FUTURE FLOOD RISK PERCEPTIONS FOLLOWING HURRICANE MATTHEW: A STUDY OF EASTERN NORTH CAROLINIANS

by

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Floods are one of the most dangerous weather-related hazard events in the world. A flood event can develop quickly and cause catastrophic damage to life and property. Residents adequately preparing for floods can help protect life and property during flood events, but not everyone prepares. This lack of preparation could be caused by many factors, but prior research has pointed to risk perception as a key factor in preparing for flood events. Past experiences with floods could also influence an individual's risk perception and motivation to prepare for future floods. Previous research has shown that perception of risk, prior experience with flooding, and resultant actions are related, but research on these relationships has not been widely undertaken in rural regions like Eastern North Carolina.

This study examines factors affecting flood risk perceptions following Hurricane Matthew and how those perceptions impact future flood preparations. In order to examine these relationships, a survey of 103 Eastern North Carolina residents was undertaken. Analyses of these relationships show that prior experience with flooding is related to risk perceptions, concern for flooding, and future preparations. Additionally, respondents believe that the sources of information that they used to prepare for Hurricane Matthew were generally reliable, but also

provided some suggestions about forecast accuracy and updated road closure information for future flood events.

It is the hope that this research will better inform Eastern North Carolina meteorologists and emergency managers of their residents' needs, and motivate them to make necessary adjustments to better protect life and property for future flood events.

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CHAPTER 1: INTRODUCTION

Eastern North Carolina has experienced a number of extreme flood events in the last two decades, with two in particular causing massive damage throughout the region. Hurricane Floyd occurred in 1999 and caused nearly every river basin in Eastern North Carolina to exceed the 500-year flood stage (National Weather Service, 1999). The Tar River led to the most extreme flooding during Hurricane Floyd with the river cresting at 29.7 feet – the highest crest on the Tar River to date (National Weather Service, 1999). As a result, Rocky Mount, Princeville and Greenville experienced very heavy flooding along the Tar River. The Neuse River also had significant flooding during Hurricane Floyd. The memories from Hurricane Floyd were brought back to life in October 2016 when Hurricane Matthew formed and was forecast to hit Eastern North Carolina as a category one hurricane. Torrential rain fell across the region on October 8 and 9, resulting in massive amounts of flash flooding across the state; however, this was just the beginning. The water-swollen rivers in Eastern North Carolina began to rise shortly after Hurricane Matthew passed through the region, and residents began to prepare for one of the most extreme flooding events in North Carolina's history.

Record flooding did indeed occur as a result of Hurricane Matthew. The Neuse River reached its highest crest to date at 28.6 feet (National Weather Service, 2016). The Tar River saw its highest crest since Hurricane Floyd, reaching 24.5 feet (National Weather Service, 2016). Many towns that experienced extreme flooding from Hurricane Floyd also experienced flooding from Hurricane Matthew. As a result of this flooding, tens of thousands of residents were forced out of their homes by the floodwaters – many never able to return. Twenty-five deaths occurred across North Carolina from Hurricane Matthew – nineteen occurring from driving or walking through dangerous floodwaters– as well as 1.6 billion dollars in damages across the state

(National Weather Service, 2016). Recovery efforts are still underway in mid- 2018 in some parts of Eastern North Carolina. The impacts from Hurricane Matthew on Eastern North Carolina were catastrophic; however, the damages were not as extensive as Hurricane Floyd in 1999. Long time residents of Eastern North Carolina likely experienced both hurricanes and can use these past experiences to better prepare for floods in the future. The use of historical context before a major flood event can be of aid to residents who lived in the area for those events. Previous research has pointed to prior experience as the best indicator of future flood response. However, not everyone has prior experience with flooding in Eastern North Carolina. Informing residents of Eastern North Carolina about the history of flooding in the region could aid them in understanding the possible impacts of similar flood events in the future.

Given these experiences and the high flood risk of communities in Eastern North Carolina, understanding resident perceptions is critical for meteorologists and emergency officials to better protect life and property for future flood events. This research explores the relationship between risk perceptions, prior experience with flooding and preparations for future flood events. Additionally, this research identifies the sources of information that residents in Eastern North Carolina used for Hurricane Matthew and if they trust those sources to inform them of future flood events.

CHAPTER 2: LITERATURE REVIEW

This section explores previous literature on various topics related to risk perception. The topics explored in this section include: vulnerability to floods, disaster knowledge and experience, false sense of security, communication, and risk perception. Additionally, the problem statement for this study is discussed at the end of the chapter.

2.1 Vulnerability

Vulnerability is generally acknowledged by most researchers to consist of three parts: degree of exposure, susceptibility and resilience or response capacity of a population in a particular area. A community is susceptible to floods because of its exposure and its ability to be resilient and cope with the damage (Salami et al., 2017). Adger (2006) describes vulnerability to a natural hazard as being based not only on the exposure, but also on the availability of coping resources. Chambers (1989) notes that vulnerability has two sides. One is an external side, which consists of risks, shock and stress. The other is an internal side, which deals with defenselessness, meaning the lack of means to cope without damaging loss. The degree of vulnerability in a community can be dependent upon many physical and societal aspects (Salami et al., 2017). Environmental and political aspects can also play a role in the degree of vulnerability. Thus, an understanding of vulnerability in a community requires integrating both physical and societal aspects of a natural hazard (Pielke, 1999).

Coastal communities are becoming more vulnerable to hurricanes than ever before because of the increase in the number of people moving to the coast. According to Bathi and Das (2016), thirty-nine percent of the American population lives in a coastal county. Thus, there is a greater threat to life and property from hurricanes. Over the past century, hurricanes have been

the single largest source of property damage from natural hazards in the United States (Meyer et al., 2014). Storm surge is the most unpredictable and dangerous aspect of a hurricane – it can lead to unexpected life-threatening flooding in communities, which can result in a greater loss of life and property. In the last decade alone, 240 billion dollars in damages have been reported from hurricanes, which seems particularly troublesome because hurricane forecasts have improved in recent years (Meyer et al., 2014). In particular, track forecasts have improved significantly, which has led to dramatic increases in landfall forecasting abilities and warning times (Meyer et al., 2014). However, the improved forecasting of hurricanes has not been matched with an improvement in preventative adaptations from the public.

In recent years, the frequency and intensity of rainfall events, flash floods, riverine and coastal flooding have been on the increase, resulting in more flood disasters around the world (Vojinović, 2015). Events in recent years provide evidence that people and property in the United States still remain highly vulnerable to floods (Pielke, 1999). Vulnerability to being flooded appears to be greater for individuals with pre-existing social vulnerability, particularly related to socio-economic, health, and demographic factors (Lowe et al., 2013). Those groups who are generally more vulnerable to floods are the very young and elderly, those with lower incomes, and women (Cutter, 2010). While the damage from Hurricane Katrina in 2005 was relatively uniform across demographics, those with lower incomes were less likely to have purchased flood insurance or evacuated (Masozera et al., 2007). The elderly and very young can be at higher risk by sheltering in place during flood events (Haynes et al., 2009). Vulnerability can be reduced by precautionary measures implemented in households before a flood (Grothmann and Reusswig, 2006).

2.2 Disaster Knowledge and Experience

Knowledge of floods in a community ranges on a spectrum from a simple awareness of flood events to detailed knowledge of the community's flood history. In acquiring this knowledge, an individual might have been exposed to a particular experience with floods or through a variety of channels and messages (Kates, 1962). However, the effect of a particular experience also can be limiting. Individuals make choices from a range of alternatives, but the alternatives considered depend on their knowledge (Montz et al., 2017). In this regard, individuals are prisoners of their own experiences because those experiences set boundaries around their knowledge (Kates, 1962).

Past studies suggest that flood experience is an important factor in motivating mitigation behavior. One possible explanation for this is that individuals with past experiences with floods may have a different emotional reaction than those who have no experience with floods (Siegrist and Gutscher, 2006). In particular, resulting fear or anxiety from a previous flood experience is more likely to motivate people to undertake action in the future (Bubeck et al., 2012). However, it could be that those without prior experience with flooding were more likely to be normalized to their prior benign experiences and will be more optimistic about future flood consequences (Lawrence et al., 2014). Past experience can affect residents' preparedness and responses to future hazardous situations. Zaleskiewicz et al. (2002) found that experience with a previous flood was the most important motive for purchasing flood insurance. In addition, experience with previous flash floods has been shown to increase the frequency with which those individuals track future flash flood events (Knocke and Kolivras, 2007). From these studies, one might assume that greater personal experience with hazards correlates with more accurate assessments

of the threat and more favorable responses. It has been found that the best predictor of flood response is often personal experience (Montz et al., 2017).

Direct experience with flooding is the presence of the individual in the affected floodplain during a flood event. The individual may not necessarily have been severely affected by the flood, but the experience of a past flood can influence the individuals' situational awareness to flooding (Kates, 1962). However, this experience may not necessarily translate into effective action (Montz et al., 2017). For example, it was found that following Hurricane Katrina, personal experience was less important than family and friends when making important evacuation decisions (Montz et al., 2017). Nevertheless, personal experience with a disaster makes people uniquely aware of their vulnerability to a disaster's consequences, which could help lessen loss of life and property in the future (Terpstra, 2011).

Recency is also a component of personal experience that can alter individual perceptions of flood risks. Hazardous events remain the focal point of people's lives for a long time. All other life events may be dated by that experience, that is, whether they occurred before or after a flood (Montz et al., 2017). We can expect that the more recent the experience, the greater the awareness of the hazard, but after some time has transpired, knowledge of its details will be minimal and no longer directly impact decision-making. This pattern is often attributed to a motivational decay – it may take only six months for the motivational effects associated with an event to decrease (Baumann and Sims, 1978). Nevertheless, major traumatic events, especially when they involve the loss of life of a close friend or relative, do become memorable life events for many individuals (Montz et al., 2017).

Another aspect of disaster experience is a tendency toward what is known as "gambler's fallacy". Many individuals believe that it if a certain event occurs, it will not occur again within

their lifetimes or, at least, not in the near future (Slovic, et al., 1974; Montz et al., 2017). Misperceptions occur because hazards are viewed as cyclical or systematic rather than probable (Slovic et al., 1974). Individuals believe that if a flood event occurs in any given year, another will not occur for quite a while after (Motoyoshi, 2006). Gambler's fallacy can be a common risk perception within a community, but this mindset can be detrimental when disaster strikes. It is important for individuals to realize that flood disasters are random and probable and that their homes may be flooded at any time (Motoyoshi, 2006).

2.3 False Sense of Security

Flood recurrence intervals – terms like "100-year flood" and "500-year flood" – were developed as a way to simplify the probabilities associated with flood events (Bell and Tobin, 2007). The initial goal of these terms was not for effective communication of risk and risk policy, but it has become particularly useful for that in recent years (Bell and Tobin, 2007). However, the language used to describe flood recurrence intervals can confound the picture – a particular issue with the designation of the 100-year flood in the United States (Montz et al., 2017). The 100-year flood is considered by many to be a very unlikely event; however, it can still occur in any given year. This seems to imply that there is a very low chance that a flood will occur in the designated floodplain and virtually no chance of flooding outside of the floodplain. This can create a false sense of security for residents who live near a flood prone area but not within the 100-year flood zone. The public assumes that if their property is not within a designated flood prone area, then they have no risk of flooding (Bell and Tobin, 2007). Depending on the magnitude of the flood, water can reach areas outside of the 100-year

floodplain and cause damage to homes and businesses whose occupants were not aware of their risk.

Dams and levees can also create a false sense of security within a community. These flood control structures are built to help control the flow of river water on a day-to-day basis and during a flood event. On floodplains below dams and behind levees, new developments attract residents to lands perceived as "protected" from floods, but which are still vulnerable to inundation (Ludy and Kondolf, 2012). People are more likely to occupy a floodplain if flood control systems are built to alleviate the risk of flooding in a particular area (Lave and Lave, 1991). Furthermore, it is not unusual to discover that individuals perceive a problem as "solved" once mitigation measures have been adopted (Montz et al., 2017). Once the government or agency has effectively controlled flooding within a community, the hazard is regarded as eliminated. This misperception can lead to increased development in "safe" areas and ultimately to catastrophic losses when the mitigation measure fails (Montz et al., 2017). This is known as the levee effect, and it can create a false sense of security within a community (Montz et al., 2017). The public cannot solely rely on flood control measures to protect them from a flood. No engineering construction can completely guarantee protection for residents living in a floodplain, and residents need to be aware that, if they are living in a floodplain, there is a chance that their homes could sustain flood damage in the future (Motoyoshi, 2006).

2.4 Communication

Communication of important risk and preparedness information before a flood event is imperative to protect life and property. The manner in which messages are conveyed to the public is a key factor in their perceptions of possible risk during a flood event (Bell and Tobin,

2007). Oftentimes, there can be a disconnect between the information that experts communicate and how residents understand and perceive that information (Grothmann and Reusswig, 2006). Experts can communicate the necessary information to individuals, but the manner in which they understand that information may be different than experts intended. The problem may be related to language difficulties, technical jargon, or ignorance of the message, but all can lead to less than optimal perceptions of risk. Perception of risk and associated behavior are related to different aspects of warnings and simply putting out a warning message is inadequate (Montz et al., 2017). Poor communication strategies can hinder adequate responses from individuals in the event of warnings. For instance, a poorly communicated message regarding an impending disaster may not convey the actual significance of the event (Montz et al., 2017). Experts need to carefully choose their target audiences so the right messages can be communicated through the right channels to increase household adoption of preventative measures by those who have low perceived personal risks or who lack adequate information about the hazard (Lindell and Hwang, 2008).

Communication is considered effective if it successfully influences the receiver's attitudes and behavior in a manner desired by the communicators (Bell and Tobin, 2007). This definition is based on persuasion and is referred to as the dominance model (McQuail and Windahl, 1981). However, there are many that contest this conceptualization and believe that understanding is the key to effective communication of flood risk (Belsten 1996; Kasemir et al., 2003). Those at risk not only need to be able to receive important communication from experts, but also understand the information well enough to make useful decisions during a disaster. Communication is effective when all residents are given the information they need to make decisions during a disaster and act upon the information given (Grothmann and Reusswig, 2006).

Cry-wolf syndrome can also be problematic in disaster situations. Warnings issued when no event follows may lead to unsatisfactory behavior in subsequent events. The impact of false alarms on future preparation and evacuation has been a source of speculation and concern in the emergency management community. Repeated false alarms can reduce the credibility of warning information (Dow and Cutter 1998). Individuals can become indifferent about warnings and the hazard and consequently take little or no action (Montz et al., 2017), however some researchers have found that such situations do not necessarily lead to non-action. Dow and Cutter (1998) found that residents do not find that officials are "crying wolf" during false alarm situations, but they are searching elsewhere for information to make their own assessments of risk. Nonetheless, managers of warning systems must take precautions to ensure that warnings generate an appropriate response from individuals (Montz et al., 2017).

2.5 Perception

Accurate perceptions during natural disasters are extremely important – residents need to know the level of risk to themselves and their property to make informed decisions about preparation; however, it is often difficult for people to appropriately perceive natural hazard risks (Slovic et al., 1974). Individuals behave as if they possess some underlying perception about the state of nature, and this perception aids them through an interpretative process through which information is transformed into a personal evaluation of the flood hazard (Kates, 1962). Since the motivation to protect oneself comes from the perceived severity of the threat and the perceived probability of the occurrence or vulnerability (Grothmann and Reusswig 2006), misperceptions of flood risk have been found to result in larger losses than necessary

(Sniedovich and Davis, 1977). One's level of flood risk awareness and sense of personal risk can influence his or her actions before and during a flood (Grothmann and Reusswig 2006).

Media can play a role in individual risk perception by amplifying or attenuating the perception of risk (Kasperson et al., 1988; Slovic, 2000; Montz et al., 2017). High-risk events, like floods, interact with various psychological, social and cultural processes in ways that heighten or attenuate public perceptions of risk. When certain events are reported disproportionately, the public's perception of the frequency of those events can be biased (Combs and Slovic, 1979). Because of media coverage, lower probability events may seem more common than they actually are, and higher probability events like floods may appear to occur less frequently than they do (Ludy and Kondolf, 2012). Media can also influence public perceptions of the environment by promoting specific agendas (Kinney, 2005 Ashlin and Ladle, 2007). For example, looting after a disaster receives a great deal of attention by the media following disaster events. A person might perceive a particular hazard threat as lower than the perceived risk of leaving their house empty and exposed to looting (Montz et al., 2017). Decisions to remain in hazardous environments may appear quite illogical, but those decisions are made on the basis of incomplete information and biased by perceptions of the individuals concerned (Montz et al., 2017).

Decision-making is quite limited by personal experience that can influence misperceptions of mitigation outcomes. Individuals tend to have their own biases about risk perception with the basic premise that if something worked once, then it will work again in future events (Montz et al., 2017). This is known as normalization bias – the learned response is essentially the best-perceived option to the individual. It can be inferred that new information presented by the government and other agencies will likely not cause individuals who have

experienced a certain event in the past to overcome this bias and change their preventative actions for future events (Mileti and O'Brien, 1992).

