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Hurricane Forecasting, Warning and Response Systems: A Lake Wales Public Perception Study

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by

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ABSTRACT

This research investigates the public perception of hurricane forecasting and warning systems with a view to improving response activities. The hazard literature shows that the effectiveness of such systems is contingent upon on the smooth operation of all components of the system and that warning recipients fully understand the implications of the warning message by taking appropriate action. It is argued that public perception of warning systems will vary depending on various socio-demographic factors, such as age, gender, level of education, socioeconomic status and area, factors that will ultimately influence overall effectiveness. To test this, a questionnaire survey was undertaken of local residents in Lake Wales, Florida, a town that was severely impacted by three hurricanes in the 2004 season. Results indicate that some demographic factors appear to influence an individual's willingness and ability to respond. Overall, level of education and income seem to have a larger affect on response than age or gender.

The two sampling areas in Lake Wales elicited more significant differences than do the other variables but, the area variable takes into account all of the other factors of age, gender, level of education, and socioeconomic status. In fact, what is argued here is that area actually acts as a surrogate variable for the others. Therefore, it is not where one is located that makes a difference but the composition of the people in the location itself.

Chapter One: Introduction

The 2004 hurricane season in the North Atlantic Ocean was rather active compared to years past. There were 15 named storms, 9 of which affected a United States coastline (Franklin et al. 2006). Three of the most notable, Charley, Frances, and Jeanne, all crossed Florida. The average number of storms per year, based on data from 1944-1996, is approximately 10 named storms and 6 hurricanes, including 2-3 major hurricanes. The pre-season prediction from the National Oceanic and Atmospheric Administration (NOAA) for the 2004 season was 12-15 named storms. Six to eight of these storms were predicted to become hurricanes and 2-4 major hurricanes. The 2004 North Atlantic Ocean hurricane prediction was based on several different factors. These factors include the continuation of a multi-decadal cycle that has been in an active phase since 1995, warmer than normal sea surface temperatures, and a neutral ENSO phase (NOAA 2004). The 2004 hurricane season was the most expensive for the United States with an estimated cost of $42 billion. Florida proved particularly vulnerable. For example, it is estimated that one in five homes in Florida was damaged by a hurricane during August and September of 2004 (NOAA 2004).

The objective and goal of this research is to evaluate forecasting, warning and response systems with respect to public perception and response associated with hurricanes. The case being investigated herein is the 2004 North Atlantic hurricane season within the city of Lake Wales, Florida.

This thesis first reviews the literature regarding forecasting, warning and response systems. Due to the fact that much of the published literature about forecasting, warning and response systems covers floods, many of the examples used have to do with these events. Second, the framework for this research, which is based on the general systems theory and the systems approach, is described. This is followed by the research questions and hypotheses, then the methodology and results. Descriptive and statistical analyses are provided along with a discussion of the findings and outcomes. Finally, this thesis concludes with a discussion of the significant outcomes and future practical applications.

Chapter Two: Literature Review

General Information

"…it should be understood that forecasts have no intrinsic value. They acquire value through their ability to influence the decisions made by users of the forecasts." (Murphy 1993)

A forecasting, warning and response system provides alerts of impending problems for individuals and organizations to take action to save lives and property. In recent years, death and injuries caused by natural hazards have been reduced (Sorensen 2000), particularly because of the implementation of forecasting, warning and response systems. Forecasting, warning and response systems help officials and individuals prepare ahead of an event and help to mitigate the effects caused by natural hazards during and after the event.

Primarily, a forecasting, warning and response system is designed to reduce the loss of life, although it is also designed to reduce structural and economic losses. These systems tend to be very complex and often involve the interaction of physical, technological, and social systems (Foster 1980). These systems also require regular evaluation (Parker and Fordham 1996) to keep up

with the society's needs. Effective forecasting, warning and response systems are vital to all members of a community.

For example, the Big Thompson flood in Big Thompson Canyon, Colorado in 1976 demonstrated to the United States that as a society the local, state, and federal levels need to work together to reduce the risks faced from flooding. Because these systems are vital to everyone, all levels of government need to work together in order to make forecasting, warning and response systems effective.

In the Big Thompson flood there was little to no warning for residents and visitors to the area. Heavy rains fell on the evening of July 31st over the central portion of the Big Thompson Watershed. Most of the major flooding occurred after dark, which compounded the problem for citizens and rescue personnel. Also, it is more difficult to get a warning message to the public at night because people are asleep and away from sources of warning information. The peak stream flow recorded at the mouth of the canyon was 31,200 cubic feet per second (Gruntfest 1996). Many communities face a similar risk to that experienced in the Big Thompson Canyon (Krimm 1997) in that warning information often times does not get to the target audience quickly enough and in understandable terms. This alone makes efficient warnings vital.

Also, although forecasting, warning and response systems reduce death and injuries, they have not been demonstrated to have any significant impact on reducing damage to social infrastructure or private property or on reducing

economic disruption (Sorensen 2001). In fact, because of population growth, some areas' economic losses are actually increasing (Sorensen 2000).

Evolution of the Forecasting, Warning, and Response System

As mentioned previously, most of the existing literature about forecasting, warning and response systems focuses on floods. In fact, some of the earliest warning activity came from flooding. For instance, there are records from ancient times of Egyptians rowing down the Nile River to warn of coming floods (Keys 1997). The earliest warning systems were most likely nothing more than word of mouth from person to person trying to warn others in time. Warnings are now utilized for several hazards in the United States such as floods, hurricanes, tornadoes, and even severe thunderstorms.

In more recent years, with the increase in technology and communication, warning messages have improved for some hazards (e.g. in many areas warning messages can reach the public faster). In addition, there have been major improvements for warnings associated with hurricanes in the last 20 years (Sorensen 2000). With the development of radio, television, mobile devices, and now the internet, warning messages can travel faster and to more people. Thus, the warning message is no longer limited to how fast people can travel to the potentially affected areas to spread the message.

