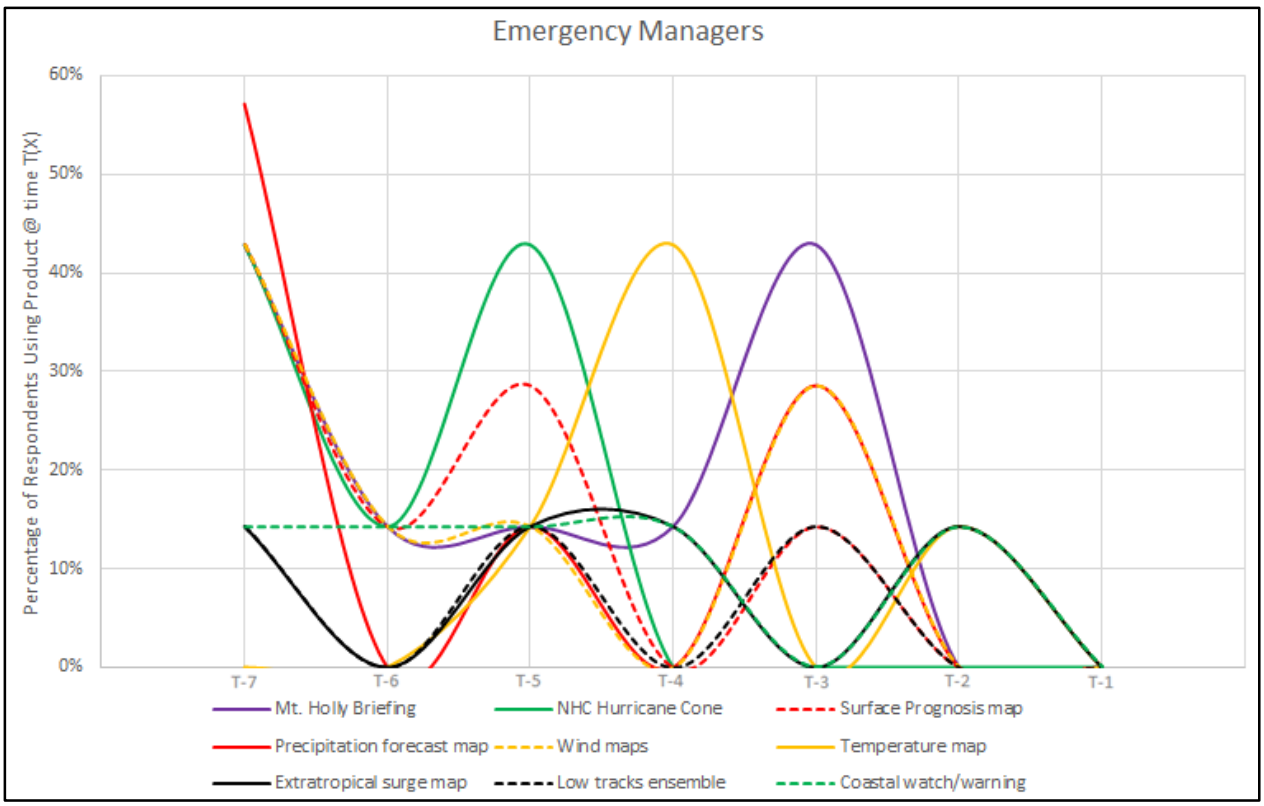

Figure 5.3. Percentage of emergency personnel using each NWS product leading up to Sandy's landfall (Carr and Montz 2015).

Lastly, the personal plea included in the briefing package was discussed in great detail during the focus groups, just as it was in many of the interviews. The personal plea was found to be a significant motivator for EMs in the focus groups. Others stated with certainty that the personal plea elicited the most concern about Sandy's potential impacts, claiming that the inclusion of the plea saved lives. Similar to the interviews, EMs in the focus groups related the tone used in the personal plea to the seriousness of Sandy. Going a step further, the participants in the focus groups suggested including more forecaster's notes in future NWS products in order for them to assess the tone of the forecasters, which ultimately influences how they perceive the storm and make preparations.

CHAPTER 6: POLITICIAN ROLE IN EVACUATION PROCESS

6.1 How Politician Role Differs from EM Role

Within the evacuation process, both EMs and politicians play significant roles. However, these roles tend to differ tremendously. With regard to the timeline of decisions made and actions taken (Figure 6.1), politicians were found to respond and behave differently than EMs leading up to and during Sandy. They received first notice about an impending storm much later than EMs, typically one week before landfall whereas EMs generally were aware of a potential storm up to two weeks before landfall. Throughout that week, the politicians interviewed mentioned monitoring the storm via various sources such as the internet and TV, but did not place emphasis on this behavior, contrasting with EM behavior that involved heavy monitoring. Politicians' "oh no" moments also shifted to later in the week, starting around Saturday, a day or so after EMs began becoming concerned about Sandy's potential impacts.

Arguably the most significant difference between the two groups in terms of what they did was in how they spent their days leading up to Sandy. Whereas EMs were constantly in the field or in conference calls, politicians held day jobs completely different from their role in community leadership. For example, one Mayor interviewed was the owner of a bed and breakfast and tended to his property and his customers during the day. This Mayor sat in on meetings and conference calls when he could, but his full-time job was a priority that limited his availability. Even though several of the EMs interviewed also held other jobs, during Sandy they tended to take off work completely or partly in order to fulfill their duties as EMs. Aside from employment, the politicians interviewed also discussed their concern for their own properties during Sandy, and mentioned

that they traveled to their various properties (i.e. a vacation home) in the few days leading up to Sandy to prepare for impacts. The EMs interviewed almost never discussed their personal needs.