2.7 Problem Statement

The ties between vulnerability, disaster experience and future flood risk perception have not been studied in depth, particularly in regions like Eastern North Carolina. Eastern North Carolina is predominately a rural region, comprised of small cities and towns. Eastern North Carolina is considered a small town region because of the small populations throughout the counties. The Community Development Block Grant (CDBG) program defines areas with small populations as 'non-entitlement' areas, in which cities must have less than 50,000 residents or counties must have less than 200,000 residents in order to receive special grants (Community Development Block Grant, 2018). Thus, all three counties surveyed in this study would be considered a non-entitlement area. Such regions generally do not have access to as much funding or research opportunities as larger metropolitan areas, due to the smaller populations. During disaster situations, small cities generally do not suffer catastrophic losses that would seriously impact the national or global economy. However, it takes much longer for smaller cities to recover from natural disasters. Megacities that are impacted by natural disasters generally recover more quickly than small cities and towns because megacities have more resources readily available to deal with a natural disaster (Cross, 2001).

While flooding in metropolitan areas will consequently impact a larger population, small towns and cities often have more people who are vulnerable to natural disasters. The impacts from natural disasters can be felt over the entirety of a small town or city, but it is rare to see a natural disaster directly affect an entire metropolitan area (Cross, 2001). Since small towns and

cities are generally more vulnerable during flood events, it is important to understand how much at risk to flooding residents in these regions believe they are and determine the factors that influence those risk perceptions.

In order to understand the relationships between vulnerability, disaster experience, and future flood risk perceptions, this study addresses the following research questions.

1. How do Eastern North Carolinians view their flood risk, and how concerned are they about flooding in their homes and communities?

2. How are past experiences with flooding, perceptions of risk and concern, and preparations related?

3. What sources of information did people rely on in preparing for Hurricane Matthew?

4. How much trust do residents put in their preferred sources to inform them of future flood events?

The goal of this study is to understand perceptions in smaller communities, and thus, inform Eastern North Carolina meteorologists and emergency managers of their residents' views on flood risk and the factors that influence these risk perceptions. Understanding what influences residents' risk perceptions could be useful to emergency officials in preparing residents for future flood events. With the information from this study, emergency officials can make necessary changes to forecasts and warnings to better serve the residents of Eastern North Carolina during catastrophic flood events.

CHAPTER 3: METHODS

This chapter presents the study area, methods used for data collection and data analysis for the study. The study area includes three counties in Eastern North Carolina that were all affected by Hurricane Matthew. Description of the counties follows information on Hurricane Matthew. The section on data acquisition explains the sampling strategy and the survey questions that were asked to answer the research questions, while the section on data analysis outlines the independent and dependent variables as well as the statistical tests that were performed on the data.

3.1 Hurricane Matthew

Hurricane Matthew was a long-lived storm, which became the first Category 5 hurricane in the Atlantic Basin since 2007 (Stewart, 2017). The background and impacts of Hurricane Matthew are important in understanding how future hurricanes could impact the region, which, in turn, could aid emergency officials in future preparation.

3.1.1 Synoptic Background

Hurricane Matthew formed from a tropical wave off the coast of Africa on September 23, 2016 and moved westward in the Atlantic, gaining speed and momentum. The wave was given a high probability of tropical cyclogenesis within five days by the National Hurricane Center. On September 26th, the tropical wave slowed and made a turn towards the west-northwest. In the days following, thunderstorm activity increased along the wave, and the system was producing winds in excess of 40 knots. However, it could not yet be classified as a tropical cyclone because of the lack of a closed circulation. On September 28th, radar imagery near Barbados indicated the

development of a closed circulation, which was confirmed by reconnaissance aircraft. The National Hurricane Center then announced the formation of Tropical Storm Matthew (Stewart 2017).

The newly formed Tropical Storm Matthew was steered by a deep ridge into an area of warm sea surface temperatures and low wind shear in the Caribbean Sea. On September 29th, only one day after tropical storm formation, Matthew had reached Category 1 hurricane status on the Saffir-Simpson Scale. The next day, despite encountering northwesterly wind shear, Hurricane Matthew doubled its wind speed from 70 knots to 145 knots in 24 hours. Thus, Hurricane Matthew went from a Category 1 hurricane to a Category 5 storm in a short period of time. On October 4, Hurricane Matthew made landfall in Haiti as a Category 4 storm and, one day later, made landfall in Cuba (Stewart 2017).

After landfall, Matthew headed north-northwest and continued to approach Florida. The outer eye wall stayed approximately 20 miles offshore of Florida. On October 8th, Hurricane Matthew made landfall in South Carolina as a Category 1 storm with winds of 75 knots. As Hurricane Matthew pulled away from the coast on October 9th, it went through an extratropical transition before merging with another low in the Atlantic (Figure 3.1).

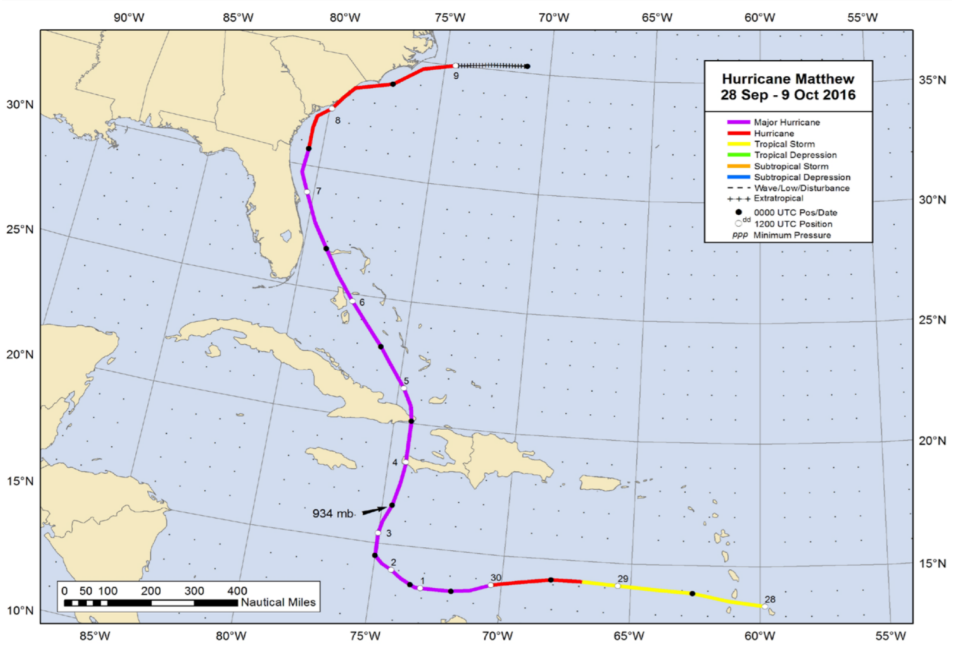

Figure 3.1: Hurricane Matthew (2016) track from September 28 through October 9 (National Hurricane Center, 2016).

3.1.2 Impacts on North Carolina

The heaviest rain from Hurricane Matthew occurred inland due to an extratropical transition that caused Matthew's rains to be heaviest on the northwest quadrant of the storm, and along the frontal boundary that was situated to the east of the storm (Figure 3.2) The maximum reported rainfall amount from the storm was reported near Evergreen in Columbus County with 18.95 inches of rain (National Weather Service, 2016). Although the Outer Banks did not experience or receive as much rain as inland areas, there was significant wind damage reported in Currituck, Dare, Hyde and Tyrrell Counties. This was caused by winds coming out of a high-pressure system over the Great Lakes being accelerated into Matthew's circulation (Stewart 2017).

Hurricane Matthew caused millions of dollars of damage and directly resulted in 25 deaths in North Carolina. Unfortunately, nineteen of those deaths occurred when individuals

drove their vehicles or walked through hazardous floodwaters and were swept away by the currents. Some of these individuals were stranded in the floodwaters after driving past posted barricades. Six indirect deaths were reported from Hurricane Matthew in North Carolina, which were mainly due to health-related issues, fires, and car accidents (Stewart, 2017).

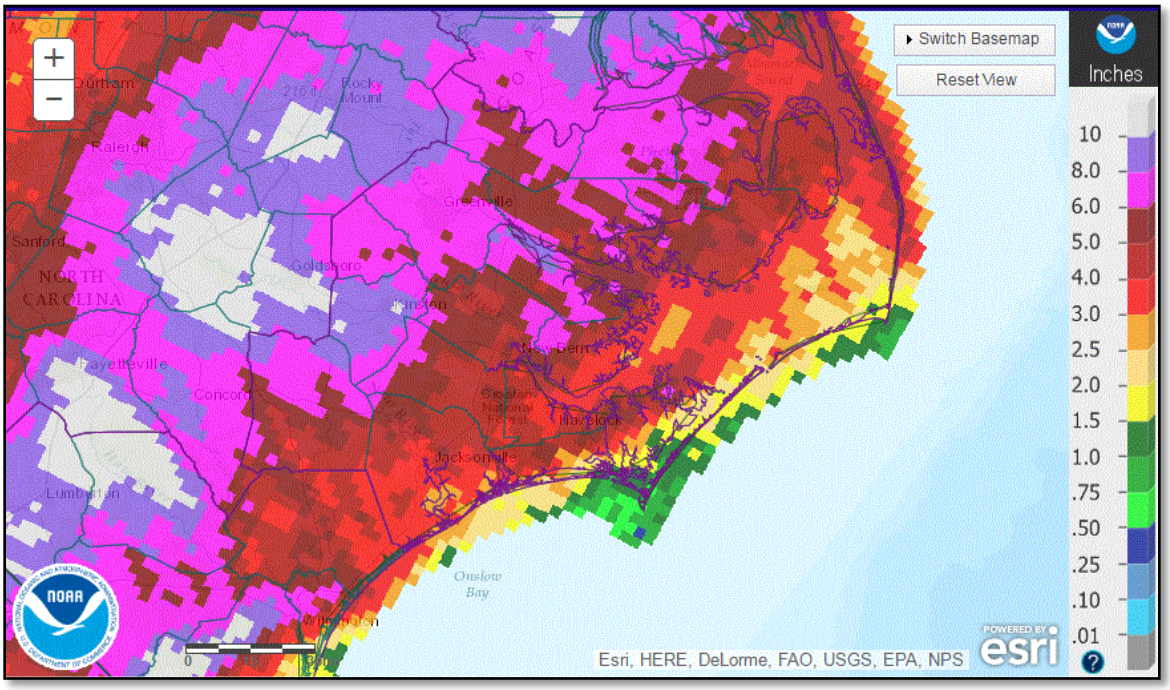

Figure 3.2: Rainfall estimates over Eastern North Carolina from Hurricane Matthew. Image retrieved from the National Weather Service (2016)

The impact from Hurricane Matthew that will be most remembered in Eastern North Carolina is the catastrophic flooding. This flooding – particularly the river flooding – caused millions of dollars of damage and multiple deaths across the region. The river levels from Hurricane Matthew had not been seen since Hurricane Floyd in 1999. The Neuse River at Kinston was one of the most notable locations to suffer extremely high water levels. The river crested at 28.6 feet, its highest crest to date, on October 14, 2016 (Figure 3.3).

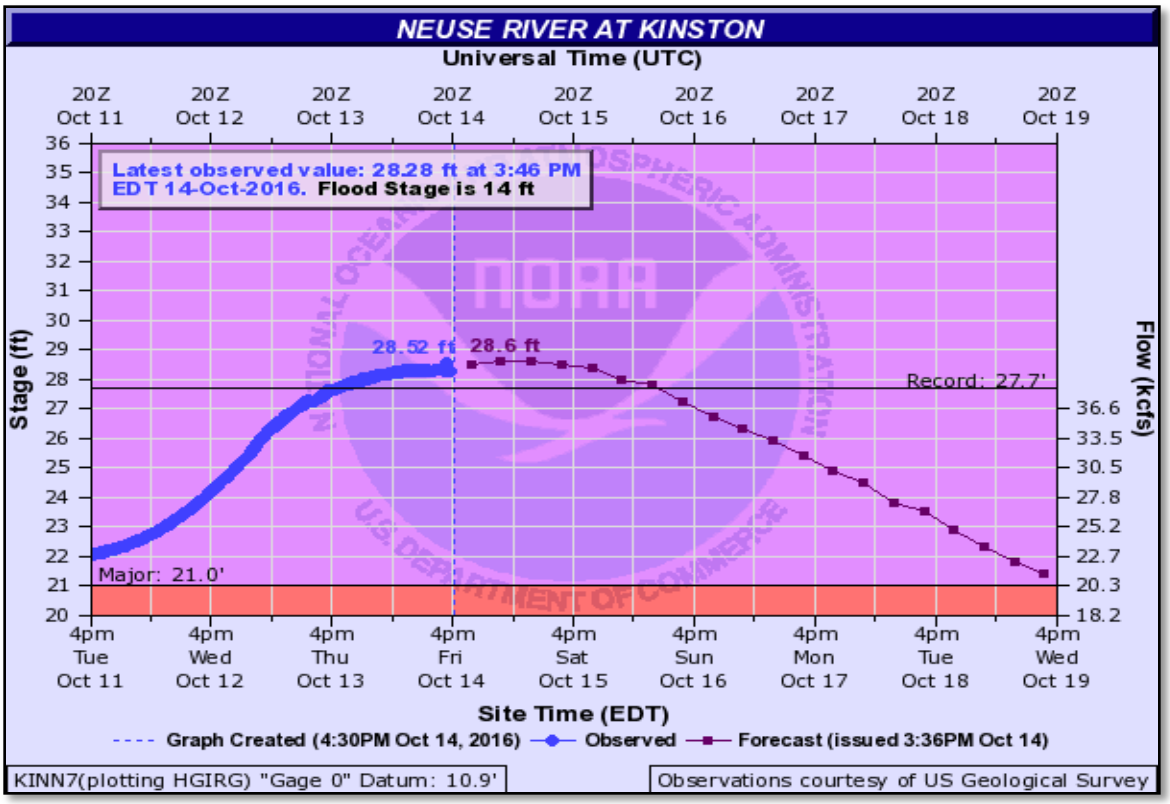

Figure 3.3: The Hydrograph of the Neuse River at Kinston from October 14, 2016. Image retrieved from the National Weather Service (2016)

The Tar River in Greenville also experienced significant flooding from Hurricane Matthew. River levels on the Tar reached the second highest levels ever recorded at 24.5 feet on October 14, 2016 (Figure 3.4) The highest river levels recorded on the Tar River occurred with Hurricane Floyd in 1999 (National Weather Service, 1999).

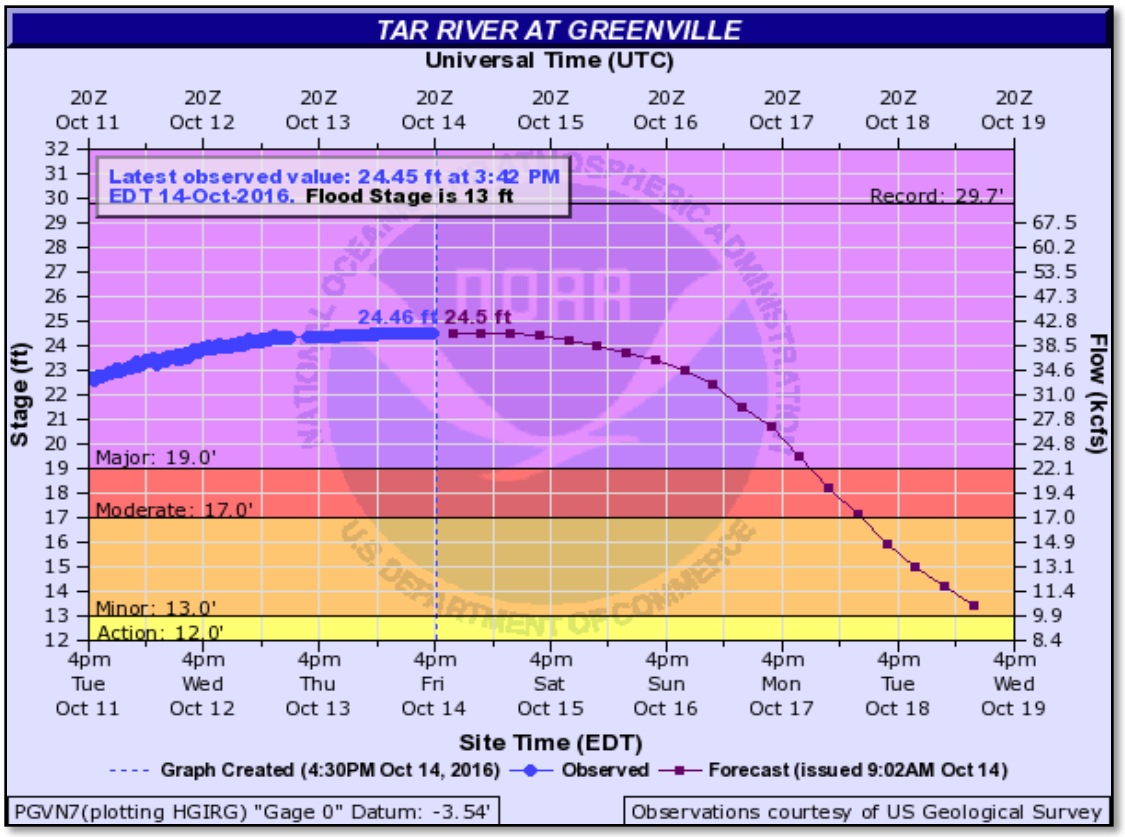

Figure 3.4: The hydrograph of the Tar River at Greenville from October 14, 2016. Image retrieved from the National Weather Service (2016)

3.2 Study Area

Eastern North Carolina is in the Coastal Plain of the eastern United States. It borders the Atlantic Ocean and has relatively flat terrain, which makes it vulnerable to many natural hazards such as hurricanes, floods, and nor'easters. The region is particularly vulnerable to riverine floods because of the presence of the Tar and the Neuse Rivers. These rivers flow through Central and Eastern North Carolina and can overflow their banks during heavy precipitation events. The three counties in Eastern North Carolina that serve as study sites include Pitt County, Beaufort County and Wayne County (Figure 3.5). These counties were chosen based on three criteria: population, location, and impacts from Hurricane Matthew. The goal was to have one

coastal county, one inland county, and a county in between. All three counties have a population over 50,000 and Hurricane Matthew impacted all of them, although each county saw different magnitudes of impacts from Matthew.