Current, warning messages also tend to be more sophisticated and specific (Keys 1997), pinpointing the areas that may be affected. Unfortunately,

the development of warning systems has been sketchy and problematic rather than carefully and purposefully planned (Keys 1997, Sorensen 2000, Handmer 2002). Many communities still do not have the ability to provide citizens with effective warning messages (Mileti 1999) in that some communities cannot afford to implement such projects. In some cases it takes a hazardous event to occur before a community becomes proactive with public education and a forecasting, warning and response system. Some believe advancements in hydrologic and meteorological forecasting techniques have not been accompanied by the necessary social science research to ensure that warning information will be taken seriously and responded to in a timely manner (Gruntfest and Carsell 2000). Nevertheless, it is important to address exactly how forecasting, warning and response systems work.

Forecasting, Warning and Response System

Exactly how forecasting, warning and response systems are developed and carried out still varies and there is clearly no one agreed upon method. Penning-Rowsell (1986) looks at flood warning systems and divides them into four stages: preparation, warning decisions, warning dissemination, and the receipt and response stage. However, Krzysztofowicz and Davis (1983) only make a distinction between the forecast and response stages. These two methods fall short of being completely adequate because they do not consider the individuals they are trying to warn. However, Schware (1982) does consider

this and believes a warning system should take into account social factors that affect public response to warnings. Mileti (1999) echoes this in that forecasting, warning and response systems must take into account social factors because these social factors have been shown to affect how people understand and respond to warnings (Mileti 1999). People understand and interpret warning messages in different ways. Therefore, taking the different social factors into consideration allows the construction of the warning messages to be more relevant to their target audience.

The basic outline of a forecasting, warning and response system is illustrated in Figure 2.1. It begins with the collection and evaluation phase, moves into the phases that include the decision to warn and dissemination of the warning, then ends with the response phase, which encompasses not only the response from the public but officials as well. This framework is meant to be a starting point and does not capture the many complexities involved in this system, nor what happens after the response and after the event. Not only is it necessary to respond to a warning message but it is also equally important to respond appropriately after the event itself. The subsystems are discussed in detail below.

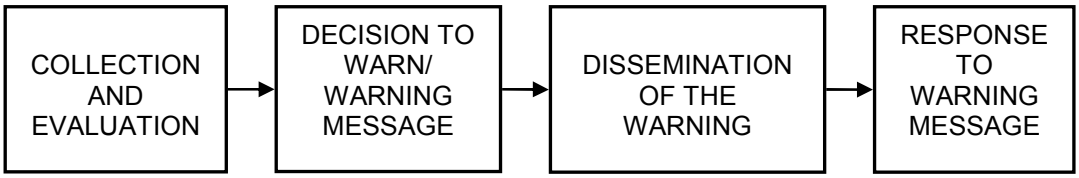

Figure 2.1: Basic Framework

Collection and Evaluation

A forecasting, warning and response system begins with the collection and evaluation of data. An event is detected and its severity is measured. From this evaluation it is decided if a public warning needs to be issued so that proper action can be taken prior to the event.

Hurricane prediction and forecasting methods have seen major improvements in the last 20 years (Sorensen 2000). There have been many models and statistical techniques introduced in recent years that provide better monitoring and detecting of tropical cyclone activity (e.g. radar and satellite imagery and computer models). However, Penning-Rowsell (1986) still states that,

> "it may be more appropriate to base forecasts on low technology and concentrate resources on efficient dissemination and response, rather than producing super-accurate forecasts which are either too late or which, when they reach those intended to respond, are in a form which cannot be understood or used."

Here Penning-Rowsell is arguing that it may be more useful to construct warning messages that are more understandable to residents in the affected areas than trying to explain complicated forecasts to the public. Mileti (1999) shares a similar sentiment, suggesting that better local management and decision making

are now more critical than most future advances in technology. This is important because if the communities affected are not prepared to handle the event then an accurate forecast is ineffective. Also, it is important that local management and officials are able to understand and use the forecasts provided in order to make better and more appropriate warnings for the public.

Decision to Warn/Warning Message

The decision to warn and the warning message are important aspects of the forecasting, warning and response system. Adequate warnings are needed because this is what turns a forecast into an action statement (Gruntfest and Handmer 2001). These warnings are for the public to prepare for the event that is expected to occur.

In the United States the National Weather Service (NWS) and local government agencies are ultimately responsible for issuing weather related warnings to the public. Good coordination and communication between the different organizations is essential to the issuance of timely public warnings. If the different organizations involved are not communicating effectively, valuable time is lost when trying to warn the public. With that, storm warnings are generally issued at the end of an often complex chain of organizations or groups whose primary function is to deliver forecasts to those at risk (Handmer et al. 2001). Again, the purpose of a warning is to improve safety and reduce damage (Gruntfest and Handmer 2001). However, these warnings must be in a language that is understood by the intended receiver. The United States is increasingly

more culturally diverse, with many different languages other than English being spoken. Having warning messages translated into these different languages also makes the warnings more efficient.

Warnings themselves do not save lives and property, but the responses generated from those warnings do (Handmer et al. 2001). This is why the message itself is so important (i.e. if no one responds then it is ineffective). Sorensen (2001) states that the style and content of a message can have a dramatic effect on the public's response. The warning message should be specific, consistent, and accurate, contain certainty, and be very clear. A significant analytical and empirical effort is required in order to get the content of a communication right (Fishchoff 1995). Also, communication barriers must be eliminated by avoiding excess use of technical terms and codes. Standardized messages are needed to ensure a consistent relay of information (Stewart 1997). Warnings are increasingly expected by those at risk and they are expected to be timely and accurate (Handmer 2002). When warning messages are either unclear or do not arrive quickly enough, the public does not have the opportunity to choose the proper response.