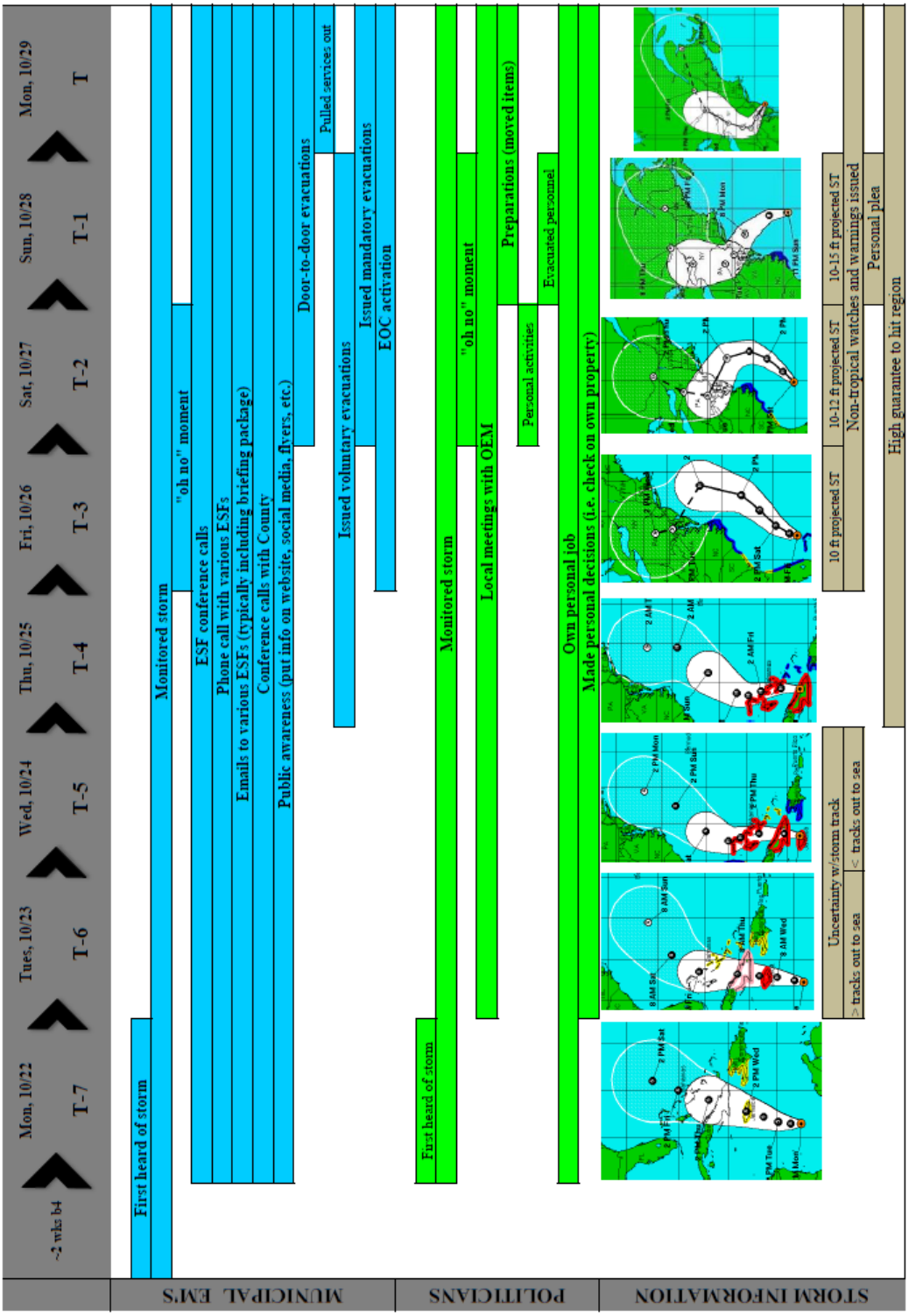

Figure 6.1. Timeline of decisions made and actions taken by municipal EMs and politicians during Superstorm Sandy along with an illustration of Sandy's track.

Additionally, politicians' day to day lives leading up to Sandy did not seem to come to a halt as quickly as it did for EMs. For example, a Deputy Mayor at the time went to a party on Saturday night, a critical time for evacuation decision making and preparedness. After leaving the party that night, he helped other officials in preparing the community for high water levels by strapping down items that could float in water and therefore damage structures. Not one EM interviewed mentioned any other personal event and focused entirely on his/her EM duties.

This is not to say that these politicians did not care about their residents. In fact, the politicians interviewed stressed that their main concern was the safety of their community. These politicians held a great deal of trust in their municipal EMs and had confidence that the decisions EMs made were for the best of the community. Instead, the main role of politicians was to be the face of the community and provide assistance during Sandy. For example, one Mayor of a small NJ community told her EM coordinator that she wanted to make the announcement to the public with Sandy information instead of the EM coordinator in order to "put out a personal touch." She felt as though the message coming from her would lead to more prompt responses by the public since she is their leader and they look to her for guidance. Another couple of mayors "were very good about getting out in the community and talking to people and pointing them to resources and letting them feel like there was some assistance coming to help." They needed to be the face of the EM services, insuring the community that actions are being taken and that safety is their top priority.

Another way in which politicians differed from EMs is in how they communicated with other town officials leading up to Sandy. While EMs tended to have strong relationships with EMs in other communities and communicated frequently, the mayors interviewed voiced concern over the lack

of communication between mayors of neighboring towns (Figure 6.2). One Mayor in particular discussed at great length the issue with the lack of lateral communication among elected officials. He believed that conversations should flow laterally as well as through the "food chain," which is how he refers to the natural hierarchy of communication (i.e. federal, state, municipal, etc.). He stated that because mayors lack communication among each other, inconsistent messages were being disseminated to the publics that only added to the confusion. He said, "we all need to be saying the same message [so we] don't have conflicting messages." He added that EMs understand each other's needs, but the same is not true for neighboring mayors, whom he refers to as "the talking heads." He wished that neighboring mayors had the same relationship as do mayors and EMs in the same community.

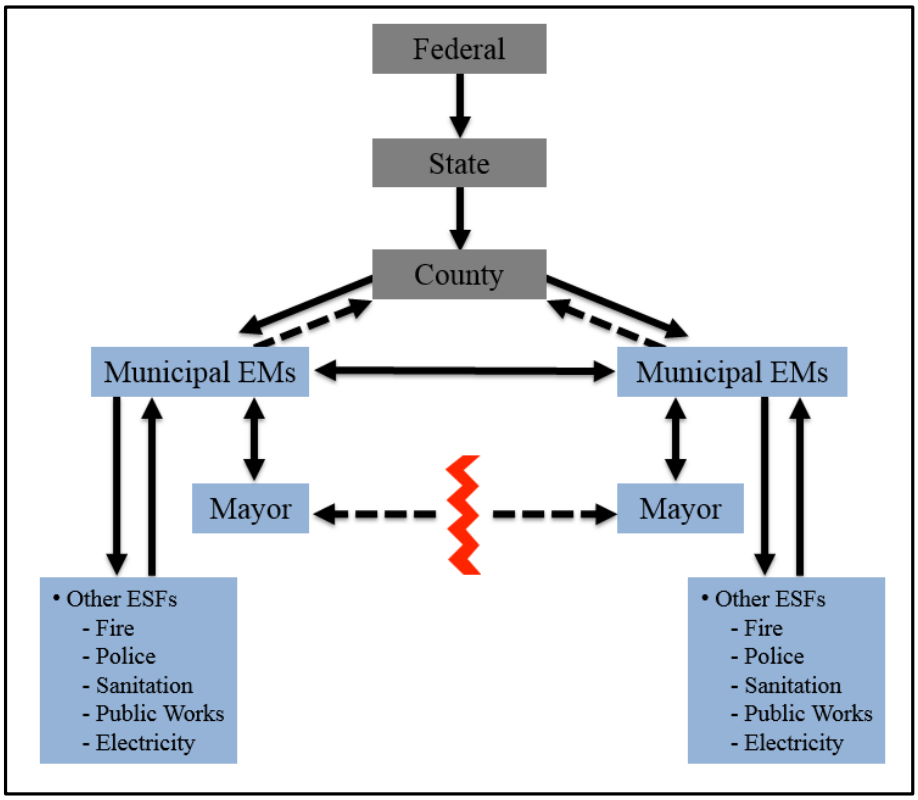

Figure 6.2. Chain of communication among various EM levels, other ESFs, and politicians. Solid lines indicate active communication while the dashed lines indicate minimal communication. Red break represents lack of communication between Mayors.