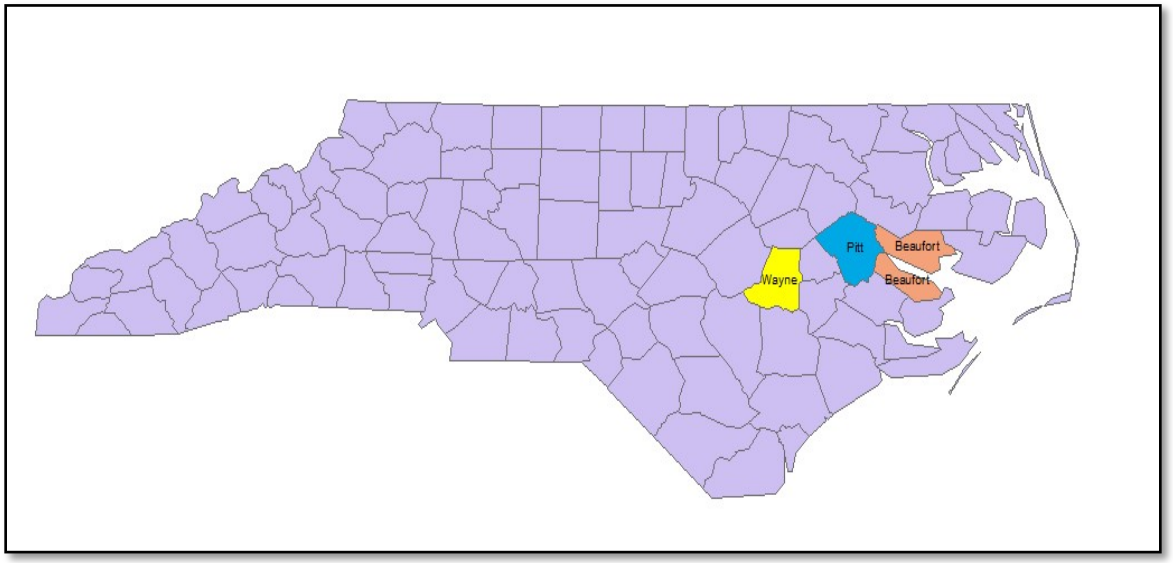

Figure 3.5: Map of North Carolina with the Counties Surveyed. Pitt County (blue), Beaufort (orange), Wayne (yellow). Map created using ArcGIS.

Pitt County is the most populated of the three counties and has the Tar River running through it (Figure 3.6). A few large branches of the Tar River, Johnsons Mill Run and Grindal Creek, meander through the northern portion of Pitt County. Little Contentnea Creek is located near the southern border of Pitt County, and smaller creeks and tributaries also meander through the southern portion of the County. During Hurricane Matthew, Pitt County had rainfall amounts between ten and eleven inches, and the Tar River crested at 24.5 feet (National Weather Service, 2016). Both Pitt and Beaufort counties were among the first counties in Eastern North Carolina to be eligible for Public and Individual Assistance through the federal government to help homeowners and businesses recover after Hurricane Matthew (North Carolina Department of Public Safety, 2016).

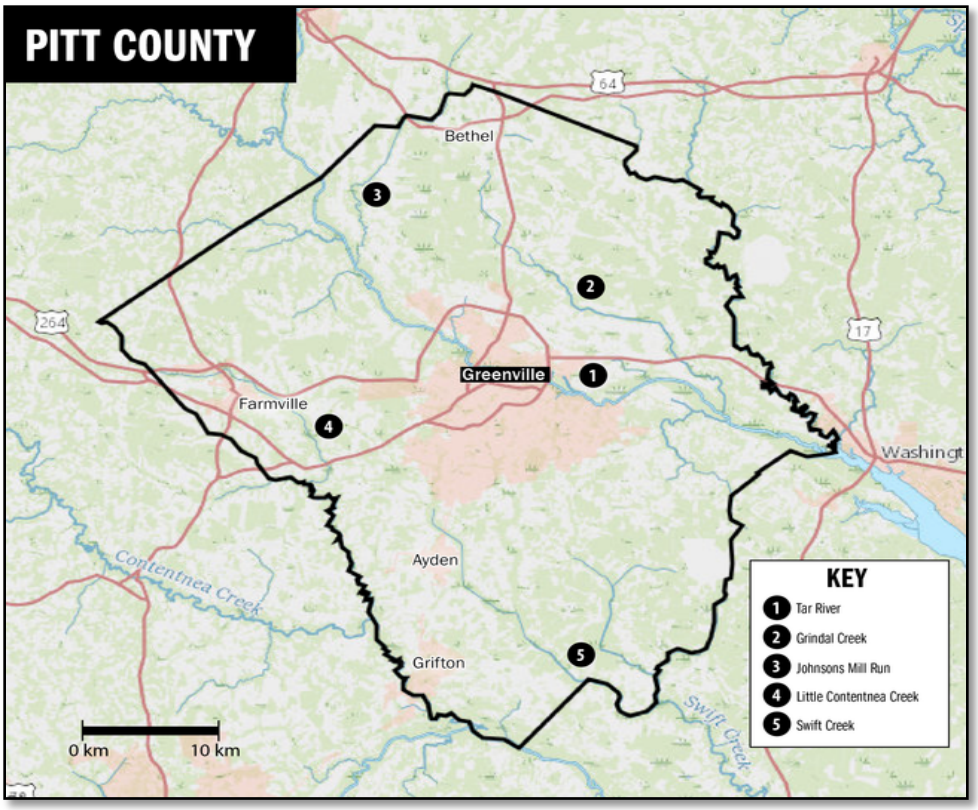

Figure 3.6: Map of Pitt County, NC with Rivers and Streams Labeled.
Map created using ArcGIS.

The mouth of the Tar River is located in Beaufort County, as are the Pamlico and Pungo Rivers (Figure 3.7). The Tar River ends near the western border of Beaufort County, and the Pamlico River begins near the downtown area of Washington. The Pungo River is located near the mouth of the Pamlico River and meanders through the eastern portion of Beaufort County. Other small creeks and swamps are located in Beaufort County, particularly south of the Pamlico River. The town of Washington experienced rainfall amounts between eight and nine inches during Hurricane Matthew (National Weather Service, 2016).

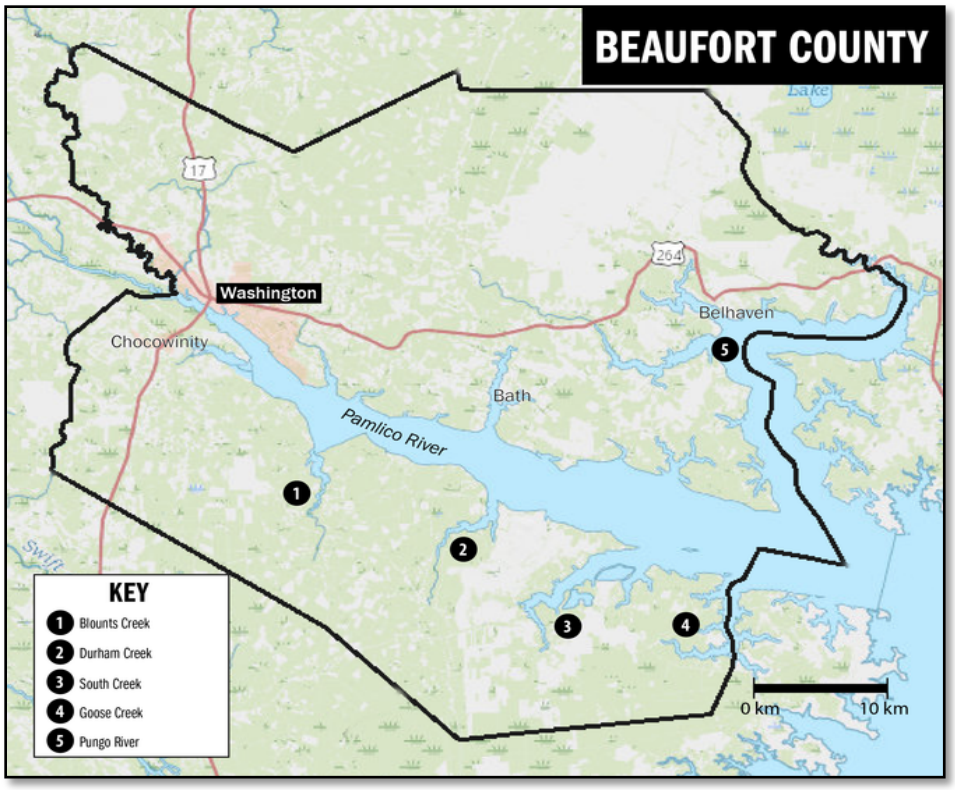

Figure 3.7: Map of Beaufort County, NC with Rivers and Streams Labeled. Map created using ArcGIS.

Wayne County has the Neuse River running through it, as well as the Little River and Bear Creek (Figure 3.8). The Little River and Bear Creek are two of the largest branches of the Neuse. There are smaller branches of the Neuse River that meander through the southwest portion of Wayne County. The Nahunta Swamp runs through the northeastern portion of the county. Parts of the county received nearly 12 inches of rainfall during Hurricane Matthew (National Weather Service, 2016). A few days after Hurricane Matthew struck Eastern North Carolina, the Neuse River near Goldsboro peaked at 29.7 feet, which surpassed the Hurricane Floyd peak of 28.85 feet (United States Geological Survey, 2016).

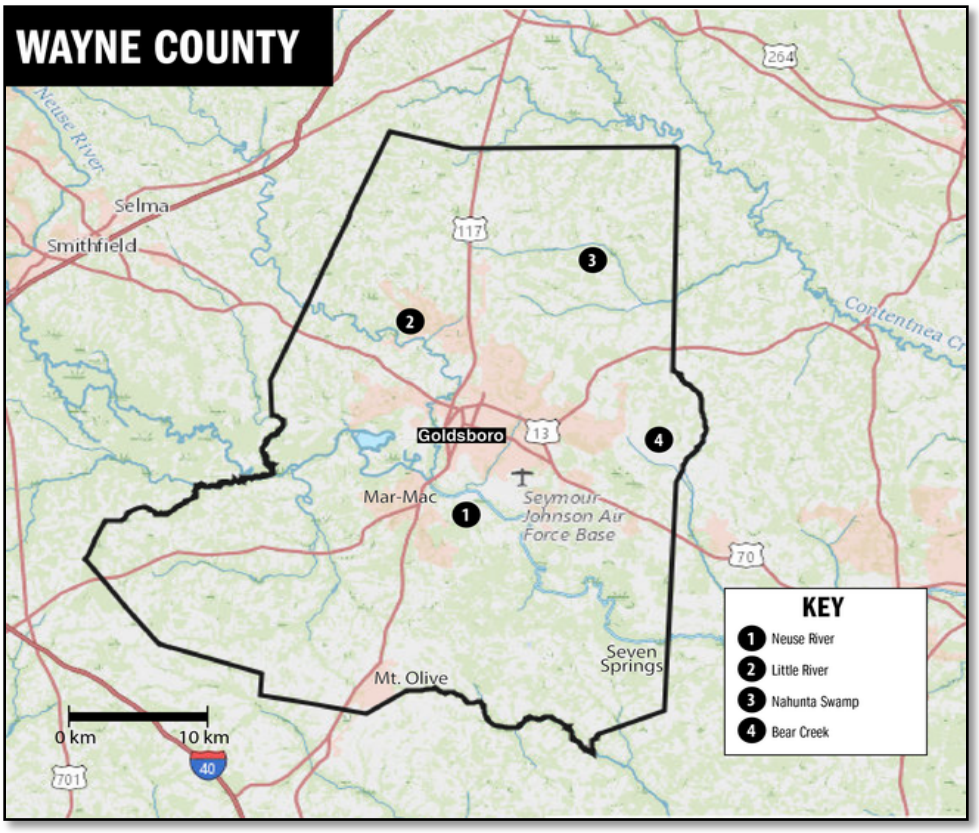

Figure 3.8: Map of Wayne County, NC with Rivers and Streams Labeled. Map created using ArcGIS

3.3 Demographics

Pitt County has the largest population out of the three counties, with nearly 180,000 residents while Beaufort County has the smallest population of 47,000 residents (Table 3.1). Those who do not have a high school education make up about 11 to 17 percent of the population across the study area. In contrast, those with a Bachelor's Degree or greater make up about 20 to 30 percent of Pitt County (United States Census Bureau, 2017).

In each county, the majority of the population is considered Caucasian, comprising approximately 60 to 70 percent. Black/African American makes up about 25 to 35 percent of the population in each county, and the percentage of Hispanic/Latino ranges between 6 and 12

percent. Females have a slight majority in each county, with about 51 to 52 percent of the population.

Table 3.1: Demographics of Population in the Study Area, North Carolina, and the U.S (United States Census Bureau, 2017)

Demographic	Pitt	Beaufort	Wayne	North Carolina	United States
Population	179,042	47,088	124,172	10,273,419	323,127,513
EDUCATION					
No high school	11.2%	15.4%	17.0%	13.7%	13.0%
High school or greater	88.8%	84.6%	83.0%	86.3%	87.0%
Bachelor's Degree or greater	29.5%	18.6%	18.7%	29.0%	30.3%
ETHNICITY					
Caucasian/White	59.8%	71.8%	63.0%	71.0%	76.9%
Black/African American	35.3%	25.1%	32.5%	22.2%	13.3%
Hispanic/Latino	6.2%	7.8%	11.5%	9.2%	17.8%
Indian or Alaskan	0.5%	1.0%	0.8%	1.6%	1.3%
Asian	2.2%	0.5%	1.4%	2.9%	5.7%
GENDER					
Male	47.1%	47.8%	49.0%	48.6%	49.2%
Female	52.9%	52.2%	51.0%	51.4%	50.8%
HOUSING					
Own	52.3%	69.4%	59.7%	64.8%	63.6%
Rent	47.7%	30.6%	40.3%	35.2%	36.4%

3.4 Data Collection

This study aims to capture responses from individuals who were directly and indirectly impacted by Hurricane Matthew. In order to survey individuals in Eastern North Carolina, a paper survey instrument was developed and distributed in person to the three counties. The initial survey distribution system was home delivery/pick up; however, that proved to be unsuccessful. Instead, in-person survey distribution was used and proved to be a success, especially outside of public libraries. Permission to collect data was obtained from the director of each library prior to

survey distribution. Library patrons were generally interested in the study and had the opportunity to ask questions about the survey before participating. Data was collected outside of four libraries in the study area: Sheppard Memorial Library in Pitt County, Beaufort/Hyde/Martin (BHM) Regional Library and Brown Library in Beaufort County, as well as Wayne County Public Library in Wayne County. A table was set up outside of the libraries for patrons to take the survey, and the principal investigator was present to answer any questions that the participants had about the survey.

East Carolina University's Institutional Review Board approved this study on August 7, 2017 (Appendix A). The survey contains 26 questions intended to assess the factors that influence flood risk perceptions of eastern North Carolinians (Appendix B). The first section asked about prior experience with flood events in the region, including experience with Hurricane Matthew. The goal of asking these questions was to assess the level of experience the participant has had with flooding while living in Eastern North Carolina and to evaluate how prior experience influences risk perception and future preparation for flood events. These questions were generally quantitative, but some had a qualitative component for the participant to include any experiences they wanted to share that were not included in the choices provided. The next set of questions asked about preparation for Hurricane Matthew and for future flood events. These questions were presented in a table that listed six common preparation actions taken ahead of a flood event, and participants indicated which actions they took or will take to prepare for floods. The goal of these questions was to assess if there were any lessons learned from preparations taken or not taken for Hurricane Matthew and how those actions might translate into preparing for future flood events.

The survey also contained questions about the sources used and information obtained to plan and prepare for Hurricane Matthew. There are questions that address types of sources used for Hurricane Matthew, the types of information wanted from these sources, effectiveness of the information received, and trust in the sources and information for future flood events. The goal of these questions is to analyze how information is being communicated to Eastern North Carolina residents and if there are any gaps in communication that need to be addressed in the region. Risk perception questions were included to gauge the level of concern and risk to floods that Eastern North Carolina residents have with respect to their homes and communities. Finally, participants were asked a few demographic questions at the end of the survey.

The survey did not take more than fifteen minutes for participants to complete. Mixes of broad and specific questions are incorporated into the survey to address topics ranging from overall preparation to more respondent-specific questions about personal flood experience. A few of the questions use a five-point Likert Scale in which informants' responses range from not at all important to very important. The survey was pre-tested with a small group of individuals to ensure that the survey content was understandable and easily interpreted. This was done so that there were no misunderstandings with the content and to be sure that the survey had enough information for the respondents to answer the questions. This survey was also peer-reviewed to make sure that the survey questions would answer the overall research questions.