When investigating how the individuals interpret warnings, Sneeringer (2001) created a ranking system for flash flood warnings to relay the severity of an impending flood to the public. Sneeringer was trying to determine if the ranking system was more effective than current warning measures taken by the NWS. This ranking system consisted of five levels similar to the hurricane ranking system (Saffir-Simpson Scale). The idea behind this was to quantify the

severity of the flood so that the public could then determine the best course of action. While the overall attitude toward the ranking system was favorable, it could not be implemented because the required Geographical Information System (GIS) software is not available in all NWS offices. Public education is also needed to inform the public of the new system and how it works so the ranking system can be effective.

Also, according to Handmer et al. (2001), flood warnings tend to be over-generalized and are used too frequently. Therefore, a lackadaisical attitude is sometimes taken towards them by the public. In some cases when individuals continually hear warning information for their area and an event does not occur, they can become complacent. This case of a false warning is termed “Cry Wolf” and can lead to not taking the necessary action when the event does occur. According to Sorensen (2000), warning systems must be continually updated and improved to keep up with the continually changing society, because there are increasingly new ways to get warning messages out to the public. Before a warning message can be disseminated to the public, the data collected about the impending event must be analyzed and a warning message must be constructed.

Dissemination of the Warning Message

Dissemination is the actual transmission of the warning statement (Mileti and Krane 1973). It is the process of getting the message out to everyone affected. This transmission of the warning message to the public must be relayed via different forms of effective communication (Handmer 2002). These

forms of communication can include: outdoor sirens, the electronic media, mobile technology, and loud speakers (Sorensen 2000). Hugh-Jones (2002) also feels that risk perception and risk communication should be an active application in the dissemination of information; however, to him they seem to still be the "purview of academe."

Warning dissemination has improved in recent years (Sorensen 2000) with the help of improved technology (e.g. television, radio, internet, satellites) and a shorter decision and response time by officials, who are now able to come to agreement about what action to take more quickly and warn the public faster. The actual content of the message should include the nature, location, guidance, time, and source of the hazard or risk (Sorensen 2000). This information should be included so the receivers of the warning message can better understand what to expect from an event and when and where it is going to occur. There are now many ways to get the message out to the public. These ways include NOAA weather radio, television broadcasting, internet webpages, email alerts, and mobile phone and pager alerts. Schware (1982) stresses that just getting a warning message out to the public is not enough to protect lives and property, because once a warning message is received by individuals they have to know what to do with the information.

Response

The goal of the response phase is for individuals to respond to warnings to save lives and property. After hearing a warning message individuals decide

whether or not to respond and what action to take. For example, if a flood warning is issued, individuals may make the decision to move to higher ground, or in the case of a hurricane warning, individuals may decide to evacuate their homes. They also decide the appropriate time to respond. Mileti (1999) says it well, stating that, “response refers to the actions taken immediately before, during, or after a disaster occurs to save lives, minimize damage to property, and enhance the effectiveness of recovery.” The response taken by the public and local officials before and after the event can have huge impacts on whether or not a forecasting, warning and response system is effective. Responding after a disaster is just as important as taking preventative steps beforehand. Because of this, how people respond to warnings, once they have received and understand them, can influence the overall impact a hazardous event has on a community. People conceptualize disasters in different ways, which causes them to respond differently. Five themes - demographic factors, cognitive and situational response phases, public education, experience and event memory, and false alarms - stand out that are related to the response process, and they are addressed below.

Demographic Factors

It is now recognized that many factors play a large part in determining the risks people encounter, whether and how they prepare for disasters, and how they fare when disasters occur (Mileti 1999). Schware (1982) and Foster (1980) both state that individual responses to warnings have been shown to be

conditioned by age, education level, cultural background, and knowledge or experience of previous events or situations. Tobin and Montz (1997) add to this, stating that social factors (e.g. economic, social, and cultural) affect perceptions of a hazard which affect the choices that ultimately are made. However, these factors may or may not allow individuals to respond as desired.

Wisner et al. (2004) use the Pressure and Release (PAR) Model to show "how disasters occur when natural hazards affect vulnerable people." The authors add that "vulnerability is rooted in social process and underlying causes which may ultimately be quite remote from the disaster event itself." A second model, termed the 'Access' model, is an expanded view of the principal factors in the PAR model that relate to human vulnerability and exposure to physical hazard, primarily focusing on the process by which the natural event impacts people and their responses. In short, the 'Access' model shows "how social systems create the conditions in which hazards have a differential impact on various societies and different groups within society" (Wisner et al. 2004).

Mileti (1999) adds to this, saying that,

> "non-minorities and households with higher socioeconomic status fare better, while low-income households are at a greater risk mainly because they live in lower quality housing, and because disasters exacerbate poverty."

Generally those individuals living in poverty do not have the access to resources to respond properly (Morrow 1999). Also, women, broadly speaking, are more vulnerable because they often times are disproportionately poor (Anderson 1994, Wisner et al. 2004). A woman's vulnerability may also increase because women

are more likely to stay with family members and children in emergencies to nurture, assist, and protect them (Mileti 1999, Morrow 1999, Drabek and Boggs 1968, Cutter et al. 1992). Research by Mileti and Sorensen (1990) reported similar results. They found that several demographic factors influence response as well, including age, socioeconomic status, gender, education, family size, and having children. There have also been similar results in the field of technological hazards. Many studies (e.g. Cutter 1993, Perlin et al. 1999, Sheppard et al. 1999) have shown, for example, that minorities and low income areas bear the brunt of chemical factory and air pollution hazards.

Cognitive and Situational Response Factors

Cognitive factors include psychological and attitudinal variables, while situational factors can complicate an individual's range of choices. Situation factors include one's physical location as well as income, age, and social system factors (Tobin and Montz 1997). These cognitive and situational factors can work separately, together, or in sequence to influence response decisions and actions. The context in which one makes decisions is critical to the understanding of how one perceives risk and vulnerability. In addition, when an individual makes any decision it must be balanced with a perceived benefit to that individual (Tobin and Montz 1997). For example, if an individual evacuates their home, they must perceive that evacuation makes them safer than staying in their own home.