An aspect of the evacuation process that was not hypothesized was how the politicians interviewed perceived issuing evacuation orders. In communities where EMs were required to sign evacuation orders, EMs signed them with confidence and little worry. Conversely, one Mayor interviewed discussed how challenging it was for him to sign the order, calling it "one of the hardest documents [he's] ever signed." In his perspective,

> "You spend your life trying to protect people, trying to protect their property, trying to protect where they are, and now suddenly you're telling them they have to leave. And you almost feel like you're betraying them by telling them they have to get out of the way, they have to move… you're signing this thing and it's against everything that you work for."

He agreed that EMs do not think this way and that he never thought he would until he was "signing something that tells people [to] leave your property," your home. This perspective differs tremendously from that of EMs, who better understand the necessity of leaving a home.

6.2 Politician Statements in Newspapers Prior to Sandy's Landfall

Due to the limited number of politicians interviewed, it was important to gather politician statements via additional means in order to gain a more holistic understanding of how they perceived and responded to Sandy. To do this, articles from two newspapers published between Oct. 27th and Oct. 29th that focused on Sandy were analyzed. The large majority of news articles focused on the response by the general public, providing shelter, sports postponement, and store closure information. Of the seventy-four articles published by the two newspapers during the critical time period (Oct. 27- Oct. 29), only twenty-seven included political official response and statements.

In general, the timeline of actions taken by political officials included in the articles did not compare with that of the politicians interviewed. It is hypothesized by the researcher that this is

due to the fact that the politicians in the articles tended to be more well-known, such as Mayors Bloomberg and Langford of NYC and Atlantic City, respectively, and Governor Christie, while those interviewed were a Mayor and Deputy Mayor of a small NJ town. Thus, although the findings from the articles cannot verify the findings from the interviews, they provide additional insight into factors influencing decision making.

The main difference was that the politicians cited in the articles were in their jobs full-time, unlike the mayors interviewed who took on their leadership roles as a part-time responsibility. Possibly because of this, politicians mentioned in the articles were more active in terms of communicating with other officials, asking for resources, making preparations, and ordering evacuations. The politicians in the articles led and/or participated in conference calls throughout the days leading up to Sandy's landfall. In fact, of the twenty-seven articles mentioning politicians, six of them included information on important conference calls or meetings with neighboring communities, EMs, and other leaders including President Obama.

The articles also seemed to emphasize how these politicians were not shy to ask for resources from the federal level. This is something that was not discussed at all by the Mayors in the smaller communities, who relied heavily on the EMs to ask for resources. Governor Christie, for example, had conference calls with President Obama, discussing the situation and ensuring needed resources. Additionally, the articles stressed the preparations the politicians were taking, which was not discussed by the Mayors interviewed. Governor Christie stated the importance, "from the state level on down, to prepare in advance of this serious storm" (Stirling, 2012). On Friday evening, he "announced that water levels at four northern NJ reservoirs would be lowered and

floodgates would be opened at Lake Hopatcong and Pompton Lake in an effort to mitigate flooding" (Stirling, 2012), and "ordered municipal officials to ensure that crews were removing leaves and other debris from storm drains" (Mueller, 2012).

Another prominent topic in the news articles was evacuation information. Of the twenty-seven articles, ten mentioned evacuation orders issued by various politicians. Unlike the mayors interviewed who relied predominately on the EMs to recommend evacuations, these politicians were responsible for ordering evacuations. On Saturday, Governor Christie declared a pre-emptive state of emergency. He also ordered a mandatory evacuation of most barrier islands south of Sandy Hook by 4 pm Sunday. Furthermore, the politicians in the articles announced evacuation information to the public, often using blunt and direct language, while the mayors interviewed tended to rely on EMs to disseminate information to the public. One particularly infamous quote is that of Governor Christie on the day of landfall, "Don't be stupid. Get out," (Breed and Peltz, 2012). That same day he continued by stating "I think all our mothers taught us, if you can avoid it, don't be stupid" (Nutt and Stirling, 2012). He also was cited saying on Sunday, "How 'bout we go by this rule? Anything that looks stupid is stupid. If you think you're being overly clever but you know it looks really stupid, don't do it. That's a good general New Jersey rule" (Mueller, 2012). Other politicians, such as Mayor Bloomberg, tried to personalize the information to reach more of the public saying, "If you don't evacuate, you are not only endangering your life, you are also endangering the lives of the first responders who are going in to rescue you. This is a serious and dangerous storm" (Breed and Peltz, 2012).

One significant similarity among all politicians, both those cited in newspapers and by those

interviewed, is their concern that Hurricane Irene the year before was biasing public perception of Sandy's potential impacts. This could be a reason for Governor Christie's tendency to be blunt in his statements to the public.

> "Governor Christie told residents Saturday that they should not underestimate Sandy's power. 'I know we get cynical about this stuff, but we can't afford to be,' he said at a news conference Saturday afternoon in North Wildwood. Christie said last year's evacuation for Irene was justified despite the storm not ending up nearly as bad as predicted. 'I don't think it's too big of an inconvenience to try and save your life,' Christie said" (Landau, 2012).

The impacts that Irene was having on the public during Sandy was also a concern for the politicians in smaller communities, as discussed earlier.

Interestingly, as evident by statements of higher-up politicians in the two newspapers, it is clear that these politicians compared more closely to EMs than to politicians in smaller towns. These more well-known politicians, as well as EMs, all communicated constantly leading up to Sandy, ordered evacuations, took preparations, and disseminated information to the public. The politicians in smaller communities tended to take more of a back seat and let their local EMs take the lead.

CHAPTER 7: CONCLUSIONS

7.1 Summary of Problem and Study Objectives

The effects of hurricanes are felt by a wide variety of people, including the general public, EMs, and public officials. In the face of a coastal storm, EMs and officials with leadership roles make varying decisions regarding evacuation based on a multitude of factors, such as the information they receive, uncertainty inherent in the information, and previous experience/knowledge. These factors, among many others, affect their perceptions of the risks associated with the hazard and ultimately how they respond to that hazard (Tobin and Montz, 1997). One of the many challenges, however, lies in the fact that individuals perceive risk differently according to cognitive and situational factors, which results in a variety of actions taken (or not taken) (Tobin and Montz, 1997). Varying levels of education, employment levels within the organization, and political constraints are a few examples of factors that can significantly shape how an individual or EM responds to an impending event. This uniqueness of individual perceptions and responses makes researching decision making especially difficult. Yet, understanding the process of decision making by those individuals with leadership roles, a population studied far less than the general public, is crucial in order to better prepare and mitigate for future extreme events as well as to keep the public as prepared as possible during disasters. This research sought to better understand how EMs and politicians made critical decisions regarding storm evacuation during Superstorm Sandy.

This research consisted of five objectives: 1) to determine the weather information sources EMs used; 2) to determine the chain of communication among EMs, politicians, and the NWS; 3) to determine the situational and cognitive factors influencing decisions; 4) to determine how the uncertainty and changing weather information influenced EM perceptions of risk and their

decision making; and 5) to determine the relationships between and roles of EMs and politicians during Superstorm Sandy. Although it is impossible to generalize how decisions on evacuations were made during Sandy, a number of significant findings emerged from the interviews, a focus group, and a newspaper analysis. These findings are objective-specific and are summarized below within each of the study's five specific objectives. These significant conclusions help to accomplish the study's main research question: how did EMs make decisions about evacuations during Superstorm Sandy?