3.5 Data Analysis

This section outlines the methodologies that were used in this study and the analyses that were performed on the data to meet the research objectives. Both quantitative and qualitative analysis methods were used in this study. The primary types of questions presented in the survey

were Likert scale and multiple-choice questions. Likert scale questions ask the participant to answer the question by choosing a rank – one through five – based on their situation. The multiple choice questions generally ask the participant to choose one answer, but sometimes all answers that apply to their situation.

There are a few limitations to using mostly Likert Scale and multiple-choice questions in this survey. If an individual did not experience any of the impacts included in the responses given, that individual will most likely not be able to answer the question accurately. Also, participants may not provide sufficient information about their situations if there is not a dedicated space for them to write in additional information. Due to these limitations, a qualitative component was incorporated into some of the questions to capture the experiences from individuals that might not be included in the survey answers.

3.5.1 Statistical Analyses

Statistical analyses were performed on the Likert Scale and multiple-choice questions from the survey. Chi-square analyses were performed on the variables to test for independence between the variables. Table 3.2 shows each of the variables tested with corresponding questions in the survey and the statistical tests that were performed on them. Results of these statistical tests are presented in Chapter 4.

Table 3.2: Statistical Tests Performed on Variables

Variable 1 (with question numbers)	***Variable 2 (with question numbers)***	***Statistical test performed***
Risk level (question 17): Table 4.6	Prior experience with flooding (question 1)	Chi-Square Analysis
Risk level (question 17): Table 4.13	Preparation actions taken for Hurricane Matthew (question 7, part 1)	Chi-Square Analysis
Risk level (question 17): Table 4.7	Future flood preparations (question 7, part 4)	Chi-Square Analysis
Prior experience with flooding (question 1): Table 4.4 and 4.5	Concern for flooding (questions 19 and 20)	Chi-Square Analysis
Prior experience with flooding (question 1): Table 4.7	Future flood preparations (question 7, part 4)	Chi-Square Analysis
Concern for flooding (questions 19 and 20): Table 4.17	Preparation actions taken for Hurricane Matthew (question 7, part 1)	Chi-Square Analysis
Concern for flooding (questions 19 and 20): Table 4.19	Future flood preparations (question 7, part 4)	Chi-Square Analysis

3.5.2 Qualitative Analyses

Participants were able to write in answers to ten questions in the survey, and those responses were analyzed using nVivo. This analysis involved identifying responses that were similar and coding the responses to find themes, patterns and sub-themes within the data. The goal of incorporating these write-in questions into the survey was to allow the participants to tell their stories or experiences. Results from the nVivo analysis are presented in Chapter 4.

CHAPTER 4: DATA AND ANALYSES

This chapter presents the findings from the 103 respondents to the survey. Characteristics of respondents are discussed first, followed by findings from the first research question, which deals with how respondents viewed their flood risk and how concerned they are about future flooding. Research question two is explored next, which used Chi-Square analyses to relate variables such as prior experience with floods, risk level, concern, and future flood preparations. Finally, research questions three and four are explored, which is about sources and how much trust respondents put into those sources to inform them of future flood events.

4.1 Characteristics of Respondents

Individuals from Pitt County and Beaufort County make up 72% of the respondents, while individuals from Wayne County make up 28%. Nearly 30% of respondents were over 60 years of age, while only 31% were under the age of 40 (Table 4.1). The predominant race of the respondents was White (48.5%), with Black/African American as a close second (41.7%). In Pitt County, the ethnicity is fairly representative of the population of the county as a whole. The respondents to the survey in Pitt County were 59.4% White, while the county as a whole is 59.8% White. The Black/African American ethnicity is also representative of Pitt County as a whole, with 37.8% in the study sample, 35.3% in Pitt County, and 22.2% in North Carolina.

In Beaufort County, the respondents were 61.1% white, which is less than the population of the county (71.8%). Nearly 40% of survey respondents in Beaufort County were Black/African American, which is much higher than Beaufort County's census of 25.1%, and much higher than North Carolina (22.2%). In Wayne County, the respondents were 28% White, which is much lower than the U.S Census estimate of 63.0% White. The Black/African

American representation in the data set was 60.0%, which is nearly double the county estimate of 32.5%.

There were more females who answered the survey (54.4%) compared to 43.7% males. This is fairly representative of the population as a whole. The majority of the respondents had some type of college education, with 26.2% having an Associate's Degree, 22.3% having a Bachelor's Degree, and 13.5% with a graduate education. In contrast, approximately 25% had only a high school diploma. Most of the respondents own their home (58.2%) compared to 37.9% who rent. This is also fairly representative of the study area population as a whole, shown in Table 4.1

Table 4.1: Demographic Information of Respondents by County (n = 101)

Demographic Variable	Pitt County	Beaufort County	Wayne County	Total
AGE				
18-29	11 (10.7%)	1 (0.99%)	4 (3.9%)	16 (15.8%)
30-39	4 (4.0%)	8 (7.8%)	4 (4.0%)	16 (15.8%)
40-49	8 (7.8%)	4 (4.0%)	5 (5.0%)	17 (16.8%)
50-59	7 (6.9%)	8 (7.9%)	7 (6.9%)	22 (21.8%)
Over 60	6 (5.9%)	16 (15.8%)	8 (7.9%)	30 (29.7%)
ETHNICITY				
White	22 (21.8%)	21 (20.8%)	7 (6.9%)	50 (49.5%)
Black or African American	14 (13.9%)	14 (13.9%)	15 (14.8%)	43 (42.6%)
Hispanic or Latino	0 (0%)	0 (0%)	3 (3.0%)	3 (3.0%)
Native American or Indian	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Asian or Pacific Islander	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Other	1 (0.99%)	1 (0.99%)	3 (3.0%)	5 (5.0%)
GENDER				
Male	20 (19.8%)	13 (12.9%)	12 (11.9%)	45 (44.6%)
Female	16 (15.8%)	24 (23.8%)	16 (15.8%)	56 (55.4%)
Prefer not to answer	1 (0.99%)	0 (0%)	1 (0.99%)	2 (1.98%)
EDUCATION				
Less than High School	0 (0%)	1 (0.99%)	0 (0%)	1 (0.99%)
High School	12 (11.9%)	7 (6.9%)	6 (5.9%)	25 (24.8%)
Trade School	4 (4.0%)	5 (5.0%)	2 (1.98%)	11 (10.9%)
Associate's Degree	7 (6.9%)	9 (8.9%)	11 (10.9%)	27 (26.7%)
Bachelor's Degree	8 (7.9%)	9 (8.9%)	6 (5.9%)	23 (22.8%)
Graduate Degree	6 (5.9%)	5 (5.0%)	3 (3.0%)	14 (13.9%)

HOUSING				
Own	20 (19.8%)	24 (23.8%)	16 (15.8%)	60 (59.4%)
Rent	17 (16.8%)	11 (10.9%)	11 (10.9%)	39 (38.6%)

Chi-Square analyses were performed to find relationships between the demographics and perceived risk and concern level. Since the sample size was relatively small, the demographic information had to be combined into broader categories for the Chi-Square analysis to be valid. Three statistically significant relationships were found between demographics, risk level and concern level. First, concern level (property) and race were tested for significance and resulted in a p-value of 0.065, which is a weak, but still significant relationship (Figure 4.2). Over 44% of non-white respondents were very concerned about flooding on their property, while only 22.9% of white respondents were very concerned about their property flooding. One-third of white respondents were not at all concerned about property flooding.

Table 4.2: Chi-Square Analysis for Concern Level (property) and Race (n = 97)

Race		Concern level (property)			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
White (0)	Count	16	21	11	48
	% within race	33.3%	43.8%	22.9%	100.0%
	% within concern level	61.5%	55.3%	33.3%	49.5%
Non-White (1)	Count	10	17	22	49
	% within race	20.4%	34.7%	44.9%	100.0%
	% within concern level	38.5%	44.7%	66.7%	50.5%

Chi-Square = 0.065
Likelihood Ratio = 0.062

Additionally, race and housing status were tested to provide further insight into why non-white respondents were more concerned about flooding on their property than white respondents ($p = 0.019$). Over 70% of white respondents owned their home, while only 49% of non-white respondents owned their home (Table 4.3). Over 50% of non-white respondents rent their home. Renters generally do not have much control over their property, which may cause more concern for those individuals during a flood event. Since there are more non-white renters than white renters in this study, it could possibly indicate that non-white people are more concerned about flooding on their property because of lack of control.

Table 4.3: Chi-Square Analysis for Race and Housing Status (n = 97)

Race		Housing Status		
		Rent (0)	Own (1)	Total
White (0)	Count	14	36	50
	% within race	28.0%	72.0%	100.0%
	% within housing status	35.9%	60.0%	50.5%
Non-white (1)	Count	25	24	49
	% within race	51.0%	49.0%	100.0%
	% within housing status	64.1%	40.0%	49.5%

Chi-Square = 0.019
Likelihood Ratio = 0.019

Next, concern level (community) and race were tested for statistical significance. A strong relationship was found between these two variables ($p = 0.033$). Over 65% of non-white respondents were very concerned about flooding in their community, while only 39% of white respondents were very concerned about flooding in their community (Table 4.4).

Table 4.4: Chi-Square Analysis for Concern Level (community) and Race (n = 97)

Race		Concern level (community)			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
White (0)	Count	6	23	19	48
	% within race	12.5%	49.7%	39.6%	100.0%
	% within concern level	54.5%	65.7%	37.3%	49.5%
Non-White (1)	Count	5	12	32	49
	% within race	10.2%	24.5%	65.3%	100.0%
	% within concern level	45.5%	34.3%	62.7%	50.5%

Chi-Square = 0.033
Likelihood Ratio = 0.031

Education level and concern (property) were also found to have weak statistical significance (p = 0.055). Respondents who had less than a Bachelor's Degree expressed higher levels of concern than those who had a Bachelor's Degree or higher. Over 43% of respondents with less than a Bachelor's Degree were very concerned about flooding on their property, compared to only 21% of respondents with a Bachelor's Degree or higher (Table 4.5).

Table 4.5 Chi-Square Analysis for Concern Level (property) and Education Level (n = 97)

Education Level		Concern level (community)			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
Less than Bachelor's (0)	Count	16	18	26	60
	% within Ed. level	26.7%	30.0%	43.3%	100.0%
	% within concern level	61.5%	48.6%	76.5%	61.9%
Bachelor's or higher (1)	Count	10	19	8	37
	% within Ed. level	27.0%	51.4%	21.6%	100.0%
	% within concern level	38.5%	51.4%	23.5%	38.1%

Chi-Square: 0.055
Likelihood Ratio: 0.051

Additionally, location (county), perceived risk and concern level were tested, and there was no statistically significant difference between the three counties. It is likely that there was no difference between these variables because of the small sample size in each county.

4.2 Research Question 1: How do Eastern North Carolinians View their Flood Risk, and How Concerned are They About Flooding in their Homes and Communities?

The first research question explores how respondents view their individual flood risk and how concerned they are about flooding in the future. The risk and concern questions were presented as 5-point Likert Scales, where respondents circled the choice that best represented their level of perception. Respondents were asked to rate their chance of experiencing flooding in their home, using a 5-point Likert Scale that ranged from "no risk" to "very high risk". Most of the respondents answered somewhere in the middle three categories – "very little risk", "slight risk", and "somewhat high risk". Approximately 14% of respondents believe they have no risk of

flooding, which is not far off from the number of respondents who believe they are at "somewhat high risk" (Figure 4.1). Only 3.1% respondents believe they are at a very high risk for flooding. The most common answer was "slight risk" with 37 responses. Most respondents (87%) believe that they have some risk of flooding in their homes.

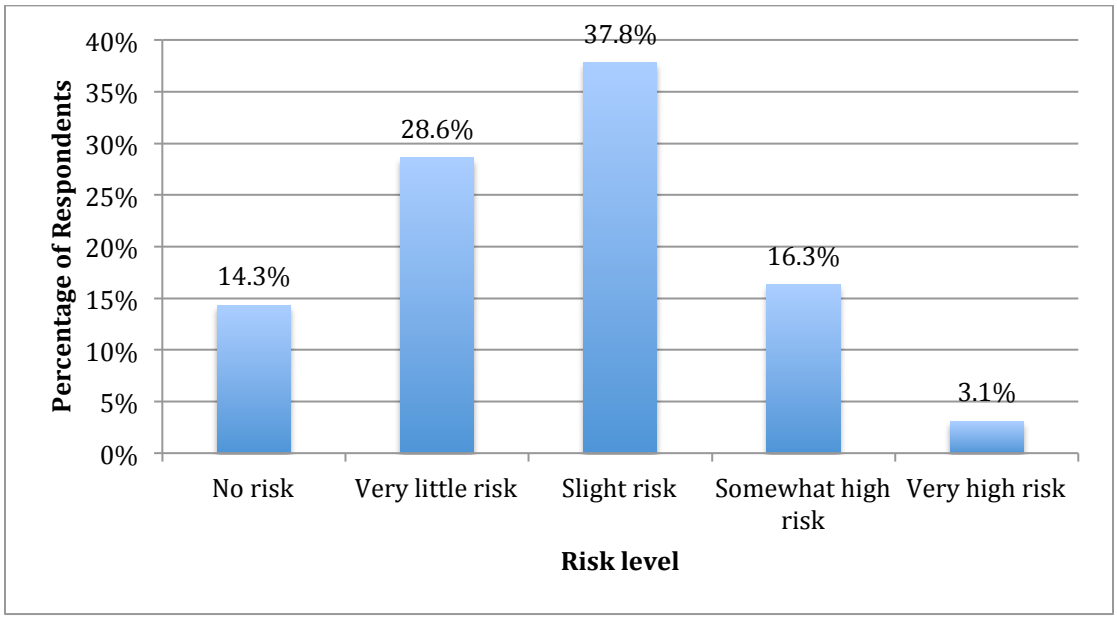

Figure 4.1: Perceived Risk Level for Flooding in Respondents' Homes (%)

Respondents were asked about their level of concern for flooding on their property or in their home, as well as in their community. Both questions were again presented using a 5-point Likert Scale, ranging from "not at all concerned" to "very concerned". Most of the respondents (52%) are "not at all concerned" or "slightly concerned" about flooding on their property. However, 35% are either "very concerned" or "fairly concerned" (Figure 4.2). Concern levels for flooding in communities were higher compared to concern levels for property. Nearly half of respondents are "fairly concerned" or "very concerned" about flooding in their communities, while only 12% were "not at all concerned". The results indicate that respondents are more concerned about flooding in their communities than about flooding on their properties.

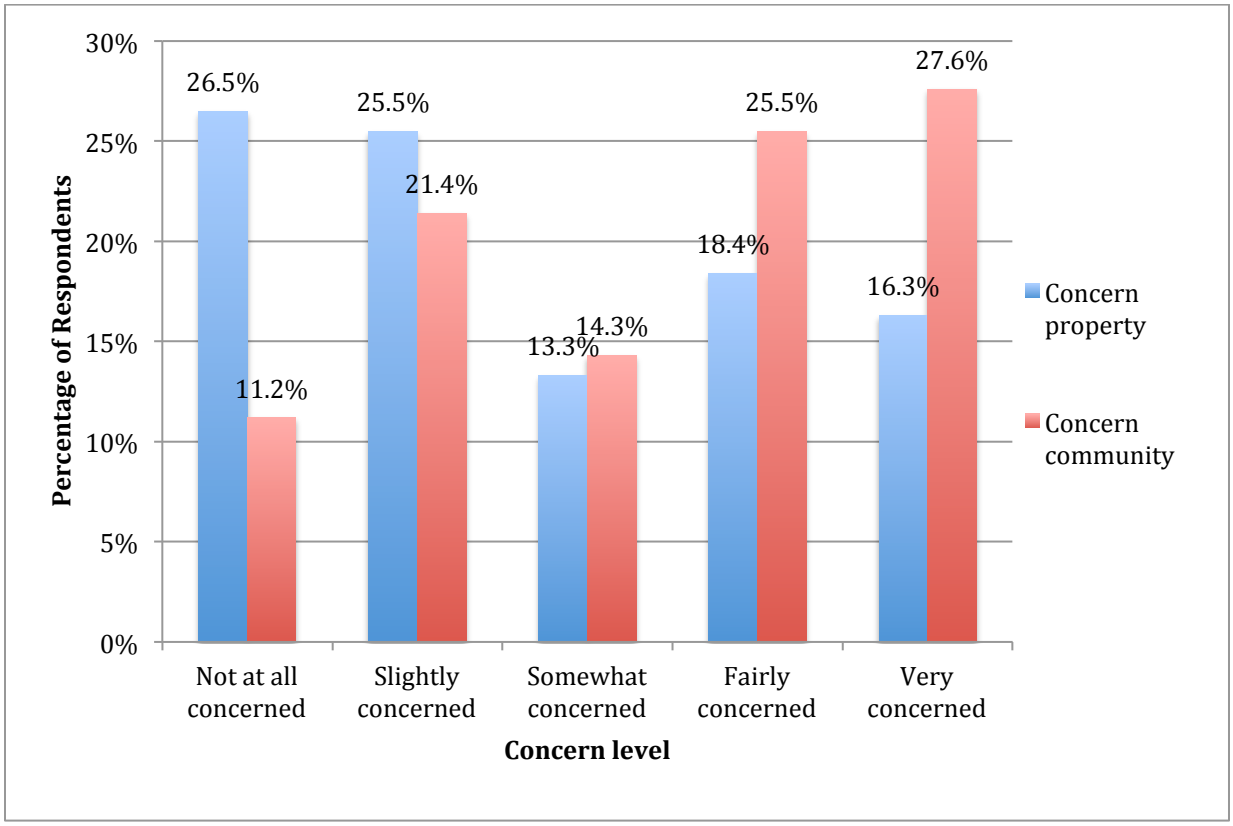

Figure 4.2: Concern Level for Respondents' Property and Community (n = 98)

A perception index was created to better quantify how respondents perceive their flood risk (Table 4.6). This index was created using the responses from the risk level question (17), and the two concern questions (19 and 20) in the survey. The respondents could choose a Likert Scale value from 0 to 4 for each question, and the sum of those answers was divided by 3 (since there were 3 questions used to determine the perception index). For example, a "0" perception index indicates that the respondent chose "no risk" and "not at all concerned" for all three questions. A "4" perception index indicates that the respondent chose "very high risk" and "very concerned" for all three answers. If the respondent scored between 0.33 and 3.67, they had varied responses for the Likert Scale questions. Most respondents (54%) had a moderate level of perception, where their perception index value was between 1 and 3. A third of respondents

(33%) rated their perception as "0" or somewhere in between "0 – 1". At the other extreme, there were 12.7% of respondents who had "high perception" on the perception index scale.