People who receive warnings of impending events typically go through stages that shape their risk perceptions and behavior based on their characteristics (Mileti and O'Brien 1992). Likewise, according to Mileti (1995), individuals go through a social psychological process in which they form personal definitions about the impending risk (event) and the steps they should follow to take action. He sees this as a social process of five phases: (i) individuals hear the warning; (ii) they form an understanding of what the warning means to them; (iii) they decide their level of belief in the risk; (iv) they will or will not personalize the message to themselves or others; and (v) they decide what if any action they should take. A person typically goes through these stages each time that new warning risk information is received.

Public Education

When the public is warned, there is no guarantee that they will take protective action but their survival can be improved by public education. Thus, programs have been implemented in many areas to educate the public about what to do when warning messages are issued for certain hazards. Informative activities and training sessions are designed to prepare individuals in areas that could be affected for rapid and correct reactions to warnings (Siudak 2001). Public education of the threat due to a hazard and proper safety rules must be an on-going campaign as part of the overall warning system (Handmer et al. 2001). This is to keep the public up to date on the best course of action in the event of a warning.

However, not all studies agree that public education is an effective tool. Sorensen (2001) points out that there is no conclusive evidence regarding whether or not a public education or information program actually makes a difference. In addition, he says that good pre-emergency information will increase response but the amount of response cannot be estimated. A better understanding of how people interpret and react to warnings (or do not) is essential (Montz and Gruntfest 2002).

Experience and Event Memory

When a community has a memory of a hazardous event it can help make forecasting, warning and response systems more effective. Prior disaster experience may provide a learning experience that has a positive effect on warning (Mileti and Krane 1973, Tobin and Montz 1997). If people realize a threat is real, they are more likely to take action (Siudak 2001). Also, if they have experience in what actions to take when faced with a warning, they are more likely to take the correct action. A negative side to this, however, is that an event may have occurred once, and an individual took the correct action, but the next time the event occurs the same action may not necessarily be the right one. For example, a person may have taken the correct action when faced with a slow-rise flood, but that same action would not necessarily be appropriate in the event of a flash flood.

False Alarms

A false alarm is when a warning is issued to the public but the event does not occur. However, a false warning can also be seen as a “near miss” in which the event did occur, but not in all of the area that was warned. When reviewing response to warnings where there have been previous false alarms, action by residents is not always adversely affected (Dow and Cutter 1998). Similar results come from Gruntfest and Carsell (2000), in which they found that for officials involved in warnings, there are no ill effects of internal false alarms. Even though officials and residents may have taken action to only a false alarm, they nonetheless get the experience of taking action, which does not seem to have negative effects on future events. However, Penning-Rowsell (1986) contradicts this, saying that more attention should be given to avoiding false warnings, which more than anything else appears to degrade response.

There is always a chance when a false warning is issued that the next time a warning is issued, the public will not take the appropriate action. These false warnings should not, though, prevent future warnings from being issued.

Evaluation of Forecasting, Warning and Response Systems

Because forecasting, warning and response systems help to inform the public about an impeding event, they need to be evaluated to make sure they remain effective (du Plessis 2002). Several studies have undertaken this evaluation task.

Parker and Fordham (1996) completed a study based on two conceptual models that evaluated the level of development of the flood forecasting, warning and response system in the European Union. France, Germany, The Netherlands and England and Wales were found to have more developed flood forecasting, warning and response systems than Portugal, Scotland and Northern Ireland. However, all of the countries examined are moving towards more effective flood forecasting, warning and response systems. Parker and Fordham (1996) suggest that a better exchange of information and experiences between these countries could have significant benefits for all. This study evaluated to what extent the forecasting, warning and response systems in the EU were developed, however, this study did not actually evaluate the system itself to see if it was actually meeting the needs of its recipients.

Weaver et al. (2000) also completed a study which showed how, when appropriate measures are taken, there does not have to be a repeat of negative outcomes from a flood event, such as loss of life, personal injury, and/or loss of assets. This study showed how changes made in the flood forecasting, warning and response system between a 1997 and a 1999 Fort Collins, CO flash flood helped make the second flood much less devastating. Fort Collins officials closely reviewed where its emergency response system partially or fully failed during the 1997 Spring Creek flash flood and were able to execute a more effective forecasting, warning and response for the 1999 Poudre River flash flood. The problems that arose from the 1997 event were found to have come mostly from lack of awareness and/or recognition of the unfolding disaster and

problems in communication (Weaver et al. 2000). People were just not prepared to handle this type of event; most did not know what to do to avoid the danger. The solution is to make sure people understand the warning messages and then know how to correctly apply that information to an effective response plan.

Measuring Effectiveness of Forecasting, Warning and Response Systems

There is an overall gap in the literature regarding the evaluation process about the forecasting, warning and response systems related to hurricanes. This includes evaluation of public perception. Indeed, according to Handmer (2002), measuring effectiveness is an ongoing critical issue. Many articles discuss what forecasting, warning and response systems are and what they should include (e.g. Sorensen 2000, Handmer 2002, Mileti 1995), but few actually take it a step further to include a methodology that examines the effectiveness of an aspect of the system. Perhaps this comes from a lack of agreed upon procedures in the evaluation process. Handmer (2002) states that there is currently no clear or agreed upon approach to assessing success or failure. Without being able to assess success or effectiveness, it is difficult to decide if a particular forecasting, warning and response system is adequate. There are many studies that describe the different factors that influence how the public responds to warnings (e.g. Mileti 1995, Mileti 1999, Schware 1982) but, few actually review the effectiveness and public perceptions and opinions of a forecasting, warning and response system.