7.2 Empirical Findings

7.2.1 Objective 1: Weather Information Sources

The majority of EMs first heard about Sandy about one to two weeks prior to landfall. The sources that indicated a potential storm occurring in the Atlantic were *pushed* to these EMs; in other words, these sources were not actively sought out by the EMs. These pushed sources include the TV, social media, fellow EMs, county and state partners (typically via email), and a meteorologist now working in the OEM office. After EMs were made aware of the impending storm, they *pulled* sources, or sought them out, to help them make critical decisions. These pulled sources include the NWS and NHC websites and private weather organizations, to name a few. Overall, the most used sources of information were the NWS and NHC websites, weather briefings disseminated by county/state partners and/or the NWS, the TV, and local landmarks as visual guides. Using landmarks as a source of information is particularly significant since it illustrates that EMs do not rely entirely on weather information to make decisions. In terms of information that they are receiving (both pushed and pulled information), direct observations of their surroundings proved to significantly influence decisions. This need for localized information was also found in Losego

et al. (2012b, p. 4), where the researchers concluded that EMs wanted "point of reference forecast" information in order to "have a benchmark to work from." EMs are knowledgeable of what areas of their community flood, during various storms; local observations and forecasts are crucial components of EM decision making.

Participants voiced concern about the lack of easily understandable weather products, both in the interviews and in the EM focus group, as well as the reality that storm surge information comes too late. At 72 hours before landfall, EMs had already made critical evacuation decisions. With surge data becoming available after this time, this information proved useless. This was also found in Losego et al. (2012a), where the researchers concluded that surge information tended not to be used in operational decisions because of its late availability. Another significant conclusion in terms of weather information is that EMs want to understand the impacts; they are less concerned with specific wind speed or precipitation amounts. EMs manage risk (Losego et al. 2012b), and understanding the potential impacts allows them to accomplish that.

7.2.2 Objective 2: Communication

Communication with various individuals and agencies was critical starting when the EMs found out about Sandy until after landfall. Participating EMs held conference calls, made phone calls, sent emails, and communicated via radio. EMs in the field relied heavily upon cell phones and radios. Emails were considered a top communication method among EMs. EMs communicated mainly with other ESFs within their community, such as fire and police chiefs, public sanitation officers, and electrical technicians, as well as neighboring ESFs to coordinate efforts. Discussions were lively, comprehensive, and two-way; all ESFs had a spot at the table and were welcomed to

comment and ask questions freely. Communication between the county and municipal levels on the other hand was primarily one-way. Conversations were generally initiated by the county EMs and information passed down to the municipal EMs and other ESFs; little information flowed upwards to the higher levels, a problem because of the need to allocate resources both pre and post event.

7.2.3 Objective 3: Situational and Cognitive Factors Influencing Decisions

A significant conclusion from this study is the realization that there is a whole host of factors that influenced the EM decision making process during Superstorm Sandy besides simply receiving weather information. In this study, the researcher consolidated these factors and created a holistic decision making model for EMs during this specific storm. The response model by Tobin and Montz (1997) and the model of situation awareness by Endsley (1995) were the theoretical frameworks used to create this model of decision making specific to EMs. This model clearly showcases the complexity involved in decision making, even when considering that other decision making concepts and tools were not incorporated into the study, such as economic utility models (Tversky et al. 1990), preference and choice weighting (Tversky et al. 1988), and affect heuristics (Slovic et al. 2007), making it even more complicated. From the research frameworks and themes discovered from the interviews, three main categories of influencing factors were found: municipal, individual, and storm factors.

Municipal factors include the location, size, socio-economics, and natural disaster plans of the community. The majority of EMs understood that their location in relation to that of the storm did not act in their favor; many participants discussed that the northeast side of the storm endured the

most severe impacts. There also tended to be a large locational divide in NJ in terms of collaboration and resources: those in North Jersey were more likely to fend for themselves and receive ample resources, while those in South Jersey, where resources were harder to come by, collaborated with neighboring and county EMs more willingly. It is hypothesized by both the EMs interviewed and the researcher that this is due to their location relative to NYC. With regard to town size, EMs in smaller towns had stronger emotional ties to their community and its residents. Interestingly, the large majority of EMs interviewed, at least those not in NYC, did not discuss any plans they had in place (if any). Of those who did, they emphasized that they are simply guidelines meant to be tweaked during an event.

Individual factors include personal and professional experience, and knowledge of the individual EM, relationships of the EM with neighboring and county EMs, and a concept of maintaining balance. Most EMs worked in their towns for some time and were familiar with the areas that flood. Some felt so familiar and knowledgeable that they knew if a storm was coming by simply "sniffing" the air. The majority of EMs used known landmarks throughout town as well as benchmark storms (typically Hurricane Irene of 2011 and the 1992 nor'easter) to communicate the severity of Sandy to the public. In this sense, their familiarity with their towns was a tremendous benefit. In another sense, having experienced Hurricane Irene in the year before proved to be a detriment. Since Irene's forecast busted, according to some, many found it difficult to believe that Sandy would not follow suit. The impacts of Irene on decision making during Sandy was also discussed frequently in the newspaper articles. Another drawback to experience, or in this case, lack thereof, was that many felt inadequately prepared to handle Sandy given their limited experience with storms in the past. These results compare to those from numerous other studies

where experience has been found to play a vital role in perception and decision making (Mileti and Sorenson 1990; Nigg 1993; Dash and Gladwin 2007).

EM relationships with other individuals and agencies varied tremendously. There tended to be a strong relationship between neighboring EMs, with much collaboration and combined efforts taken. The same was not true for EM relationships with county EMs. Several reasons for this were discussed, including a lack of understanding of municipal EM needs on the part of the county EMs, confusion over the type of evacuation ordered, with county EMs and municipal EMs issuing different orders in some cases, and because municipal EMs did not receive adequate resources from their superiors. Concerning EM relationships with politicians, town size mattered significantly. In smaller towns, relationships with local politicians were strong and politicians held a great deal of trust in their EMs. In NYC, by contrast, EMs did not have a strong relationship with their politicians.

The concept of maintaining balance comes in a variety of forms. EMs needed to balance the risks of evacuating with the risks of not evacuating. Issues of injury and the "Cry Wolf Syndrome" played vital parts in this balance dilemma. Additionally, EMs were faced with the difficult decision of knowing when and how many resources could be allocated. Spending too much during Sandy's immediate aftermath would lead to limited funds in the next year, when a storm with similar impacts could occur. Lastly, EMs, and especially politicians, were tasked with balancing their personal and professional lives. Politicians seemed to prioritize their personal lives more highly than did EMs (at least in NJ).