Table 4.6: Perception Index for Risk and Concern (n = 102)

Perception Index Range	Number of Respondents
0 (low perception)	5 (4.9%)
> 0 – 1 (low perception)	29 (28.4%)
> 1 – 2 (moderate perception)	31 (30.4%)
> 2 – 3 (moderate perception)	24 (23.5%)
> 3 – 4 (high perception)	13 (12.7%)

When asked what damages respondents believed their homes would sustain if another flood like Hurricane Matthew were to occur, nearly 80% believe that they will experience flooding in their yard in another flood (Table 4.7). Only 16% believe they would not experience flooding in their homes for future flood events. Nearly 20% of respondents believe that the first level of their home would be flooded, while about 8% believe their entire home would be flooded.

Table 4.7: Expected Damages for Future Floods (n = 97)

Expected Damage	Yes	No
Flooding will not affect my home or property	16 (16.5%)	81 (83.5%)
Flooding in the yard	76 (78.4%)	21 (21.6%)
Flooding in the basement	10 (10.3%)	87 (89.7%)
Flooding into the first level of the home	19 (19.6%)	78 (80.4%)
Flooding in the entire home	8 (8.2%)	89 (91.8%)
Other	8 (8.2%)	89 (91.8%)

4.3 Research Question 2: How are Past Experiences with Flooding, Perceptions of Risk and Concern, and Preparations Related?

Past research has shown that prior experience with floods is related to risk perception (Grothmann and Reusswig 2006, Montz et al. 2017, Mileti and O'Brien 1992). Chi-square

analyses were performed to find statistically significant associations between experience, risk perception and concern for flooding. Likert Scale categories for concern were combined into 3 categories to obtain reliable results: not at all concerned (0), concerned (1), and very concerned (2). Respondents indicated whether they had prior experience with flooding, the number of years since that experience occurred, as well as the type of flooding experienced before and during Hurricane Matthew. Nearly 70 percent of respondents had some sort of experience with flooding while living in Eastern North Carolina (Figure 4.3).

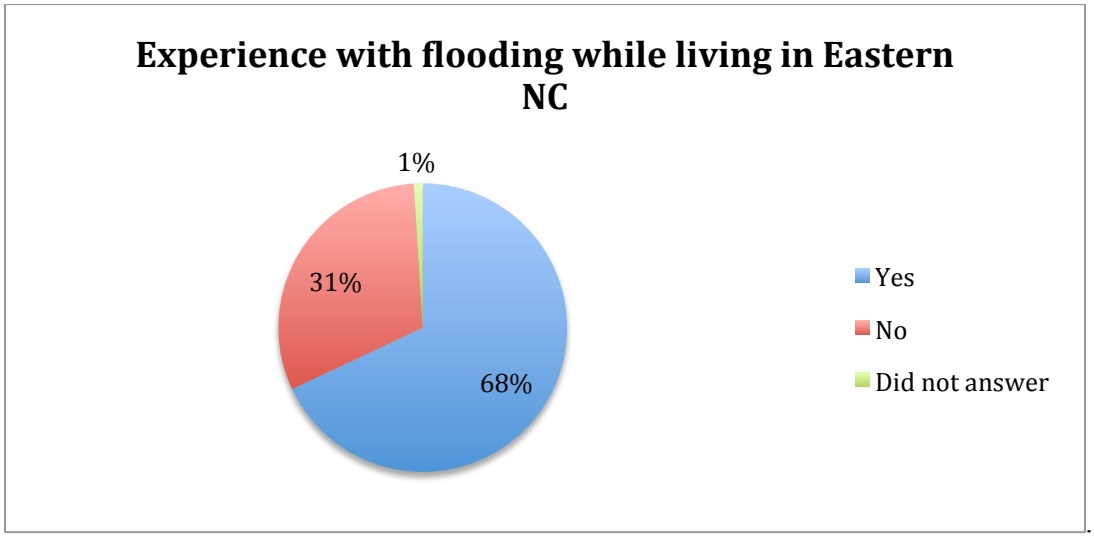

Figure 4.3: Experience with Flooding while Living in Eastern North Carolina

Additionally, many respondents (30) experienced flooding in the last two years, 26 respondents experienced flooding more than 5 years ago, while 33 respondents have never experienced flooding in Eastern North Carolina (Figure 4.4).

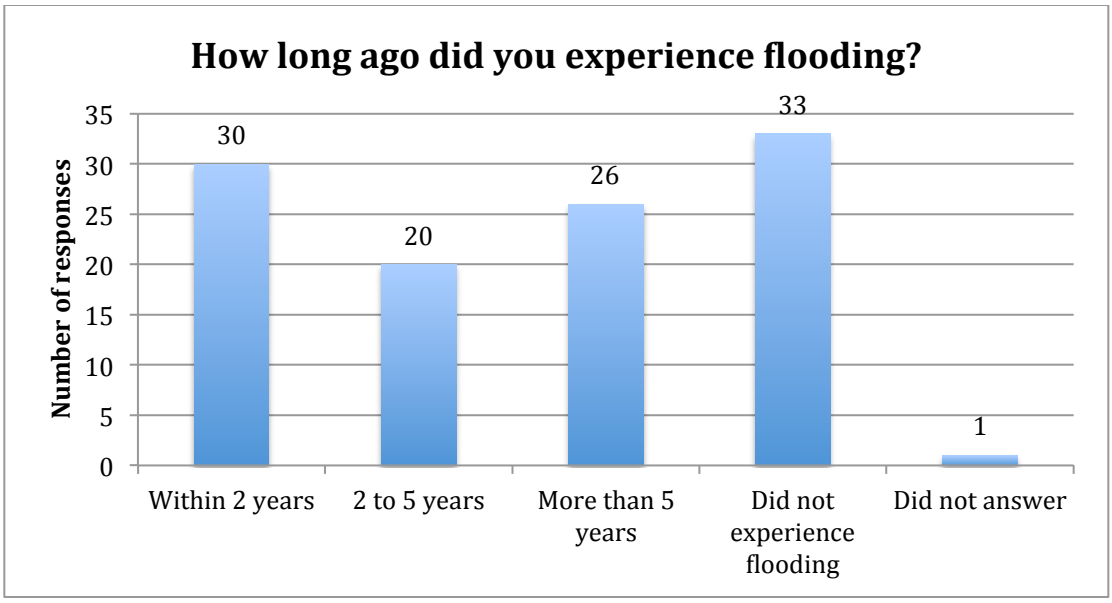

Figure 4.4: How Long Ago did You Experience Flooding?

Respondents were asked about their experience with flooding before Hurricane Matthew. Most respondents indicated either they had no experience with flooding, or they had experience with flash flooding. A total of 24 respondents had experience with major river flooding before Hurricane Matthew (Figure 4.5).

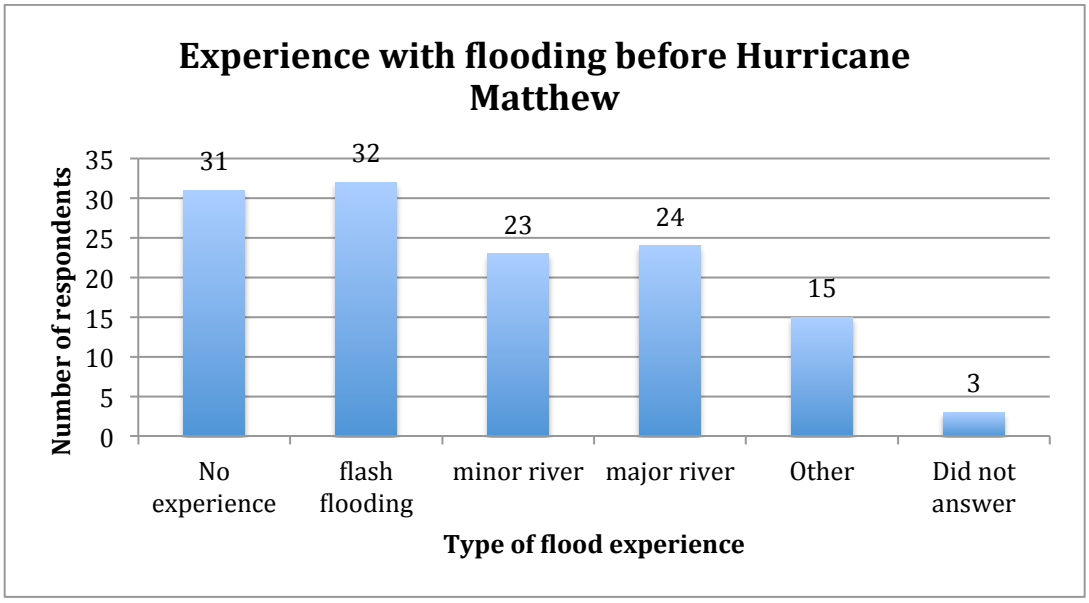

Figure 4.5: Experience with Flooding before Hurricane Matthew

Next, respondents indicated their experience with flash flooding during Hurricane Matthew. Seventy respondents stated they either had no experience with flash flooding from Matthew, or experience but no damage to their personal property. Another 18 respondents indicated they suffered some damage, and 11 respondents stated they sustained major damage with flash flooding from Matthew (Figure 4.6).

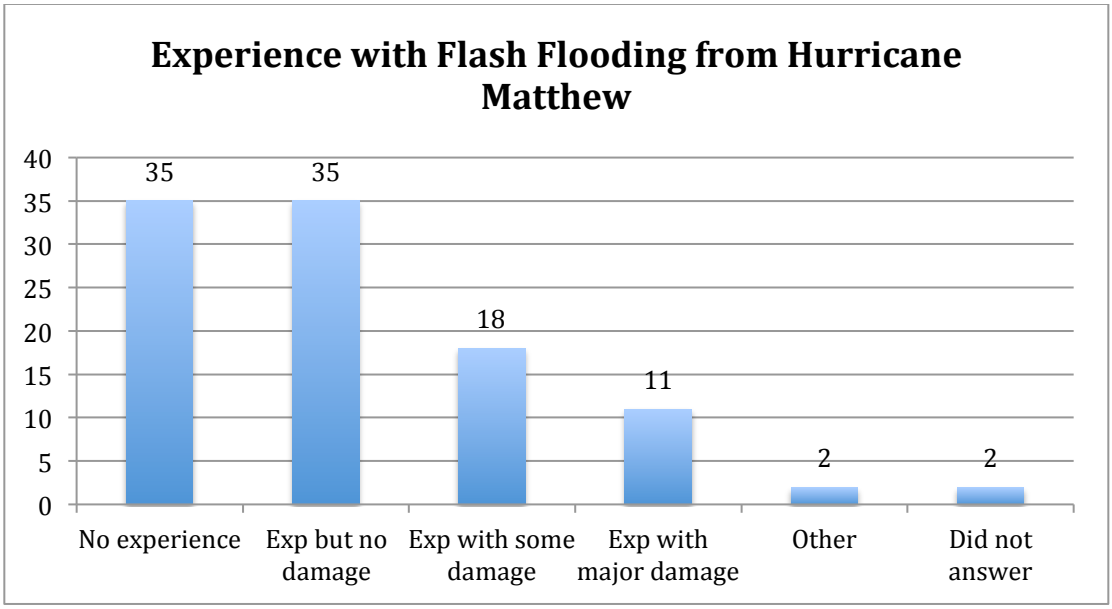

Figure 4.6: Experience with Flash Flooding from Hurricane Matthew.

Additionally, respondents were asked about their experience with river flooding from Hurricane Matthew. The majority of respondents (48) stated they had no experience, while 16 respondents experienced damage from river flooding from Hurricane Matthew (Figure 4.7)

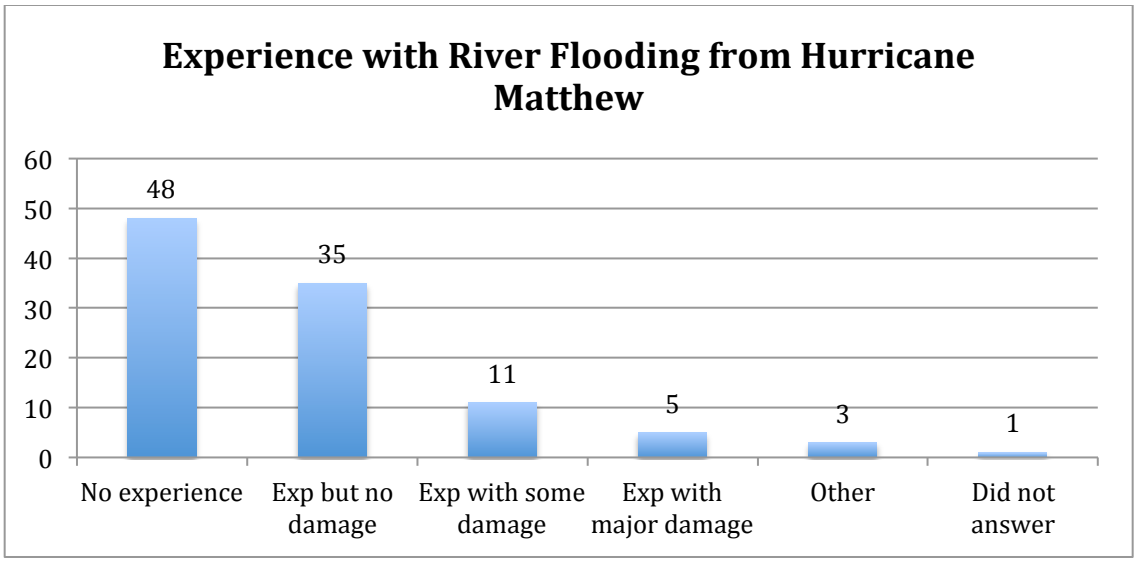

Figure 4.7: Experience with River Flooding from Hurricane Matthew.

4.3.1 Experience and concern level (property)

The first set of variables tested was prior experience with flooding and concern for flooding on one's property (Table 4.7). The results from the Chi-Square (significant at 0.012) indicate an association between experience and concern. Specifically, 17.9% of those with experience said they were not at all concerned, compared to 80% who are either concerned or very concerned. Similarly, only about 23% of those without experience responded that they are very concerned.

Table 4.8: Chi-Square Analysis for Concern Level (Property) and Experience (n = 97)

Experience with flooding		Concern level (property)			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
Yes (1)	Count	12	28	27	67
	% within experience	17.9%	41.8%	40.3%	100.0%
	% within concern level	46.2%	75.7%	79.4%	69.1%

No (0)	Count	14	9	7	30
	% within experience	46.7%	30.0%	23.3%	100.0%
	% within concern level	53.8%	24.3%	20.6%	30.9%

Chi-Square: 0.012
Likelihood Ratio: 0.014

4.3.2 Experience and Concern Level (Community)

Prior experience with flooding and concern for flooding in the community were the next variables tested, which shows significance at 0.002 (Table 4.9). There were 7.5% of respondents who had experience with flooding who are not concerned about flooding in their community. In contrast, the majority of respondents (64.2%) who had experience with flooding are very concerned about flooding in their community. Similarly, of the respondents who had no prior experience with flooding, 20% are not at all concerned about flooding in their community, 53.3% are concerned, and 26.7% are very concerned.

Table 4.9: Chi-Square Analysis for Concern Level (community) and Experience (n = 97)

Experience with flooding		Concern level (community)			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
Yes (1)	Count	5	19	43	67
	% within experience	7.5%	28.4%	64.2%	100.0%
	% within concern level	45.5%	54.3%	84.3%	69.1%
No (0)	Count	6	16	8	30
	% within experience	20.0%	53.3%	26.7%	100.0%
	% within concern level	54.5%	45.7%	15.7%	30.9%

Chi-Square: 0.002
Likelihood Ratio: 0.002

4.3.3 Experience and Perceived Risk

The next set of variables tested that relates to this research question was experience and perceived risk level (Table 4.10). Again, the Likert Scale categories for the risk level were combined: no risk (0), some risk (1), and high risk (2). The results indicate a weak statistical significance ($p = 0.099$). Of the respondents who reported they had experience with flooding, only 11.6% believe they have no risk, while 63.8% believe they have some risk, and 24.6% believe they are at high risk for flooding. Of the respondents who said they have no experience with flooding, 21.4% believe they have no risk, while only 7.1% believe they have a high risk for flooding.