Successful Forecasting, Warning and Response Systems

There is some evidence to suggest that the most enduring, most successful forecasting, warning and response systems have been run by authorities with taxation powers, such as large cities or regional flood districts, which can make the systems integral to their operations and have strong political support (Handmer et al. 2001). With this, the size of the community may be important. For instance, small communities generally do not have the infrastructure to adequately prepare, organize, and execute an effective forecasting, warning and response system. Nevertheless, small communities should still strive to implement some sort of public education to inform residents of possible hazards; even if it is just with a pamphlet they receive at the local grocery or hardware store. Larger communities may have access to more resources.

Summary

Mileti and O'Brien (1992) sum up public perception and response well. They state that public response to communicated risk information is a direct consequence of perceived risk, the warning information received, and personal characteristics of the warning recipient. In addition, perceived risk is a direct function of both the warning information received and the personal characteristics of the warning recipient. Forecasting, warning and response systems must be clear and understood by the public in order for the public to correctly respond.

However, there are still debates and confusion about whether warning systems have an effect on hazardous events. Sorensen (2000) says warning systems have not been shown to have significant impact, but Handmer disagrees, saying that substantial progress has occurred in many local areas (Handmer 2002). We are still very much working to achieve this comprehensive forecasting, warning and response system. There is still much work to be done in the area of forecasting, warning and response systems (Sorensen 2000).

Chapter Three: Theoretical Framework

Forecasting, warning and response systems can be viewed as a system. The subsequent parts build from the earlier ones and all parts are related and depend on each other.

General systems theory was first proposed by Ludwig von Bertalanffy and his colleagues in the 1940s (Davidson 1983). Systems theory is an interdisciplinary field which has applications in geography, sociology, and economics. It is related to the theories of complexity, chaos, cybernetics, and complex adaptive systems (Mileti 1999). Systems theory works to combine both reductionism and holism as it is based on the premise that everything is related. This approach lends itself to the current study.

A forecasting, warning and response system is a complex interrelated chain of events and sequences that can be thought of as a system. This means that any deficiency or break in one of the links that make up the chain of communications between forecast agency and the public to be warned affects the entire process (Penning-Rowsell 1986). Indeed, warning systems are only as strong as their weakest link (Foster 1980). According to Mileti (1999), hazards researchers and practitioners would do well to take a more systems-based

approach to understanding the complex interactions between the natural environment and human perceptions, actions (including what people build and where it is located), and organizations. These linkages are discussed below.

Research Framework

As previously described the basic outline of a warning system is illustrated in Figure 2.1. This framework, however, does not capture the many complexities involved in this system. Foster (1980) provides a layout of an ideal warning system (Figure 3.1). The system starts with an official recognition of a threat. The system then goes through fifteen additional steps, ending with the testing and operation of the revised system. This model also contains feedback loops to ensure the ideal warning is achieved. This warning system by Foster is an expanded view of the first three phases of the system shown in Figure 2.1, and is primarily concerned with the warning phases. Critical to this model are the different feedback loops which help to provide adequate warnings. These feedback loops are not in the basic outline (Figure 2.1), but are essential for an efficient system. Seldom are warnings completely correct and adequate the first time they are devised.

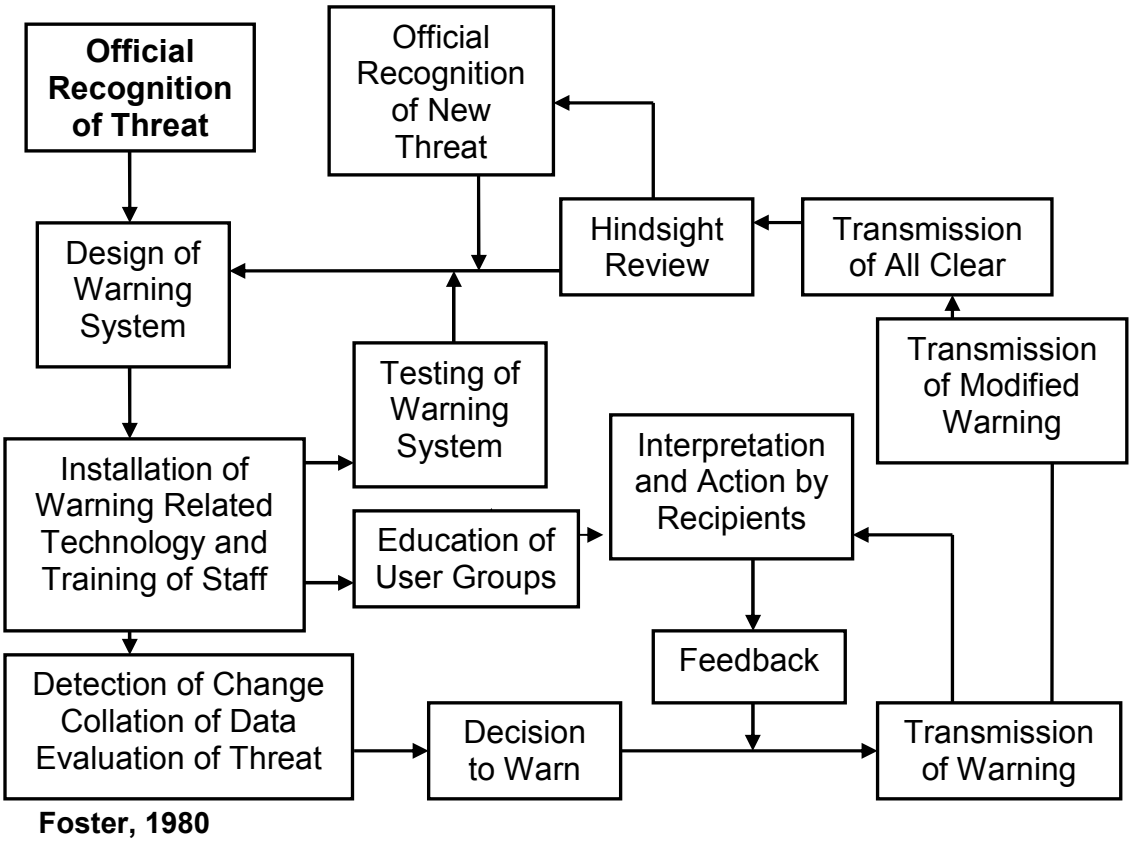

Figure 3.1: Ideal Warning System

While useful, this system (Figure 3.1) does not give sufficient attention to the response phase. This system also does not point out which phases of the warning process are more important, but rather gives equal weight to all phases.