Storm factors include Sandy's storm characteristics, classification uncertainty, and its timing both in terms of occurring during astronomical high tide and occurring during the weekend with busy casinos, festivals, and vacationers. Sandy's characteristics absolutely shocked all EMs interviewed. Its magnitude and unique combination of tides, surge, and winds left EMs in complete awe. A particular surprise was the bay side flooding that occurred during Sandy, for which many were not prepared. Due to the combination of various characteristics, beyond wind, that storms can have, EMs in NYC moved away from the Saffir Simpson scale prior to Sandy since it does not accurately depict storms impacts. This was discussed in depth during the interviews since Sandy proved to be a perfect example of how characteristics other than wind can lead to destruction.

The uncertainty in its classification type made it difficult to both communicate the risk to residents and make critical decisions since there were no plans in place for "Superstorms." EMs seemed to agree though that they were more concerned with how the public would respond to the confusing classification, not how they understand it. Regardless of whether or not EMs understood exactly what Sandy was when, they primarily wanted to know what the impacts would be. Like others have found, EMs manage risk (Losego et al. 2012b). Impacts dictate risks.

Once the decision was made that an evacuation was necessary, the EMs interviewed tended to take one of three routes before actually ordering the evacuation. They either waited until they had visual confirmation (i.e. flooding of certain streets in their community), were influenced by any of three "accelerating factors" (EMs believing storm was going to be bad based on their gut feelings and tone in forecasters voice, visual shift in track, and the personal plea issued by a MIC), or a combination of the verification and accelerating routes. A significant conclusion is the recognition

that there was a myriad of factors completely specific to Sandy that influenced when they issued evacuation orders. This aids in proving the point that the evacuation decision making process is not streamlined across all EMs, across all regions, and across all storms. Each event is unique, as is how each EM processes the information, whether that data is pushed onto them or pulled by them.

7.2.4 Objective 4: Integrating the Physical and Social Components

In order to fully understand how EMs made decisions during Sandy, it was vital to not only assess when and why they did what they did, but also to compare the timing of their decisions and actions to the storm's evolution. It is this integration that allows for a complete picture including understanding how forecasted weather information and storm uncertainty in track and magnitude influenced decision making. EMs used both the forecasted storm information and actual observations throughout the event for various tasks. They relied on forecasted information when communicating Sandy's potential risk to the public by comparing Sandy's forecasted surge level and other components to those of benchmark storms like Irene or the 1992 nor'easter. When it came to making decisions about evacuation, however, they relied more heavily on actual observations. For example, one major determining factor in their issuing an evacuation order was when the storm track shifted left in real time. This shift was forecasted days earlier, but it was the visual confirmation that led to their decisions to evacuate. Additionally, it is interesting to note that regardless of weather information available, EMs seemed to be more influenced by other factors, external to the NWS, such as their experiences with past storms and knowledge of their towns. It is hypothesized that had this storm occurred in an area that receives more hurricanes, the

decision making process would have depended more on forecasted information and less on visual confirmation since the notion of disbelief would be out of the picture.

7.2.5 Objective 5: The Role of Politicians in Evacuations

The extent of politician involvement in evacuation decisions depended largely on location and size of the town. Politicians of smaller towns in NJ relied heavily on their EMs and fully trusted their decisions. EMs tended to make critical decisions without their politicians. Politicians in turn agreed with their decisions and signed any necessary evacuation orders. Politicians of larger cities, like NYC, however acted more independently of their EMs. NYC EMs made recommendations to their Mayor that were not always considered; the Mayor made the final evacuation decision and signed the evacuation order. EMs in NYC disagreed with the Mayor's decision in not evacuating the Saturday before landfall and voiced their concern over the disconnect and lack of trust between them and their Mayor. Since only EMs in larger cities like NYC were interviewed and not politicians, the researcher relied on numerous political statements in newspaper articles to provide the politician perspective. These statements provided additional evidence to help prove the hypothesis that there is a substantial difference in political involvement depending on location and town size.

The original research hypothesis that perceptions and decisions of EMs and politicians with regard to evacuation are different could be partially confirmed. It was hypothesized that EMs would be constrained politically in having the power to order evacuations. Although in many cases the Mayor signed the evacuation orders, the EMs were the ones who actually recommended issuing these orders. In NJ at least, the EMs made all decisions and the politicians simply agreed without

hesitation. In larger cities, the EMs were constrained politically and the Mayor made all decisions. Thus, this "break" between perceptions and decisions is more permeable than originally hypothesized. The hypothesis on politicians, on the other hand, was found to be entirely confirmed. It was hypothesized that politicians had full power to issue an evacuation order, but that there were barriers in how politicians perceived the event. In NJ in particular, this was shown to be true in that politicians took a back seat and relied on how EMs perceived the event.

7.3 Limitations and Considerations for Future Work

While the findings of this research are plentiful and substantially add to the current body of literature, there are several limitations to this work that need to be noted. First, the date of Sandy, having occurred over a year and a half before the interviews, may have impacted the participants' memories of the event. Although it has been found that events with tragic impacts such as Sandy allow for retention of the information over long time periods (Cappelletto 2003), there may still have been some memory loss. Future studies should aim to conduct interviews as soon after the event as possible.

Second, the sample size used was relatively small. This sample size was acceptable for this study since its aim was to understand how a small subset of EMs made decisions during a specific storm. In order to generalize EM decision making more broadly, further research would need to include a larger sample size that is geographically diverse as well as consider additional hazard types. Using a case study in this research was a convenient and useful first step in contributing to the literature on EM decision making. It is hopeful that this work will initiate further research on this unique group of decision makers.

Third, in order to gain a more robust and thorough understanding of the communication and relationships between the various sectors of the weather enterprise, notably EMs and politicians, future studies would need to include a larger sample of politicians. Although various methods were used to offset the small politician sample size, such as conducting an analysis of articles in two newspapers, this research was limited in data on perceptions of politicians. Fully understanding the entire weather spectrum and each component's role should be the focus of future research within the field of social science and meteorology. This study is a prominent first step to understanding that process.

7.4 Contributions

This research adds significant information to the "end-to-end-to-end" process discussed by Morss et al. (2005), where tool developers, the publics, and decision makers all play significant roles in the weather enterprise. Understanding what only one "end" needs in terms of weather information or how one "end" makes decisions is not enough. It is vital that all groups, including decision makers such as EMs, are included in this process when researching what influences evacuation decisions.

A major contribution of this study is the addition of a holistic decision making model focused specifically on EMs. The Situation Awareness Model by Endsley (1995) and the Hazard Response Model by Tobin and Montz (1997) were used as frameworks for creating this model on EM decision making. Several key themes from these models were incorporated and adapted to appropriately represent the EM decision making process. One way in which this model differs from others in the literature is that it is multifaceted. It illustrates the factors influencing not only

decisions, but also the factors that determine how and when those decisions are acted upon. In natural hazard events, there are always unanticipated issues or factors that arise that influence EM actions. As seen with Sandy, a myriad of factors influenced a final evacuation decision. This decision was then influenced by a variety of unforeseen factors unique to Superstorm Sandy before the action of ordering an evacuation occurred. The inclusion of this multi-step process from perception to decision to action as well as its focus on EMs, a group far less studied than the general public, makes this model unique in hazards literature.