Table 4.10: Chi-Square Analysis for Perceived Risk Level and Experience (n = 97)

Experience with flooding		Perceived risk level			
		No risk (0)	Moderate risk (1)	High risk (2)	Total
Yes (1)	Count	8	44	17	69
	% within experience	11.6%	63.8%	24.6%	100.0%
	% within perceived risk level	57.1%	68.8%	89.5%	71.1%
No (0)	Count	6	20	2	28
	% within experience	21.4%	71.4%	7.1%	100.0%
	% within perceived risk level	42.9%	31.3%	10.5%	28.9%

Chi-Square: 0.099
Likelihood Ratio: 0.075

4.3.4 Experience and Preparation for Future Floods

The final set of variables tested relating to this research question was experience and preparation for future floods (Table 4.11). Three out of the six future actions were statistically significant at 0.05 level: moving furniture to a higher level of home, putting together a disaster preparedness kit, and evacuating.

Table 4.11: Chi-Square Analysis for Experience and Future Preparation Actions (n= 97)

Preparedness action (Future)	Pearson's Chi-Square Test	Likelihood Ratio
Purchasing flood insurance	.185	.182
Bring in outdoor belongings	.120	.118
Moving furniture to a higher level of home	.007*	.005*
Putting together a disaster preparedness kit	.011*	.012*
Purchasing or obtaining a weather radio	.327	.326
Evacuating	.007*	.007*

* = statistically significant at 0.05 level

The significant relationship between experience and moving furniture to a higher level for future floods shows that 80% of individuals who do not have experience with floods do not plan to move their furniture for future floods (Table 4.12). In contrast, 49% of individuals who do have experience with flooding plan to move their furniture for future floods, and 50.7% do not plan on taking that action.

Table 4.12: Chi-Square Analysis for Experience and Moving Furniture to Higher Level (Future) (n = 97)

Experience with flooding		Plan to move furniture to higher level of home for future floods		
		Yes (1)	No (0)	Total
Yes (1)	Count	33	34	67
	% within experience	49.3%	50.7%	100.0%
	% within furniture	84.6%	58.6%	69.1%

No (0)	Count	6	24	30
	% within experience	20.0%	80.0%	100.0%
	% within furniture	15.4%	41.4%	30.9%

Chi-Square = 0.007
Likelihood Ratio = 0.007

The next statistically significant relationship is between experience and putting together a disaster preparedness kit for future floods (Table 4.13). Of those respondents who do not have experience with floods, 50% plan to put together a disaster preparedness kit, and 50% plan to not take that action for future floods. Of those respondents who do have experience with floods, 76% plan to put together a disaster preparedness kit for future floods, while 24% do not plan on taking that action.

Table 4.13: Chi-Square Analysis for Experience and Putting Together a Disaster Preparedness Kit (Future) (n = 97)

Experience with flooding		Plan to put together a disaster preparedness kit for future floods		
		Yes (1)	No (0)	Total
Yes (1)	Count	51	16	67
	% within experience	76.1%	23.9%	100.0%
	% within disaster prep kit	77.3%	51.6%	69.1%
No (0)	Count	15	15	30
	% within experience	50.0%	50.0%	100.0%
	% within disaster prep kit	27.7%	48.4%	30.9%

Chi-Square = 0.011
Likelihood Ratio = 0.012

Additionally, there was a statistically significant relationship between experience and evacuating for future floods (Table 4.14). Of those respondents who do not have flood

experience, 33.3% plan to evacuate for future floods, while 66.7% do not plan to take that action. In contrast, of those respondents who have flood experience, 62.7% plan to evacuate for future floods, while 37.3% do not plan to evacuate.

Table 4.14: Chi-Square Analysis for Experience and Evacuating (Future) (n = 97)

Experience with flooding		Plan to evacuate in the future		
		Yes (1)	No (0)	Total
Yes (1)	Count	42	25	67
	% within experience	62.7%	37.3%	100.0%
	% within evacuating	80.8%	55.6%	69.1%
No (0)	Count	10	20	30
	% within experience	33.3%	66.7%	100.0%
	% within evacuating	19.2%	44.4%	30.9%

Chi-Square = 0.007
Likelihood Ratio = 0.007

4.3.5 Preparation Actions Taken for Hurricane Matthew

To determine what preparation actions respondents took for Hurricane Matthew, a chart was presented, where the respondent checked off those preparation actions that they took (Table 4.15). These six are common actions that the American Red Cross (2016) recommends people do before a flood event. The actions that were most common among respondents for Hurricane Matthew were "bring in outdoor belongings" and "put together a disaster preparedness kit". The preparation actions that were least common among respondents were "purchased flood insurance" and "evacuated".

Table 4.15: Preparation Actions Taken by Respondents for Hurricane Matthew (n = 97)

Preparation Action	Took the preparation action for Hurricane Matthew	Did not take the preparation action for Hurricane Matthew
Purchased flood insurance	16 (16.5%)	81 (83.5%)
Bring in outdoor belongings	60 (61.9%)	37 (38.1%)
Moved furniture to a higher level of the home	26 (26.8%)	71 (73.2%)
Put together a disaster preparedness kit	50 (51.5%)	47 (48.5%)
Purchased or obtained a weather radio	31 (32.0%)	66 (68.0%)
Evacuated	14 (14.4%)	83 (85.6%)

4.3.6 Preparations Respondents Plan to Take for Future Flood Events

Respondents were asked to check all preparation actions they believe they will take for a future flood event (Table 4.16). The future preparation actions that were most frequent choices from respondents were "putting together a disaster preparedness kit" and "evacuating". Evacuating was the action that the least number of respondents said they took for Hurricane Matthew, but it is the second most common action that respondents plan to take for future flood events. The two least chosen preparedness actions are "moving furniture to a higher level of home" and "purchasing flood insurance".

Table 4.16: Preparation Actions Respondents Plan to take for Future Floods (n = 98)

Preparation Action	Plans to take the preparation action	Does not plan to take the preparation action
Purchasing flood insurance	43 (43.9%)	55 (56.1%)
Securing outdoor belongings	48 (49.0%)	50 (51.0%)
Moving furniture to a higher level of the home	40 (40.8%)	58 (59.2%)
Putting together a disaster preparedness kit	67 (68.4%)	31 (31.6%)
Purchasing or obtained a weather radio	47 (48.0%)	51 (52.0%)
Evacuating	53 (54.1%)	45 (45.9%)

4.3.7 Perceived Risk and Preparation Actions Taken for Hurricane Matthew

Again, Chi-Square tests were performed to find statistically significant relationships between the preparation actions, concern levels, and perceived risk levels. This first Chi-Square analysis tested for a relationship between perceived risk and preparation actions taken for Hurricane Matthew (Table 4.17). The only statistically significant preparation action was "bringing in outdoor belongings" (p = .032). Because the actions "purchased flood insurance", "moved furniture to a higher level of home" and "evacuated" had expected counts lower than 5, it was not possible to undertake a valid Chi-Square analysis.

Table 4.17: Chi-Square Analysis for Perceived Risk and Hurricane Matthew Preparation Actions (n= 93)

Preparedness action (Matthew)	Pearson's Chi-Square Test	Likelihood Ratio
Purchased flood insurance	.264 (not valid)	.112 (not valid)
Bring in outdoor belongings	.032*	.035*
Moved furniture to a higher level of home	.162 (not valid)	.182 (not valid)
Put together a disaster preparedness kit	.138	.132
Purchased or obtained a weather radio	.137	.106
Evacuated	.846 (not valid)	.857 (not valid)

* = statistically significant at 0.05 level

The Chi-Square analysis relating to "bring in outdoor belongings" and perceived risk level is shown in Table 4.18. Of those respondents who brought in their outdoor belongings for Hurricane Matthew, 5.2% believed they have no risk of flooding. Of those respondents who did not bring in their outdoor belongings, 22.9% believe they have no risk of flooding and 20% believe they are at high risk for flooding.

Table 4.18: Chi-Square Analysis for Perceived Risk Level and Bringing in Outdoor Belongings for Hurricane Matthew (n = 93)

Bringing in outdoor belongings for Matthew		Perceived risk level			
		No risk (0)	Moderate risk (1)	High risk (2)	Total
Yes (1)	Count	3	44	11	58
	% within outdoor belongings	5.2%	75.9%	19.0%	100.0%
	% within perceived risk level	27.3%	68.8%	61.1%	62.4%
No (0)	Count	8	20	7	35
	% within outdoor belongings	22.9%	57.1%	20.0%	100.0%
	% within perceived risk level	72.7%	31.3%	38.9%	37.6%

Pearson Chi-Square: 0.032
Likelihood Ratio: 0.035

4.3.8 Perceived Risk and Future Preparation Actions

All six preparation actions related to future floods were tested with perceived risk level, but no statistically significant relationships were found. Table 4.19 shows the cross-tabulation between perceived risk and future preparation actions. There was very little difference in the percentage of those who plan to take the future action and those who will not. No matter the perceived risk level, the intended actions are the same. For all preparedness actions, the majority of respondents believe they are at "moderate risk" of flooding no matter if they will take the future action or not.

Table 4.19: Cross-Tabulation for Perceived Risk Level and Future Preparation Actions (n = 94)

Action	Take future action?	No Risk (0)	Moderate Risk (1)	High Risk (2)
Purchasing flood insurance	Yes	12.5%	70.0%	17.5%
	No	13.0%	66.7%	20.4%
Securing outdoor belongings	Yes	6.5%	73.9%	19.6%
	No	18.8%	62.5%	18.8%
Moving furniture to a higher level of home	Yes	5.3%	68.4%	26.3%
	No	17.9%	67.9%	14.3%
Putting together a disaster preparedness kit	Yes	7.8%	73.4%	18.8%
	No	23.3%	56.7%	20.0%
Purchasing or obtaining a weather radio	Yes	8.9%	71.1%	20.0%
	No	16.3%	65.3%	18.4%
Evacuating	Yes	10.0%	70.0%	20.0%
	No	15.9%	65.9%	18.2%

4.3.9 Concern Level (Property) and Matthew Preparedness Actions

The same was done for concern about property flooding and again, there were no statistically significant relationships. Table 4.20 shows the cross-tabulation between these variables. Similar to the previous table, there was very little difference between the percentages of those who plan to take the future action and those who will not.

Table 4.20: Cross-Tabulation for Preparedness Actions Taken for Matthew and Concern Level (Property) (n = 94)

Action	Took the action?	Not Concerned (0)	Somewhat Concerned (1)	Very Concerned (2)
Purchased flood insurance	Yes	26.7%	40.0%	33.3%
	No	27.8%	38.0%	34.2%
Bringing in outdoor belongings	Yes	27.6%	39.7%	32.8%
	No	27.8%	36.1%	36.1%
Moved furniture to a higher level of home	Yes	20.0%	44.0%	36.0%
	No	30.4%	36.2%	33.3%
Put together a disaster preparedness kit	Yes	33.3%	35.4%	31.3%
	No	21.7%	41.3%	37.0%
Purchased or obtaining a weather radio	Yes	33.3%	40.0%	26.7%
	No	25.0%	37.5%	37.5%
Evacuated	Yes	25.0%	41.7%	33.3%
	No	28.0%	37.8%	34.1%

4.3.10 Concern Level (Community) and Preparation Actions Taken for Hurricane Matthew

When the six preparation actions were tested with concern level (community), statistically significant relationships were found with "purchased flood insurance" (Table 4.21).

Table 4.21: Chi-Square Analysis for Preparedness Actions Taken for Matthew and Concern Level (Community) (n = 94)

Preparedness action (Matthew)	Pearson's Chi-Square Test	Likelihood Ratio
Purchased flood insurance	.038*	.018*
Brought in outdoor belongings	.982	.982
Moved furniture to a higher level of home	.223	.216
Put together a disaster preparedness kit	.569	.569
Purchased or obtained a weather radio	.591	.606
Evacuated	.898 (not valid)	.893 (not valid)

* = statistically significant at 0.05 level

Of those respondents who purchased flood insurance, 20% are not at all concerned and 73.3% are very concerned about flooding in their community (Table 4.22). Of those respondents who did not purchase flood insurance before Hurricane Matthew, 10.1% are not at all concerned, while 49.4% are very concerned about flooding in their community.

Table 4.22: Chi-Square Analysis for Concern Level (Community) and Purchased Flood Insurance for Hurricane Matthew (n = 94)

Purchased flood insurance for Hurricane Matthew		Concern Level			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
Yes (1)	Count	3	1	11	15
	% within flood insurance	20.0%	6.7%	73.3%	100.0%
	% within concern level	27.3%	3.0%	22.0%	16.0%
	Count	8	32	39	79

No (0)	% within flood insurance	10.1%	40.5%	49.4%	100.0%
	% within concern level	72.7%	97.0%	78.0%	84.0%

Pearson Chi-Square: 0.038
Likelihood Ratio: 0.018

4.3.11 Concern Level (Property) and Future Preparation Actions

There was only one statistically significant relationship that relates to concern level (property) and future preparation actions (Table 4.23). The future preparation action "evacuating" and concern level for property were found to be statistically significant.

Table 4.23: Chi-Square Analysis for Future Preparation Actions and Concern Level (Property) (n = 96)

Preparedness action (Matthew)	Pearson's Chi-Square Test	Likelihood Ratio
Purchasing flood insurance	.970	.970
Securing outdoor belongings	.331	.329
Moving furniture to a higher level of home	.379	.372
Putting together a disaster preparedness kit	.467	.464
Purchasing or obtained a weather radio	.580	.579
Evacuating	.042*	.039*

* = statistically significant at 0.05 level

The statistically significant Chi-Square test (p = 0.042) between concern level (property) and "evacuating" shows that of those respondents who plan to evacuate in the future, about 79% are concerned about flooding on their property (Table 4.24). Of those respondents who do not plan to evacuate for future flood events, 65.9% are concerned about flooding on their property.

Table 4.24: Chi-Square Analysis for Concern Level (Property) and Evacuating for Future Floods (n = 96)

Evacuating for future floods		Concern Level			
		Not at all concerned (0)	Concerned (1)	Very concerned (2)	Total
Yes (1)	Count	11	26	15	52
	% within evacuating	21.2%	50.0%	28.8%	100.0%
	% within concern level	42.3%	70.3%	45.5%	54.2%
No (0)	Count	15	11	18	44
	% within evacuating	34.1%	25.0%	40.9%	100.0%
	% within concern level	57.7%	29.7%	54.5%	45.8%

Pearson Chi-Square: 0.042
Likelihood Ratio: 0.039

4.3.12 Concern Level (Community) and Future Preparation Actions

When testing for concern level (community) and future preparation actions, none of the actions showed statistically significant relationships. The cross-tabulation for the variables is shown in Table 4.25.

Table 4.25: Cross-Tabulation for Future Preparation Actions and Concern Level for Community (n = 96)

Action	Take future action?	No Risk (0)	Moderate Risk (1)	High Risk (2)
Purchasing flood insurance	Yes	14.0%	32.6%	53.5%
	No	9.4%	37.7%	52.8%
Securing outdoor belongings	Yes	10.4%	31.3%	58.3%
	No	12.5%	39.6%	47.9%
Moving furniture to a higher level of home	Yes	10.0%	25.0%	65.0%
	No	12.5%	42.9%	44.6%
Putting together a disaster preparedness kit	Yes	10.6%	31.8%	57.6%
	No	13.3%	43.3%	43.3%
Purchasing or obtaining a weather radio	Yes	14.9%	27.7%	57.4%
	No	8.2%	42.9%	49.0%
Evacuating	Yes	11.5%	34.6%	53.8%
	No	11.4%	36.4%	52.3%

4.4 Research Question 3: What Sources of Information did People Rely on in Preparing for Hurricane Matthew?

The third research question explores the sources of information respondents used to get information for Hurricane Matthew, and whether or not that information was sufficient to aid them in preparing. Overall, most of the respondents (89.3%) used television to get information. The least common sources of information were the Internet and Facebook. A large percentage of respondents (54.4%) used various radio stations to get information, and over 50% used smartphone applications (Figure 4.8)

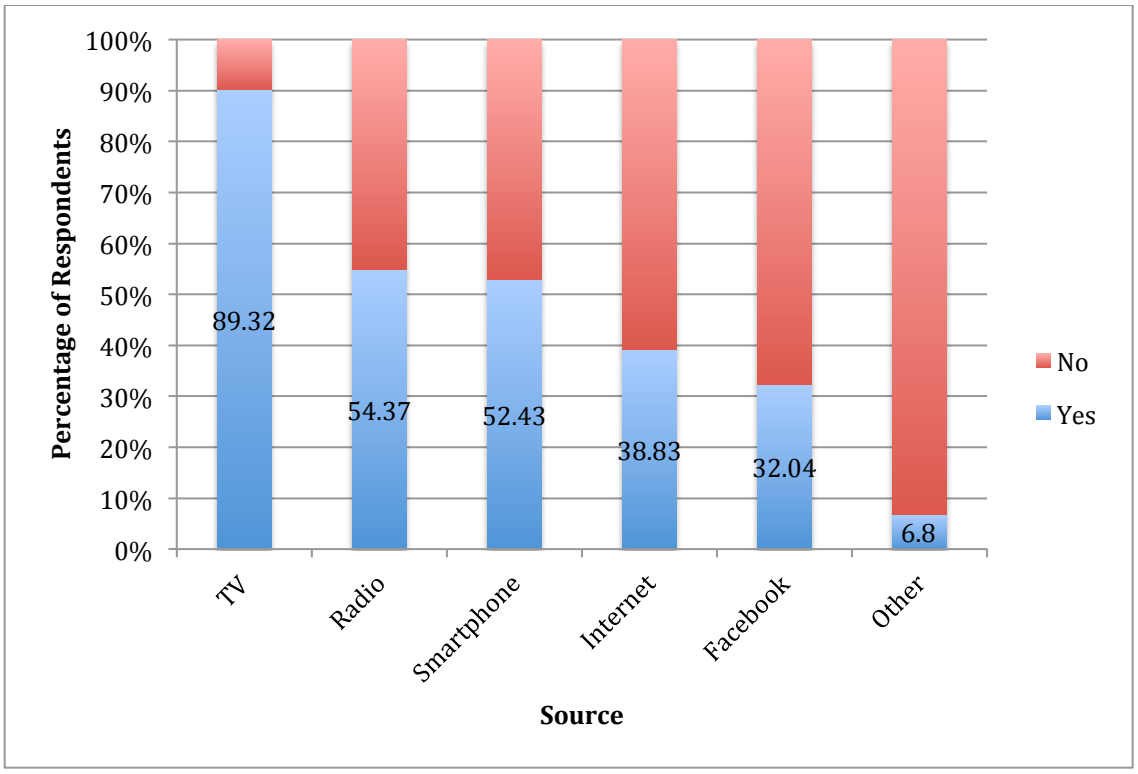

Figure 4.8: Sources of Information Respondents Used for Hurricane Matthew (%)

Respondents were asked to indicate how much advance notice they need to prepare for a flood (Figure 4.9). The majority of respondents (82%) want at least 3 days to prepare – most want 5 or more days. There were very few people who indicated they want less than 3 days to prepare for a flood, and no one wanted less than one day. Some respondents in the "other" category stated that they want as much notice as possible to prepare for a flood event.