The warning system proposed by Murray (1980) provides a much more detailed response phase (Figure 3.2). This system also contains two sub-systems, the evaluation-dissemination sub-system, which is basically phase one through three of Figure 2.1, and the response sub-system, which is the focus of this research.

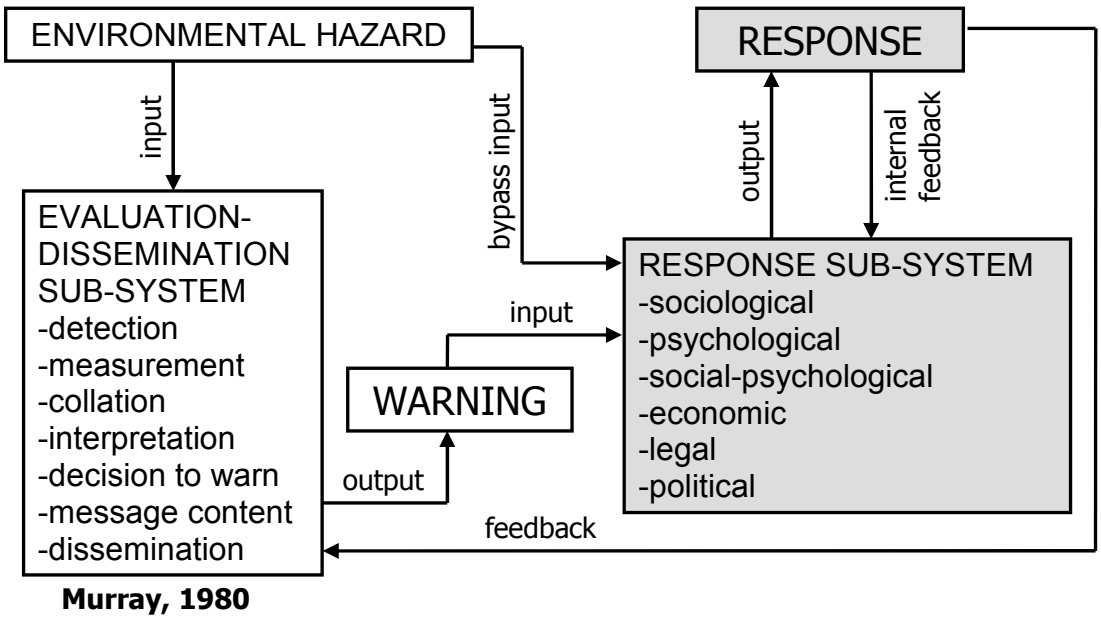

Figure 3.2: Warning and Response System

Murray's framework begins with the recognition of an environmental hazard. After an environmental hazard (e.g. hurricane or flood) is identified, the system can either move to the evaluation-dissemination or the response sub-system. The evaluation-dissemination subsystem works to achieve the ideal warning and get the message out to the intended receivers. However, after the ideal warning is achieved, the system can still transition into the response phase, which is what the previous model (Foster 1980, Figure 3.1) lacked. The response subsystem then considers the different factors which influence an individual's response decision. Six categories of factors are identified in the model that can influence response. These categories are sociological, psychological, social-psychological, economic, legal, and political. Other previous literature also explains that these different factors influence individual's

decision-making processes (Mileti 1999, Schware 1982, Morrow 1999). This system takes these factors into account in the sub-system to explain the actual response of individuals. This research focuses on the sociological portion of the response sub-system and investigates how socioeconomic status affects response. Four other specific social variables are investigated as well, including age, gender, level of education, and area (location). Along with socioeconomic status, these four variables are important when evaluating the public perception of forecasting, warning and response systems because they directly affect how people interpret and respond to warnings issued. As discussed above, several studies (e.g. Mileti and Sorensen 1990, Mileti 1999, Schware 1982) point out that these factors are related to a person's ability and willingness to respond effectively.

Chapter Four: Research Questions and Hypotheses

Research Questions

From the literature review, some overall gaps in the literature become apparent. Therefore, five research questions can be developed:

- *Does age affect how a person responds to a warning?*
- *Do males and females respond differently to warnings?*
- *Does level of education affect how a person responds to a warning?*
- *Does socioeconomic status affect a person's ability to respond to a warning?*
- *Does place or location affect a person's ability or willingness to respond to a warning?*

Research Hypotheses

From the research questions, five hypotheses were developed in order to further investigate these topics.

1. *Older people are more likely to respond positively to a warning than younger people.* Older people are more likely than young people to respond positively to a warning because they may already perceive themselves as more vulnerable or may have more experience with previous events. However, this relation may be rather complex. For instance, even though older people may be more likely to respond, it may take them longer to take any action or they may not have the means to respond at all, because of limited resources such as money, vehicles or physical disabilities.

2. *Females are more likely to respond to warning messages than males.* The argument is that females are more likely than males to have the responsibility of caring for others such as children, parents, and pets, and hence may be more responsive to the warning message. They respond because of having to protect and care for their dependents. However, because of this added responsibility of "caretaker", they may be inhibited from acting as quickly as others (Drabek and Boggs 1968, Cutter et al. 1992).

3. *Those individuals with higher levels education are more likely to take the appropriate response to a warning than*

individuals with lower levels of education. It is argued that higher levels of education are correlated with a greater ability to understand correctly what the warning message says and what action needs to be taken. Individuals with higher levels of education also may have better means in which to take the action, since education is positively correlated with income.