In addition, this model provides a framework for reassessing and rethinking earlier models. The findings from this research challenge what others have found, notably Tobin and Montz (1997), whose model on hazards response may not be entirely appropriate for the EM and politician communities (Figure 2.10). The researcher found various "breaks" within their model, revealing that perhaps the impacts of factors on response is not as streamlined as they make it out to be. Thus, this work not only complements and supplements existing research in the hazards field, but it also challenges it and sets boundaries that were unknown before this work.

Futhermore, this model is significant because it is not static; rather, it is dynamic and applicable to other decision making groups and future events. The participants in this study were particularly experienced, most having worked in the emergency services for over a decade. These communities should expect a transition in personnel in the near future that will set this decision making process and model back in motion. Most EMs are not provided training and tend to learn as they go. These new EMs will have to make decisions under duress with less experience and knowledge to lean on than their predecessors. This model sets up a framework under which future decisions can be

evaluated. Regardless of the population or storm type, this model will always be applicable and a useful assessment tool for understanding official decision making.

This study also provided significant results that need to be considered by forecasters and tool developers when creating new weather products and disseminating weather alerts and advisories. A particularly significant take-away message from this study that would benefit the forecasting community is the recognition that EMs are not trained meteorologists. Rather, many EMs are often local residents who take on the role of EM as an additional responsibility. A primary determining factor found in this study for EMs to begin to take evacuation measures was actually visualizing the track shift to the left, even though it was forecasted to do this several days prior. In this case, actual weather information was not the prominent influence, rather, innate human behavior and prior experience led to delayed EM action. Additionally, EMs would greatly benefit from the modification of weather information products that are easier to understand, more localized, and incorporate surge data earlier in the forecast. It is important that the NWS and other related government agencies keep these points in mind as they continue to improve risk communication.

Beyond the field of forecasting, this study also has practical applications for both the EMs who participated in this study as well as other EMs who can learn from these participants' experiences. Many participating EMs now are more familiar with the information available to them during storms, which will help tremendously when making critical decisions in the future.

REFERENCES

Abramson, D. M., & Redlener, I. E. (2013). Hurricane Sandy: lessons learned, again. *Disaster Medicine and Public Health Preparedness, 6*(4), 328-329.

Bernard, R. H. (2002*). Research Methods in Anthropology: Qualitative and Quantitative Approaches.* Walnut Creek, CA: Altamira Press.

Biernacki, P., & Waldorf, D. (1981). Snowball sampling: Problems and techniques of chain referral sampling. *Sociological Methods & Research,* 10(2), 141-163.

Blake, E. S., Kimberlain, T. B., Berg, R. J., Cangialosi, J. P., & Beven, J. L. II. (2013). *Tropical Cyclone Report Hurricane Sandy*. National Hurricane Center. Retrieved from http://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf.

Breed, A. G. & Peltz, J. (2012, Oct 29). Hurricane Sandy/Northeast braces for damage. *The Press of Atlantic City*, p. A1.

Call, D. A. & Coleman, J. S. M. (2014). The decision process behind inclement- weather school closings: A case-study in Maryland, USA. *Meteorological Application, 21(3),* 474-480.

Cappelletto, F. (2003). Long term memory of extreme events: From autobiography to history. *Journal of the Royal Anthropological Institute, 9(2),* 241-260.

Carr, R. H. & Montz, B. (2015). They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts. *Coastal Storm Awareness Program (CSAP) Final Progress Report Form.* Retrieved from http://njseagrant.org/wp-content/uploads/2015/05/CSAP-Report-NNC-They-Had-the-Facts-Why-Didnt-They-Act-FINAL-1.pdf.

Colle, Brian A., Buonaiuto F., Bowman M. J., Wilson R. E., Flood R., Hunter R., Mintz A. & Hill, D. (2008). New York City's vulnerability to coastal flooding. *Bulletin of the American Meteorological Society, 89(6),* 829–841.

Corbin, J. & Strauss, A. (2015). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Los Angeles: Sage Publications.

Daiute, C., & Lightfoot, C. (2003). *Narrative Analysis: Studying the Development of Individuals in Society*. Los Angeles: Sage Publications.

Dash, N., & Gladwin, H. (2007). Evacuation decision making and behavioral responses: Individual and household. *Natural Hazards Review, 8,* 69-77.

Dash, N. (2002). *Decision-making under Extreme Uncertainty: Rethinking Hazard Related Perceptions and Action*." Unpublished Ph.D. dissertation, Department of Sociology, Florida International University, North Miami, Fla.

Demuth, J. L., Morss, R. E., Morrow, B. H., & Lazo, J. K. (2012). Creation and communication of hurricane risk information. *Bulletin of the American Meteorological Society, 93(8),* 1133-1145.

Dolan, R., & Davis, R. E. (1993). Nor'easters. *American Scientist, 81(5),* 428-439.

Dolan, R., & Davis, R. E. (1994). Coastal storm hazards. *Journal of Coastal Research, 12,* 103-144.

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors, 37(1),* 32-64.

FEMA (2008). *National Response Framework.* Retrieved from http://www.fema.gov/national-response-framework.

Fritz, H. M., Blount, C., Sokoloski, R., Singleton, J., Fuggle, A., McAdoo, B. G., Moore, A., Grass, C., & Tate, B. (2007). Hurricane Katrina storm surge distribution and field observations on the Mississippi Barrier Islands. *Estuarine, Coastal and Shelf Science, 74(1),* 12-20.

Gladwin, H., Willoughby, H. E., Lazo, J. K., Morrow, B. H., & Peacock, W. G. (2009). Social science research needs for the hurricane forecast and warning system. *American Meteorological Society, 90,* 25-29.

Hoekstra, S., Nichols, A., & Gruntfest, E. (2014). How K-12 school district and university officials anticipated and responded to 2011 National Weather Service tornado warnings. *International Journal of Mass Emergencies and Disasters, 32(2),* 353-374.

Hunt, H. & Varner, C. J. (2012). United States: Hurricane Sandy and refusing to evacuation: Criminal law and civil liability. *Mondaq: Connecting Knowledge and People.* Retrieved from http://www.mondaq.com/unitedstates/x/206028/Public+Order/Hurricane+Sandy+and+Refusing+to+Evacuate+Criminal+Law+and+Civil+Liability.

Jones, S. C., Harr, P. A., Abraham, J., Bosart, L. F., Bowyer, P. J., Evans, J. L., Hanley, D. L., Hanstrum, B. N., Hart, R. E., Lalaurette, F., Sinclair, M. R., Smith, R. K., & Thorncroft, C. (2003). The extratropical transition of tropical cyclones: Forecast challenges, current understanding, and future directions. *Weather Forecasting, 18,* 1052–1092.

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist, 58(9),* 697-720.

Kaplan, S., & Kaplan, R. (2003). Health, supportive environments, and the reasonable person model. *American Journal of Public Health, 93*(9), 1484–1489.

Landau, J. (2012, Oct 28). Hurricane Sandy/ Casinos, islands close for storm/ past storms no indicator, Christie says. *The Press of Atlantic City*, p. A1.

Lazo, J. K., Morss R. E., & Demuth J. L. (2009). 300 billion served: Sources, perceptions, uses, and values of weather forecasts. *Bulletin of the American Meteorological Society, 90(6),* 785-798.