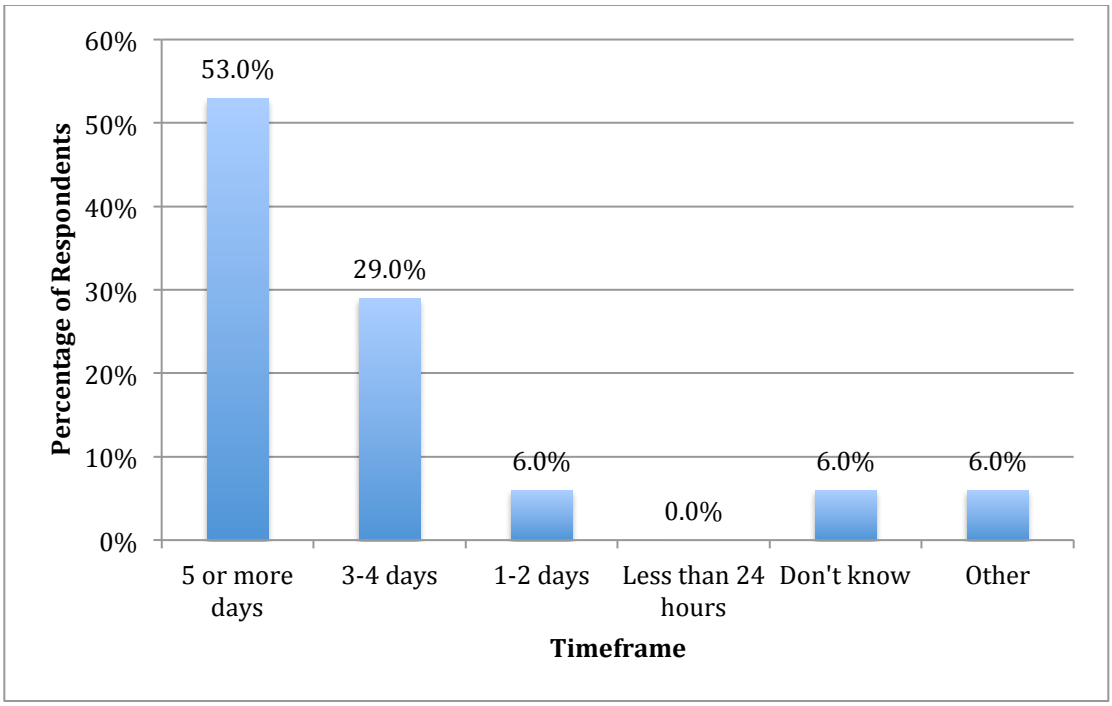

Figure 4.9: Notice to Prepare for a Flood (%)

4.4.1 Information Wanted from Sources for Hurricane Matthew

The types of information that respondents need to plan and prepare for a natural disaster can vary depending on their needs. Forecast information was the most commonly reported type, with nearly 90% percent of respondents choosing this option. Preparation information was the least frequent response among respondents, with only 60% of respondents wanting that type of information. Over 70% of respondents wanted evacuation and flood information for Hurricane Matthew (Figure 4.10).

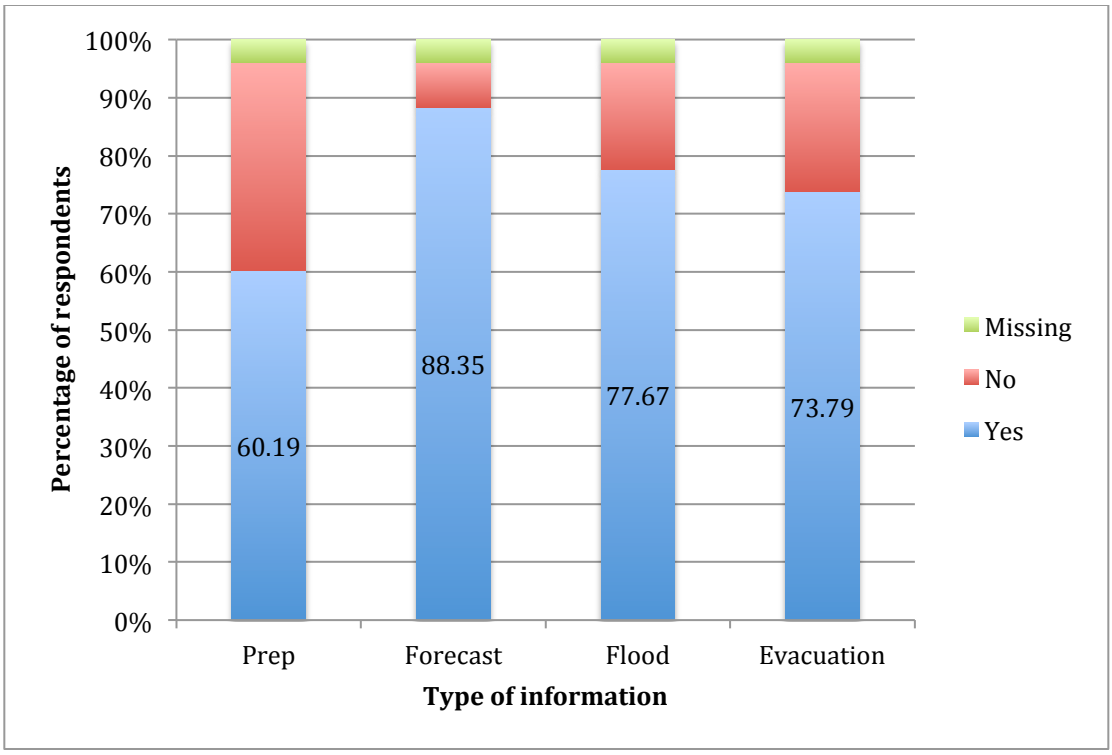

Figure 4.10: Information Wanted from Sources for Hurricane Matthew (%)

4.4.2 Effectiveness of the Information Received for Hurricane Matthew

Respondents were also asked to rate the effectiveness of the information they received from various sources in helping them plan and prepare for Hurricane Matthew. The question was presented as a 5-point Likert Scale, ranging from not effective to very effective. The category "very effective" had the greatest number of responses, while "not effective" had the least number (Figure 4.11). Clearly, most of the respondents believed that the information they received was effective in helping them prepare for Hurricane Matthew.

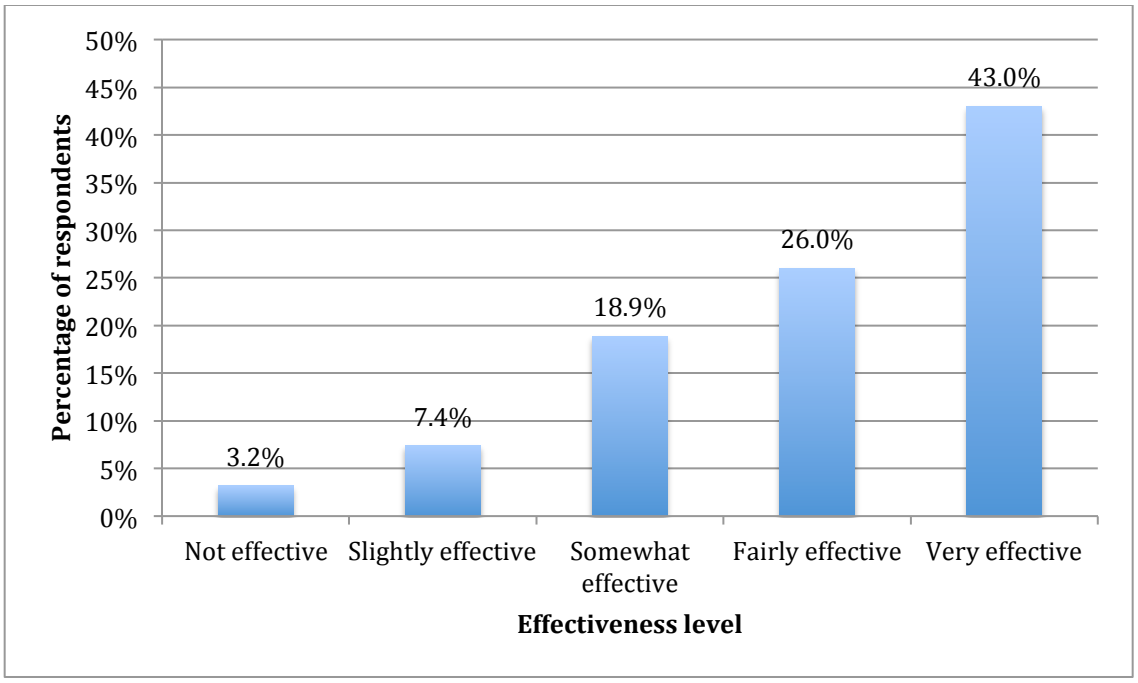

Figure 4.11: Effectiveness of the Information in Helping the Respondent Prepare for Hurricane Matthew (%)

Respondents were asked if the information they received from sources for Hurricane Matthew was what they wanted. Over 84% of respondents believed that this was the case for Hurricane Matthew, while about 15% of respondents stated that they did not get the information they wanted (Figure 4.12). Overall, the majority of respondents were satisfied with the information they received from various sources for Hurricane Matthew.

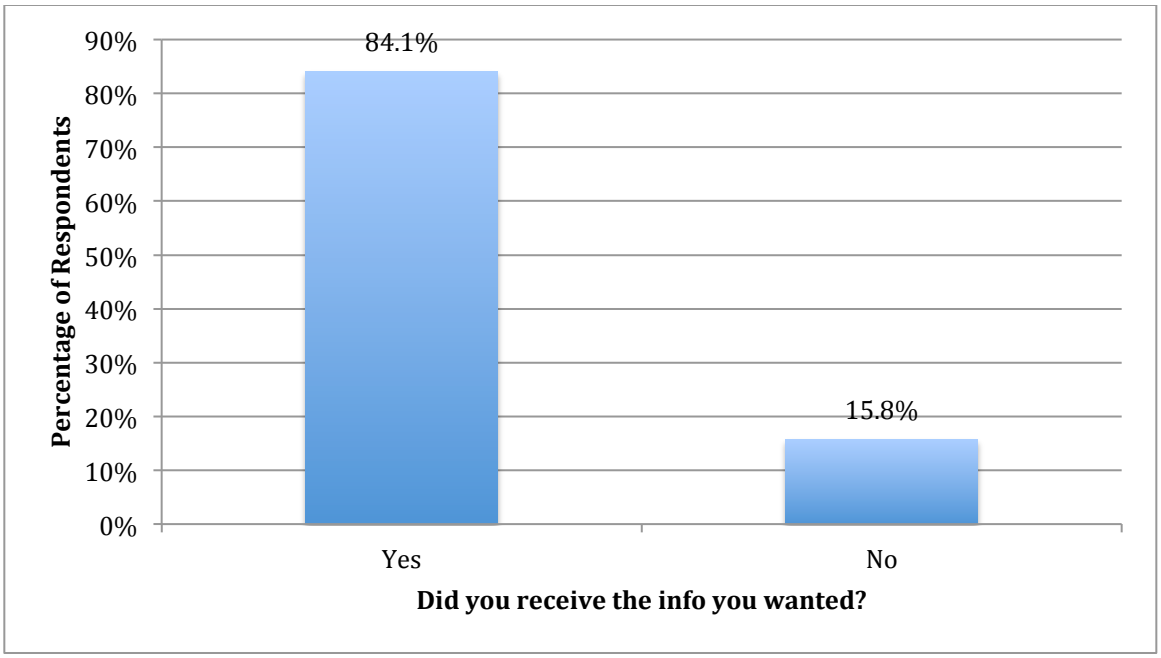

Figure 4.12: Did the Respondent Receive the Information They Wanted for Hurricane Matthew? (%)

If the respondents did not get the information they wanted, they had the opportunity to explain how that lack of information affected their situation (Table 4.26). Fourteen respondents filled in information for this question. It was then analyzed for the main theme and sub-themes, as well as examples for each sub-theme. Road closure information was the most common answer to this open-ended question – respondents wanted to know which roads in the area were closed so they could prepare accordingly. Other information they wanted was the track of Hurricane Matthew. A few respondents stated that the track of the storm did not go where it was forecasted. Evacuation time frame and underestimation of impacts round out the top four answers for this question. Two respondents stated that they could not evacuate quickly enough before Hurricane Matthew made landfall.

Table 4.26: Content Coding Categories and Examples of Lack of Information

Theme	Sub-Theme	Example	Number of responses
Lack of Information for Hurricane Matthew	Road Closures	"My nurse could not reach our location to provide medical treatment"	4
	Track of Hurricane	"I do feel like the landfall was much further west than anticipated."	2
	Evacuation Timeframe	"I wasn't able to evacuate fast enough"	2
	Underestimated Impacts	"They underestimated"	2
	Information for Other Areas	"I was worried about relatives in other counties."	1
	Correct Information	"I would have been better prepared if I was given the correct information"	1
	Wind Damage	"There was some wind damage to my roof that I wasn't expecting"	1
	Flood Information	"Need more information on flooding"	1

Respondents were asked what other information would they have wanted to plan and prepare for Hurricane Matthew (Table 4.27). Twenty-nine percent of respondents filled in information for this open-ended question. The information that respondents wanted most was more forecast information, which they said was necessary for their situations. Examples of desired forecast information include: better track information, more warnings, and more location-based forecasts and potential damage predictions. In the previous content coding, there were respondents who stated the track and landfall of Hurricane Matthew affected their

situations, which could make them want more forecast information for future flood events. Evacuation information, preparation information, and road conditions rounded out the top four responses to this question. Respondents also expressed concerns about the visuals presented to them, as well as the dams releasing water. Shelter information appeared a couple of times as a response to this question – respondents expressed concern about where to find shelters and having more shelter locations open during natural disasters.

Table 4.27: Content Coding Categories and Examples of Other Information

Theme	Sub-Theme	Example	Number of responses
Other information desired	More Forecast Information	"I would like more info on areas most likely to flood"	9
	Evacuation Information	"More urgency about evacuation"	3
	Preparation Information	"Perhaps a comprehensive preparation list"	3
	Road Conditions	"I wish we had a possible detour route when flooding and storms occur"	3
	Shelter Information	"More locations for shelters"	2
	Dam Release Information	"How the release of water from the dam will affect my area"	2
	Better Visuals	"Literacy levels are low here… visuals could aid those who struggle with reading"	1
	Better Warnings	"More advanced warnings"	1
	Damage Information	"Need more info on local damage"	1

4.5 Research Question 4: How much Trust do Residents Put in their Preferred Sources to Inform Them of Future Flood Events?

The final research question examines the level of trust residents put into various sources to inform them of flood events. Two questions in the survey relate to this research question. Respondents were asked if they would rely on the same sources they used to plan and prepare for

Hurricane Matthew for future flood events. The majority of respondents (95%) would use the same sources (Figure 4.13).