4. *Individuals with a higher socioeconomic status (e.g. higher income or class status) are more likely to take the appropriate action and response to a warning.* Higher socioeconomic status may give them access to more resources; they are able to access the resources and funds needed more quickly. As previously stated, this variable is usually correlated with education.

5. *Spatial location within a community affects the ability or willingness to respond to a warning.* With this, however, area or place may act as a surrogate for other variables such as age, gender, level of education, or socioeconomic status.

The literature suggests that the first four variables, age, gender, level of education, and socioeconomic status, have a major influence on a person's ability and willingness to respond to a warning. However, area (location) may act

as a catchall for all of the previously mentioned variables and result in significant differences as well.

Chapter Five: Study Site

Physical Context

The community selected for this study was in Polk County, Florida (Figure 5.1) in the city of Lake Wales (Figure 5.2). Lake Wales is located about 28 miles southeast of Lakeland and about 61 miles east of Tampa.

Figure 5.1: Study Area: Polk County, Florida

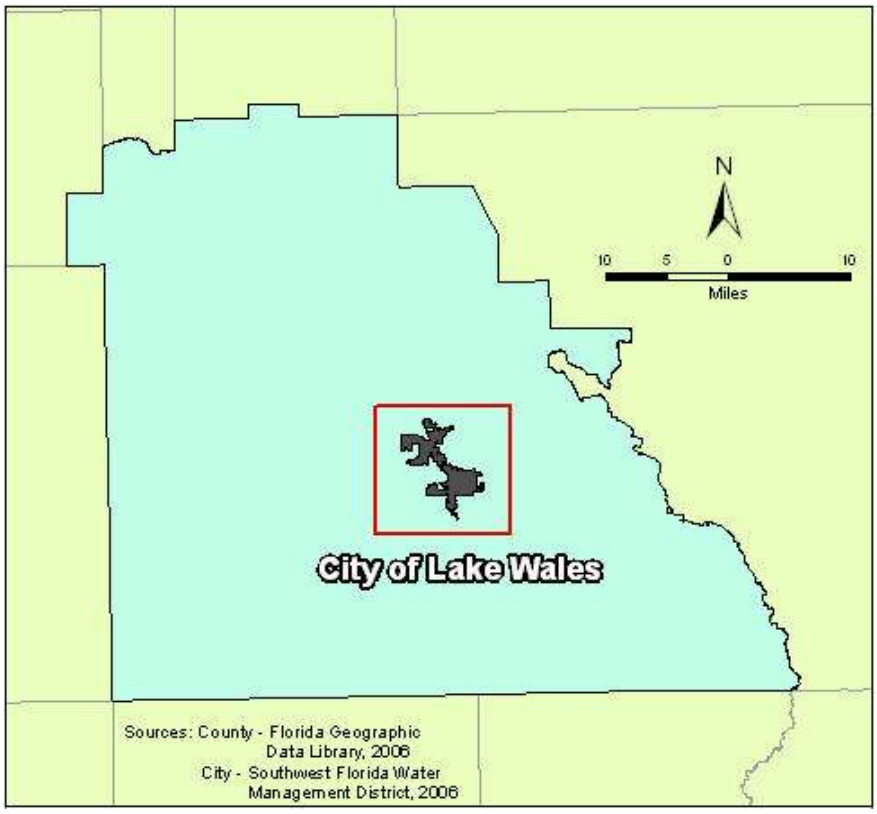

Figure 5.2: Study Area: Lake Wales, Florida

There were a couple of factors that influenced the selection of this site. First, Lake Wales was affected directly by three hurricanes (Charley, Frances, and Jeanne) during the 2004 hurricane season (Figure 5.3). Lake Wales was the first city on record to have three direct hits in one season. Therefore, this city is familiar with forecasting, warning and response to hurricanes. Second, Lake Wales is a small city with a total population of 10,194 according to the 2000 census and an estimated 2005 population of 12,964. This increased the chance that the sample selected would be representative of the whole city.

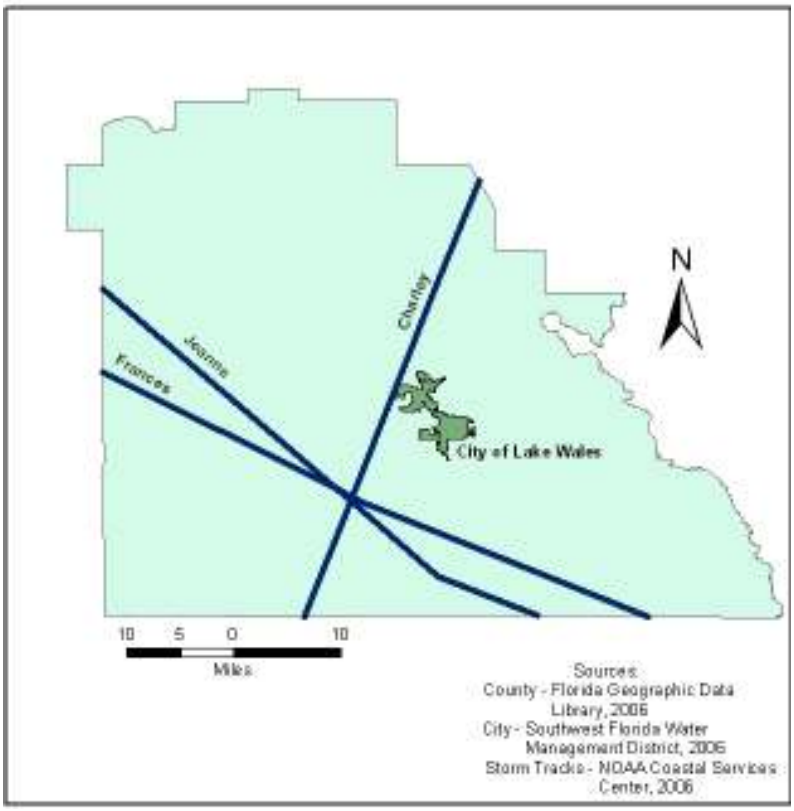

Figure 5.3: 2004 Polk County Hurricane Tracks

Social Context

Lake Wales, Florida was founded in 1911 by a group of businessmen from the Lake Wales Land Company, to be the home to turpentine, lumber, and citrus industries. Since 1911 Lake Wales has seen some growth. The population of Lake Wales according to the 2000 census was 10,194. Of this population, 4,791 (47%) are males and 5,403 (53%) are females. In addition, the population of Lake Wales that is 18 years of age and over is 7,451 (73.1%) and total