League, C., Philips, B., & Bass, E. J. (2012). Tornado warning communication and emergency manager decision making. *Weather and Society Watch, 6,* 10-12.

Lee, T. L. (2006). Neural network prediction of a storm surge. *Ocean Engineering, 33(3-4),* 483-494.

Leech, B.L. (2002). Asking questions: Techniques for semistructured interviews. *PS: Political Science and Politics, 35(4),* 665-668.

Legates, D. R. & Biddle, M. D. (1999). *Warning Response and Risk Behavior in the Oak Grove- Birmingham, Alabama, Tornado of 08 April 1998*. Quick Response Report #116. Boulder, CO: Natural Hazards Research Applications and Information Center.

Lindell, M. K. & Perry, R.W. (2004). *Communicating Environmental Risk in Multiethnic Communities.* Thousand Oaks, CA: Sage Publications.

Losego, J.L., Galluppi, K.J., Montz, B.E., Smith, C. F., & Schotz, S. (2012a). Weather for emergency management: Implications for NWS tropical weather products and services. Seventh Symposium on Policy and Socio-Economic Research, New Orleans, LA, American Meteorological Society. Retrieved from https://ams.confex.com/ams/94Annual/webprogram/Paper234352.html.

Losego, J.L., Galluppi, K.J., & Montz, B.E. (2012b). Improving risk characterization for NWS decision support for emergency managers. *Weather and Society Watch, 6,* 13-15.

Lussenden, H. Emergency managers and social media: Case study of Superstorm Sandy. *Forthcoming*.

McNoldy, B. (2012). Hurricane Sandy becomes stronger and larger than expected. *Capital Weather Gang.* Retrieved from http://www.washingtonpost.com/blogs/capital-weather-gang/post/hurricane-sandy-becomes-stronger-and-larger-than-expected/2012/10/25/59172f10-1eb2-11e2-9cd5-b55c38388962_blog.html.

Mileti, D. S., & Sorenson J. H. (1988). Planning and implementing warning systems, in Lystad, M. (Ed.*), Mental Health Response to Mass Emergencies*. New York: Brunner/Mazel.

Mileti, D. S., & Sorenson J. H. (1990). Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. *Oak Ridge National Laboratory,* U.S. Department of Energy. Retrieved from http://www.cires.org.mx/docs_info/CIRES_003.pdf.

Montz, B. E., Galluppi, K. J., Losego, J. L. & Smith, C. F. (2014). Winter weather decision-making: North Carolina school closures, 2010–2011. *Meteorological Applications, 22(3),* 323-333.

Morris, M.W., Leung, K., Ames, D., & Lickel, B. (1999). Views from inside and outside: Integrating emic and etic insights about culture and justice judgment. *Academy of Management Review, 24(4),* 781-796.

Morss, R. E., Wilhelmi, O. V., Downton, M. W., & Grunfest, E. (2005). Flood risk, uncertainty, and scientific, information for decision making. *Bulletin of American Meteorological Society, 96,* 1593-1601.

Mueller, M. (2012, Oct 28). Jersey scurries as Sandy closes in- Residents gearing up to settle in or move out. *The Star-Ledger,* p. 001.

National Hurricane Center (2013a). *NHC Data Archive*. Retrieved from http://www.nhc.noaa.gov/pastall.shtml.

National Hurricane Center (2013b). *Tropical Cyclone Climatology*. Retrieved from http://www.nhc.noaa.gov/climo/.

National Oceanic and Atmospheric Administration (2008). *The Perfect Storm October 1991*. National Climatic Data Center. Retrieved from http://www.ncdc.noaa.gov/oa/satellite/satelliteseye/cyclones/pfctstorm91/pfctstorm.html

New York City Office of Emergency Management. (2015). *NYC Hazards: Hurricane Evacuation.* Retrieved from www.nyc.gov/html/oem/html/hazards/storms_hurricaneevac.shtml.

New York Executive Law § 24(1)(b). Homeland Security and Emergency Services, Office of Emergency Management.

New York Executive Law § 24(5). Homeland Security and Emergency Services, Office of Emergency Management.

New York Penal Law § 70.15(2). New York State Law. Retrieved from www.ypdcrime.com/penal.law/article70.htm#p70.15.com.

Nigg, J. M. (1993). Risk Communication and Warning Systems. *Proc., Int. Conf. on Natural Risk and Civil Protection,* Commission of European Communities, 209-236.

Nutt, A. E. & Stirling, S. (2012, Oct 29). State forecast: A catastrophe- N.J. battens down, braces for devastating flooding. *The Star-Ledger*, p. 001.

Parker, D.J. & Handmer, J.W. (1998). The role of unofficial flood warning systems. *Journal of Contingencies and Crisis Management, 6(1),* 45-60.

PBS & J (2000*). Hurricane Floyd Assessment- Review of Hurricane Evacuation Studies Utilization and Information Dissemination*. Tallahassee, FL: Post, Buckly, Schuh and Jernigan, Inc

Perry, R. (1979). Evacuation decision-making in natural disasters. *Mass Emergencies, 4*, 25–38.

Pike, K. L. (1954). Language in Relation to a Unified Theory of the Structure of Human Behavior. Glendale, CA: Summer Institute of Linguistics.

Riley, R. (2012). An assessment of the climate information needs of Oklahoma decision makers. *Weather and Society Watch, 6,* 16-17.

Robertson, P., Bunting, W., Haydu, K., Brown, V., Faul, M., Green, M. Girasek, D., Feyen, J., Brown, J., & Medlin, J. (2013). *Hurricane/Post-Tropical Cyclone Sandy, October 22-29, 2012. Service Assessment,* National Oceanic and Atmospheric Administration. Retrieved from http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf.

Simon, H. A. (1957). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization.* New York: The Macmillan Company.

Simon, H. A. (1987). Bounded rationality. *The New Palgrave: A Dictionary of Economics*. London: Macmillan. Pp. 15-18.

Sink, S. A. (1995). Determining the public's understanding of precipitation forecasts: Results of a survey. *National Weather Digest, 19(3),* 9-15.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352.

Sorensen, J. H. (1991). When shall we leave? Factors affecting the timing of evacuation departures. *International Journal of Mass Emergencies and Disasters, 9(2),* 153 165.

Sorenson, J. H. (2000). Hazard warning systems: Review of 20 years of progress. *Natural Hazards Review, 1(2),* 119-125.

Spradley, J. P. (1979). *The Ethnographic Interview.* New York: Holt, Rinehard and Winston.

Stein, R. M., Duenas-Osorio, Leonardo, Buzcu-Guven, B., Subramanian, D., & Kahle, D. (2011). How risk perceptions influence evacuations from hurricanes. James A. Baker III Institute for Public Policy, Rice University. Retrieved from http://bakerinstitute.org/files/724/.

Stein, R. M., Duenas-Osorio, L. & Subramanian, D. (2010). Who evacuates when hurricanes approach? The role of risk, information, and location. *Social Science Quarterly, 90(3),* 816-834.