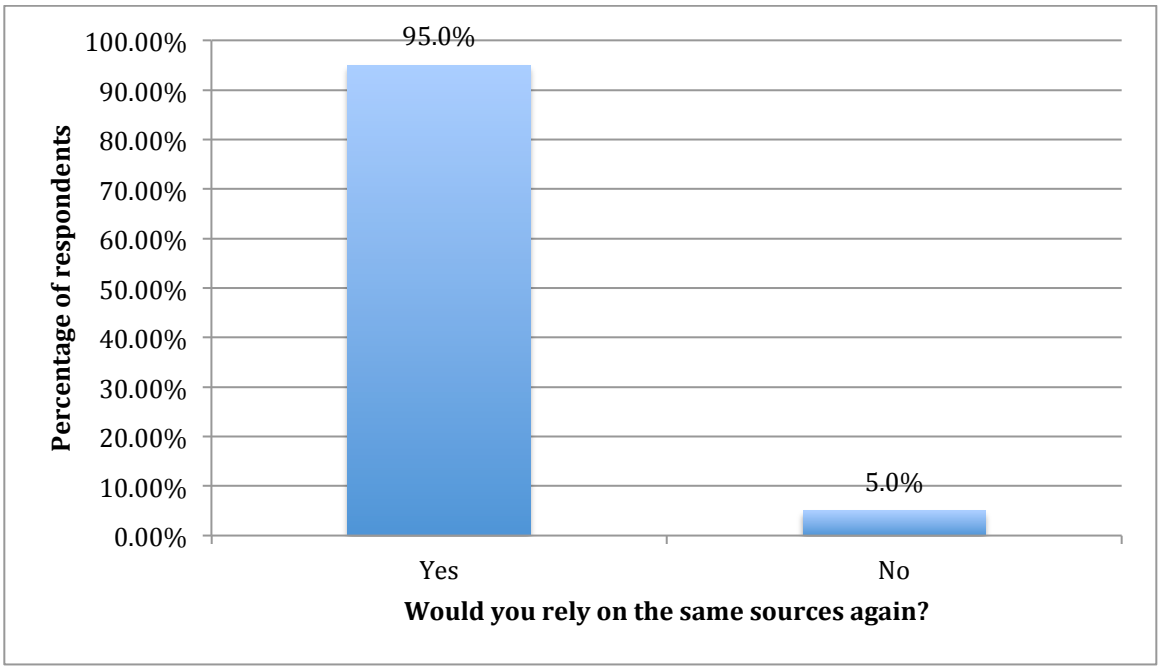

Figure 4.13: Would Respondents Use the Same Sources for Future Flood Events? (%)

Respondents were also asked to describe why they would or would not use the same sources again for future flood events. Their responses were content-coded in nVivo to find themes in the data. Each data point was coded as either "positive" or "negative", then divided into different coding categories. There were 5 responses that were coded "negative" and 43 responses that were coded "positive". In the negative category, responses were then split up into three different categories based on the topic of the response (Table 4.28). Two respondents stated that for future flood events, they need better forecasts and warnings to prepare, and two respondents said that the sources they used to prepare for Hurricane Matthew were the only ones available. One respondent stated that he/she needs better sources to prepare for a future flood event.

Table 4.28: Negative Responses for Using the Same Source for Future Flood Events

Theme	Sub-Theme	Example	Number of responses
Using the Same Source for Future Floods	Better forecasting/warnings	"Need to be more focused on track information"	2
	Only sources available	"This is all there is"	2
	Need better sources	"I'll find better sources next time"	1

The 43 positive responses were coded into 11 different themes (Table 4.29). The most common was "good information presented" with 10 responses related to that theme. Satisfaction with sources was the second most common theme with 6 responses. The themes "kept me safe" and "helpful" had 5 responses, which rounded out the top four most popular common themes for this question. Other notable themes identified include "effective", "prepared me well", "trustworthy" and "reliable".

Table 4.29: Positive Responses for Using the Same Source for Future Flood Events

Theme	Sub-Theme	Example	Number of responses
Using the Same Source for Future Floods	Good information presented	"Accurate and timely info"	10
	Satisfied with sources	"The sources were enough"	6
	Kept me safe	"I stayed safe"	5
	Helpful	"They were the most helpful sources available"	5
	Effective	"They were effective for me"	4
	Prepared me well	"I was able to evacuate before all access road shut down"	3
	Local stations	"Local stations are best for local news and information"	3
	Trustworthy	"Easily available and trustworthy"	2
	Reliable	"As reliable as possible"	2
	Convenience	"Convenient"	1
	Informative	"Informative"	1

CHAPTER 5: DISCUSSION AND ANALYSIS

Eastern North Carolina is a particularly flood prone region, and it is important to understand what factors influence residents' perceptions of flooding. Past studies have developed a solid foundation for further examination of factors that influence flood risk perceptions; however, many of these studies have been conducted in Europe or in large cities in the United States. This research is aimed at filling a gap in regions that primarily consist of small towns and cities, like Eastern North Carolina, while also adding to prior knowledge on flood risk perceptions.

5.1 Summary of Results

The demographics of respondents showed slight variation – especially in education. Most people had a college education – either an Associate's degree or a Bachelor's degree, and a small percentage with a graduate degree. Most respondents in this study were either White or Black/African American, and over the age of 50.

The first research question revealed how respondents view their flood risk, and how concerned they are about future flooding in their homes and communities. Most of the respondents believe they are at some risk of flooding in their homes, but are generally not very concerned about it. Respondents were more concerned about flooding in their communities – over half of respondents chose the top two concern categories (fairly concerned or very concerned). Most respondents believe their property will see flooding if another Hurricane Matthew were to occur. Eighty percent believe that they will see flooding in their yard, while over 20 percent believe there will be flooding in their home.

Prior experience with flooding and concern level for flooding on property were found to be related, with over 80 percent of those with prior experience either being concerned or very concerned about future floods. Additionally, prior experience with flooding and concern level for flooding in the community are related. Residents who have experienced floods have a higher level of concern for flooding in their communities compared to those who have never experienced a flood event. Prior experience with flooding and perceived risk of flooding are related, but it is not a strong relationship ($p = 0.099$). Generally, respondents who had experience with flooding perceived their flood risk level to be higher than those who had no experience. Additionally, significant relationships were found between three out of six future preparedness actions and prior experience with flooding. This aligns with previous research on the effects of experience. How long this influence will last remains unknown, but given that the last major flood occurred in 1999, it appears that the experience remains important in people's perceptions.

Research question two relates risk perceptions and concerns for flooding with preparation actions. Perceived risk for flooding and the preparation action "securing outdoor belongings" for Hurricane Matthew were related. Those who brought in outdoor belongings for Hurricane Matthew generally viewed their flood risk as higher compared to those who did not bring in their outdoor belongings. Concern level for the respondents' community and the preparation action "purchased flood insurance" for Hurricane Matthew are also related. Those who purchased flood insurance prior to Hurricane Matthew have a higher concern level for flooding than those who did not have flood insurance. Some of this might be related to their location in or near the floodplain, and/or the requirements for flood insurance under the National Flood Insurance Program.

Additionally, concern level for flooding on the respondents' property and the future preparation action "evacuating" are related. Respondents who plan to evacuate for future floods are overall more concerned about flooding on their property compared to those who do not plan to evacuate for future floods. However, there is a relatively large percentage of respondents (40.9%) who do not plan to evacuate for future flood events and, yet, are very concerned about flooding on their property. This may be related to the magnitude of flooding anticipated or difficulties seen with evacuation. Unfortunately, these questions were not part of the survey.

Television was the source that respondents mostly relied on to prepare for Hurricane Matthew. Many respondents stressed the importance of local television during high impact weather events and expressed their trust in local television to inform them of future flood events. This aligns with prior research on the role of local television in preparing them for weather events. People can develop a relationship with their local television meteorologist and ultimately trust them during adverse weather events (Sherman-Morris, 2005).

5.2 Implications

The results of this study add to our knowledge about individual perceptions of risk and the factors that could be influencing those perceptions. This study reinforces the work by Siegrist and Gutscher (2006) and Box et al. (2016) who found that prior experience with floods could play a role in risk perception. Additionally, Siegrist and Gutscher (2006) found that those who have prior experience with flooding oftentimes have a different emotional reaction than those who do not have flood experience. This study aimed to capture the emotional aspect of risk perception, by asking respondents to rate their level of concern for future floods. Prior experience with floods and concern were found to be related in this study, such that those who

experienced a flood event before expressed higher levels of concern for future floods than those who have never experienced a flood. This suggests that those with flood experience have a different emotional reaction than those with no flood experience. It is likely that those who have never experienced a flood event before are more optimistic when it comes to the consequences of future floods (Lawrence et al., 2014), as this research suggests.

Past experience can also impact residents' preparedness and responses to future hazardous situations (Box et al., 2016). The resulting fear and anxiety from previous flood experience are more likely to motivate people to undertake action in the future (Bubeck et al., 2012). Experience was related to three future preparation actions: moving furniture to a higher level of the home, preparing a disaster preparedness kit, and evacuating. Generally, respondents who have prior experience with flooding plan to undertake more preparedness actions compared to those who do not have experience. A public outreach program dedicated to flood education would be beneficial in Eastern North Carolina. Since prior experience with flooding does relate to future preparations for flood events, it is vital for all residents of Eastern North Carolina to know the history of floods in the region as well as the dangers of flooding.

Again, a rather large percentage of respondents (40.9%) indicate they do not plan to evacuate for future floods but are "very concerned" about future flooding. This may be related to the difficulties of evacuating for extreme weather events, such as transportation, finances, and temporary housing. Future research in Eastern North Carolina could include exploring why respondents are concerned about flooding but do not plan to evacuate in the future.

5.3 Limitations

While this study provides some important information, there are some limitations that must be acknowledged. The information presented in this research is valuable, but not necessarily generalizable. This study only examines flood risk perceptions of Eastern North Carolinians chosen from specific counties, so the respondents were very similar geographically. The demographics of the respondents did show slight variation, but not necessarily enough variation to make broad conclusions about North Carolina or the American public in general.

Another limitation is that respondents were not required to answer every question in the survey. Respondents were allowed to skip questions. This was done in order to increase the number of completed surveys, but analyzing responses was more difficult since not everyone answered every single question. For the cross-tabulation analyses, where two variables were analyzed, some respondents only answered the question for one of the variables but skipped answering the question for the second variable. This resulted in some respondent answers not being able to be analyzed using cross-tabulation and Chi-Square analyses.

Additional questions could have been asked in this survey to help solidify the results, specifically, more detailed questions. It would have been beneficial to directly ask respondents whether their experience with Hurricane Matthew was direct or indirect. Understanding the type of experience that respondents had with Matthew could have provided more detailed results from Chi-Square analyses. It would have been interesting to ask respondents more open-ended questions about the preparation actions they took for Matthew and those they plan to take in the future. Respondents were only give a few common preparation actions to choose from, and including open-ended questions may have provided some insight into other preparation actions that Eastern North Carolinians take to prepare for floods. Additionally, it would have been

helpful to know the respondents' location with respect to the 100-year and 500-year flood plains. Since respondents may not be able to identify their location on a survey, or could potentially get it wrong, the most effective way to accomplish this would be a door-to-door survey. Respondents could also mark their location on a map.

This study was constrained to one geographical area and three counties in North Carolina. In the future, this study could be expanded to encompass a larger geographic area to reach a larger audience. While a paper survey instrument is an effective data collection tool for social science research, online survey instruments could be useful for a study like this in order to reach a larger audience. Additionally, focus groups and interviews could be useful tools to collect data in order to gain more insight into respondents' experiences with flooding and flood risk perceptions in Eastern North Carolina.

5.4 Contributions to Knowledge

This study extends the knowledge from existing literature on flood risk perception research and builds a foundation for continuing research on this topic. With floods increasing in quantity and severity, it is critical to understand how individuals view their flood risk in their homes and communities. In particular, risk perception research in rural regions like Eastern North Carolina is particularly valuable since these regions can be quite vulnerable in flood events (Cross, 2001). Building on previous literature, this study highlights the role that prior experience with flooding plays into future flood risk perceptions and preparations. Previous experience with flooding can impact how people view their flood risk and their motivation to undertake life-saving preparation measures for future flood events.

Survey data collected through this study could be analyzed in different ways in the future to gain more insight. More analysis could be put into preparations, specifically which preparation actions are most and least important to the respondents, and comparing that to future actions the respondent plans to take to help mitigate flood risk. Additionally, further analysis on the demographic information and future preparation actions could potentially lead to significant results.

This study integrates a wide range of research and ideas from a variety of disciplines, including meteorology, geography, social science, psychology, and communications, making this research valuable to many different fields. It is the hope that this research can fill gaps in previous risk perception literature, and will provide thorough knowledge to Eastern North Carolina's meteorologists and emergency officials in order to help them better prepare their residents for future flood disasters.

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Appendix A: IRB Approval Letter

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/ORIC/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Samantha Connolly
CC: Burrell Montz Covey
Samantha Connolly
Date: 8/7/2017
Re: UMCIRB 17-001618
Understanding Flood Risk Perceptions

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 8/7/2017 to 8/6/2018. The 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:

Name	Description
Consent Form	Consent Forms
Survey	Surveys and Questionnaires
Thesis Proposal	Study Protocol or Grant Application

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

Appendix B: The Survey

1. Have you experienced one or more significant flood events (ex: experienced damage, loss, evacuation)?
    - o Yes
    - o No

2. If yes, please indicate:
    - o Within the last 2 years
    - o 2-5 years ago
    - o More than 5 years ago

3. What was your experience with flooding ***before*** Hurricane Matthew? Check all that apply.
    - ☐ Never experienced flooding before Matthew
    - ☐ Experienced flash flooding before Hurricane Matthew
    - ☐ Experienced minor riverine flooding before Hurricane Matthew
    - ☐ Experienced major riverine flooding before Hurricane Matthew
    - ☐ Other (please describe) _____

4. What was your experience with precipitation flooding (i.e flash flooding) from Hurricane Matthew? Please check one.
    - o Did not experience precipitation flooding from Hurricane Matthew
    - o Experienced precipitation flooding but no damage to personal property

- Experienced precipitation flooding that caused some damage to personal property
- Experienced precipitation flooding that caused massive damage to personal property
- Other (please describe) _____

5. What was your experience with flooding from the river during Hurricane Matthew? Please check one.
    - Did not experience river flooding from Hurricane Matthew
    - Experienced river flooding but no damage to personal property
    - Experienced river flooding that caused some damage to personal property
    - Experienced river flooding that caused massive damage to personal property
    - Other (please describe) _____

6. How much advance notice do you want to prepare for a flood?
    - 5 or more days
    - 3-4 days
    - 1-2 days
    - Less than 24 hours
    - Don't know
    - Other (please describe) _____

7. Please check all that apply

Question	**Purchase flood insurance**	**Bring outdoor belongings inside**	**Move furniture to higher level of home**	**Assembling a disaster preparedness kit**	**Buy/obtain a weather radio**	**Evacuate**
What preparation actions did you take for Hurricane Matthew?						
Which preparedness actions do you believe are the most important when preparing for a flood disaster?						
Which preparedness actions do you believe are the least important when preparing for a flood disaster?						
Which preparedness actions will you take in the future to prepare for a flood disaster?						

8. What sources did you use to get information about Hurricane Matthew? Check all that apply.

   ☐ TV: Station(s)?

   _____

   ☐ Radio: Station(s)?

   _____

   ☐ Smartphone: App(s)?

   _____

   ☐ Internet: Website(s)?

   _____

   ☐ Facebook: Source(s)?

   _____

   ☐ Other

   _____

9. What information would you have wanted from these sources during Hurricane Matthew? Check all that apply

   ☐ Forecast/track information

   ☐ Preparedness information

   ☐ Evacuation information

   ☐ Flood information

   ☐ Other (please describe)

   _____

10. What information would you like to receive prior to a hurricane/tropical cyclone? Check all that apply

    ☐ Forecast/track information

    ☐ Preparedness information

    ☐ Evacuation information

    ☐ Other (please describe)

    _____

11. Did you receive the information you would like to have for Hurricane Matthew?

    o Yes

    o No

12. If no, how did this lack of information affect your situation?

    _____

    _____

13. How effective was the information you received in helping you prepare for Hurricane Matthew? Please circle one

Not at all effective	Slightly effective	Somewhat effective	Fairly effective	Very effective

14. What other information would you have wanted to plan and prepare for Hurricane Matthew?

_____

_____

_____

15. Would you use the same sources you used during Hurricane Matthew to plan and prepare for a future flood event?

    - o Yes
    - o No

16. Why would you use or not use those same sources for a future flood event?

_____

_____

17. How do you rate your own chance of experiencing flooding in your home? Please circle one.

No risk	Very little risk	Slight risk	Somewhat high risk	Very high risk

18. What damages do you believe your property or home would sustain if another flood in the future were to occur similar to the flood from Hurricane Matthew? Check all that apply.

    - ☐ Flooding in the yard
    - ☐ Flooding in the basement
    - ☐ Flooding into the first level of home
    - ☐ Flooding into the entire home
    - ☐ Flooding will not affect my property or home

☐ Other (please describe)

_____

19. How concerned are you about riverine flooding on your property or in your home? Please circle one

Not at all concerned	Slightly concerned	Somewhat concerned	Fairly concerned	Very concerned

20. How concerned are you about riverine flooding in your community? Please circle one

Not at all concerned	Slightly concerned	Somewhat concerned	Fairly concerned	Very concerned

21. Which of the following best describes your age?

- 18 to 29
- 30 to 39
- 40 to 49
- 50 to 59
- Over 60

22. What is your gender?

- Male
- Female
- Transgender
- Prefer not to answer

23. With what racial or ethnic group do you most identify?
- White
- Black or African-American
- Hispanic or Latino
- Native American or American Indian
- Asian or Pacific Islander
- Other

24. What is the highest level of education you have completed?
- Less than high school
- High School or GED
- Trade School

- Associate's Degree
- Bachelor's Degree
- Professional or Graduate Degree

25. In what zip code do you consider your permanent home to be located?

_____

26. Do you own your home or rent?

- Own
- Rent

Thank you for your participation!