Stewart, S. R. (2013). Atlantic hurricanes 2012: Northeastern United States devastated by Sandy. *Weatherwise, 66(3),* 28-39.

Stirling, S. (2012, Oct 27). Eye of the storm focused on N.J.- State prepares for wind damage, power outages. *The Star-Ledger,* p. 001.

Sweet, W. V., & Zervas, C. (2011). Cool-season sea level anomalies and storm surges along the U.S. East Coast: Climatology and comparison with the 2009/10 El Nino. *Monthly Weather Review, 139,* 2290-2299.

Thinkexist (2015). *William Pollard Quotes*. Retrieved from http://thinkexist.com/quotation/information_is_a_source_of_learning-but_unless_it/226524.html.

Tobin, G. A., & Montz B. E. (1997). *Natural Hazards: Explanation and Integration.* New York: The Guilford Press.

Tunstall, S. M. (1990). The flood warning system and flood events of January and February 1990 in Maidenhead and other locations within the western area of the NRA Thames Region. Flood Hazard Research Centre, Middlesex University, Enfield.

Tutino, G. (2012). Battered New York and downtown residents brace or approaching nor'easter on the heels of Hurricane Sandy. *Downtown*. Retrieved from http://downtownmagazinenyc.com/battered-new-york-and-downtown-residents-brace-for-approaching-noreaster-on-the-heels-of-hurricane-sandy/.

Tversky, A., Sattath, S., & Slovic, P. (1988). Contingent weighting in judgment and choice. *Psychological Review*, *95*(3), 371.

Tversky, A., Slovic, P., & Kahneman, D. (1990). The causes of preference reversal. *The American Economic Review*, *80,* 204-217.

Urbina, E. & Wolshon, B. (2003). National review of hurricane evacuation plan and policies: a comparison and contrast of state practices. *Transportation Research Part A, 37,* 257-275.

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.

Zielinski, G.A. (2002). A classification scheme for winter storms in the eastern and central United States with an emphasis on nor'easters. *Bulletin of the American Meteorological Society, 83*, 37-51.

APPENDIX A: IRB APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Continuing Review Approval: Expedited

From: Social/Behavioral IRB
To: Stephanie Hoekstra
CC:
Burrell Montz Covey
Date: 1/27/2015
Re: CR00002580
UMCIRB 14-000210
Decision Making During Superstorm Sandy

The continuing review of your expedited study was approved. Approval of the study and any consent form(s) is for the period of 1/27/2015 to 1/26/2016. This research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Document	Description
Consent for Presentation(0.01)	Consent Forms
Consent.doc(0.02)	Consent Forms
Email and Phone Scripts(0.01)	Recruitment Documents/Scripts
Hoekstra_Proposal.docx(0.01)	Study Protocol or Grant Application
Interview Questions(0.01)	Interview/Focus Group Scripts/Questions

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX B: IRB CONSENT FORM

Study ID:UMCIRB 14-000210 Date Approved: 3/3/2014 Expiration Date: 3/2/2015

Dear Participant,

I am a Stephanie Hoekstra at East Carolina University in the Coastal Resources Management department. I am asking you to take part in my research study entitled, **"To order an evacuation or not: Influences on public official decision making during Superstorm Sandy".**

The purpose of this research is to understand what and who influences your decisions made during Superstorm Sandy. By doing this research, I hope to learn what impacts decision making from an official's perspective. Your participation is voluntary.

You are being invited to take part in this research because you are an Emergency Manager, NWS employee, or political official. You are being asked to participate in a semi-structured interview regarding the decisions you made and information you used during Superstorm Sandy.
The amount of time it will take you to complete this study is approximately 2 hours.

Because this research is overseen by the ECU Institutional Review Board, some of its members or staff may need to review my research data. However, the information you provide will not be linked to you in any way. Your identity will be evident to those individuals who see this information. However, I will take precautions to ensure that anyone not authorized to see your identity will not be given access. **Signing below provides your consent to participate and be audio recorded to assist with accurate recording of participant responses.**

If you have questions about your rights as someone taking part in research, you may call the UMCIRB Office at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of UMCIRB Office, at 252-744-1971.

Thank you for taking the time to participate in my research.

Sincerely,

Stephanie Hoekstra, Principal Investigator

Signature _____ **Date** _____

____ **I consent to being quoted directly.**
____ **I do not consent to being quoted directly.**

APPENDIX C: RECRUITMENT SCRIPTS

Email Script
Dear _____,

My name is Stephanie Hoekstra and I am a PhD student at East Carolina University in the Coastal Resources Management department. I am asking you to take part in my dissertation research entitled, "To order an evacuation or not: Influences on public official decision making during Superstorm Sandy". The purpose of this research is to understand what and who influenced the decisions you made during Superstorm Sandy. By doing this research, I hope to learn what impacts decision making from an official's perspective.

You are being invited to take part in this research because you are an [Emergency Manager, NWS employee, or political official]. You are being asked to participate in a semi-structured interview regarding the decisions you made and information you used during Superstorm Sandy. The amount of time it will take you to complete this study is approximately 2 hours.

Please let me know if you have any questions about the scope of my dissertation. If you agree to participate, I will provide you with a consent form detailing the information about my study prior to the interview. The interviews would take place in person at a location of your choosing. I would love to hear about your experiences! Thank you for your time and consideration. I greatly appreciate it!

Sincerely,
Stephanie Hoekstra, Principal Investigator

Phone Script
Hello _____,

My name is Stephanie Hoekstra and I am a PhD student at East Carolina University in the Coastal Resources Management department. My dissertation is on what influences decisions made by officials during Superstorm Sandy regarding evacuation. The purpose of this research is to understand what and who influenced the decisions you made during this storm. By doing this research, I hope to learn what impacts decision making from an official's perspective.

I am asking you in particular to take part in this research because you are an [Emergency Manager, NWS employee, or political official]. If you agree, you will be asked to participate in a semi-structured interview regarding the decisions you made and information you used during Superstorm Sandy. The amount of time it will take you to complete this study will be no more than 2 hours.

Is this something you would be interested in participating in? I am more than willing to answer any questions you have. If you agree to participate, I will provide you with a consent form detailing the information about my study prior to the interview. The interviews would take place in person at a location of your choosing. Thank you!

APPENDIX D: INTERVIEW CODES

Communication
- BEMA
- Communication with Politicians
- Conference Calls
- EOC
- In Person Communication
- Lateral Communication
- Avenues for Communication
- Communication with county EMs

Complications
- Pre- and during Sandy
- Post-Sandy

Roles
- EMs
- Politicians

Evacuations
- Communication
- Factors
- Who evacuates

Factors
- Balance
- Characteristics
- Classification
- Experience
- Location
- Personality
- Personal Plea
- Relationships
- Timing
- Tone/Gut
- Turning Point

Hierarchy

Lessons Learned

Perceptions

Planning and Preparedness

Everything Post Sandy

Sources

Timeline

Location
- North Jersey
- South Jersey
- NYC

Positions

- county EM
- Forecaster
- Municipal EM
- Politician

APPENDIX E: NEWSPAPER ARTICLE CODES

Closings
Conferences/Meetings
Hurricane Irene
Preparation
Shelters/Evacuation
Statements