population that is 60 years of age and over is 2,476 (24.3%) (US Census Bureau 2000).

According to the US Census Bureau, 26.9% of adults 25 years and older do not have a high school diploma or its equivalency, while 18.1% of the population have earned at least a Bachelor's degree (Table 5.1).

Table 5.1: Highest Level of Education Attained

Level of Education	N	Percent
Less than high school diploma or its equivalency	1,751	26.9
High School diploma or its equivalency	2,012	30.9
Some College, no degree	1,257	19.3
Associate degree	310	4.8
Bachelor's degree	772	11.9
Graduate or professional degree	405	6.2
Total	4,756	100.0

Source: US Census Bureau, 2000

There are 4,065 households in the city of Lake Wales (Table 5.2). Eighteen percent of the households are living on less than $10,000 per year, while, at the opposite end of the scale, 11.4% are living on more than $75,000 per year. The median household income for Lake Wales is $26,884 (US Census Bureau 2000). However, this is lower than the median household incomes for both Polk County and Florida which reported $36,036 and $38,819, respectively (US Census Bureau 2000).

Table 5.2: Annual Household Income

Income ($)	N	Percent
Less than 10,000	718	17.7
10,000 to 14,999	393	9.7
15,000 to 24,999	758	18.6
25,000 to 34,999	662	16.3
35,000 to 49,999	618	15.2
50,000 to 74,999	455	11.2
More than 75,000	461	11.4
Total	4,065	100

Source: US Census Bureau, 2000

2004 Polk County Annual Report

In order to assist the residents of Polk County, Florida during the 2004 hurricane season a Citizen's information line was opened on August 13, 2004, the day Hurricane Charley came through Lake Wales (Polk County Annual Report 2004). This information line was staffed 24 hours a day and 7 days a week. Between August 13th and September 30th, this line received 175,000 calls for information regarding everything from shelter locations, FEMA information, food, ice, housing repairs, to just general assistance (Polk County Annual Report 2004). In addition, more than 40,000 information flyers were distributed to help keep citizens informed about the different sources of help and aid available. Also, more than 4,330 Polk County residents received tarps from the Army Corps of Engineers "Operation Blue Roof" (Polk County Annual Report 2004).

Lake Wales Damage

Lake Wales received heavy damage from Hurricanes Charley, Frances, and Jeanne during the 2004 hurricane season. Figure 5.4 shows the damage sustained to a public housing facility in Northeast Lake Wales during hurricane Charley. Most homes in Lake Wales received damage to some degree.

Photo courtesy of Graham Tobin

Figure 5.4: Storm Damage – Lake Wales Public Housing

Even commercial buildings, such as the Wausau Homes Manufacturing facility did not escape massive damage (Figure 5.5, Figure 5.6). After the hurricanes of 2004 Wausau Homes did not rebuild in Lake Wales.

Photo courtesy of Graham Tobin

Figure 5.5: Storm Damage – Wausau Homes A

Photo courtesy of Graham Tobin

Figure 5.6: Storm Damage – Wausau Homes B

Some advertising and store signs did not make it through the storms unscathed either, such as the Family Dollar business sign in the downtown area of Lake Wales (Figure 5.7). This photo was taken after Hurricane Charley passed through the area in mid August of 2004.

Photo courtesy of Graham Tobin

Figure 5.7: Storm Damage – Family Dollar

In addition, the Lake Wales Municipal Airport sustained major damage and was closed for a period of time after the hurricanes (Florida Airport Damage Survey 2004). However, while the airport was closed it was used as a staging area for getting relief and recovery supplies to those who needed them. All of the buildings at the airport, including the terminal and hangars, were almost complete losses (Figure 5.8, Figure 5.9). Figure 5.8 shows the damage sustained to the hangars at the airport, while Figure 5.9 shows the damage to the terminal building. There was no damage to the two runways due to the hurricanes;

however, one runway had to be repaired after being used as a staging area for supplies.

Photo courtesy of Florida Airport Damage Survey, http://www.floridadisaster.org/eoc/eoc_activations/charley04/Pictures/FloridaAirport/index.htm

Figure 5.8: Storm Damage – Airport Hangar

Photo courtesy of Florida Airport Damage Survey,
http://www.floridadisaster.org/eoc/eoc_activations/charley04/Pictures/FloridaAirport/index.htm

Figure 5.9: Storm Damage – Airport Terminal

Chapter Six: Methodology

This research addresses whether age, gender, income, level of education, and location affect a person's response to a warning message for hurricanes. The research was undertaken in Polk County, Florida in the city of Lake Wales (Figure 5.1; Figure 5.2).

Data Collection – Public Perception

To obtain public perceptions and opinions, a questionnaire survey was conducted with residents in Lake Wales, Florida. A face to face questionnaire survey was used to provide a better response rate as compared to a mail-out or telephone survey. The questionnaire survey contained both closed and open ended questions. These question types were used because closed ended questions allow for the quantification of data while open ended questions allow the respondents to express themselves more fully.

Residences were selected using stratified random sampling. Two census block groups in Lake Wales with different demographic characteristics were used (Figure 6.1).

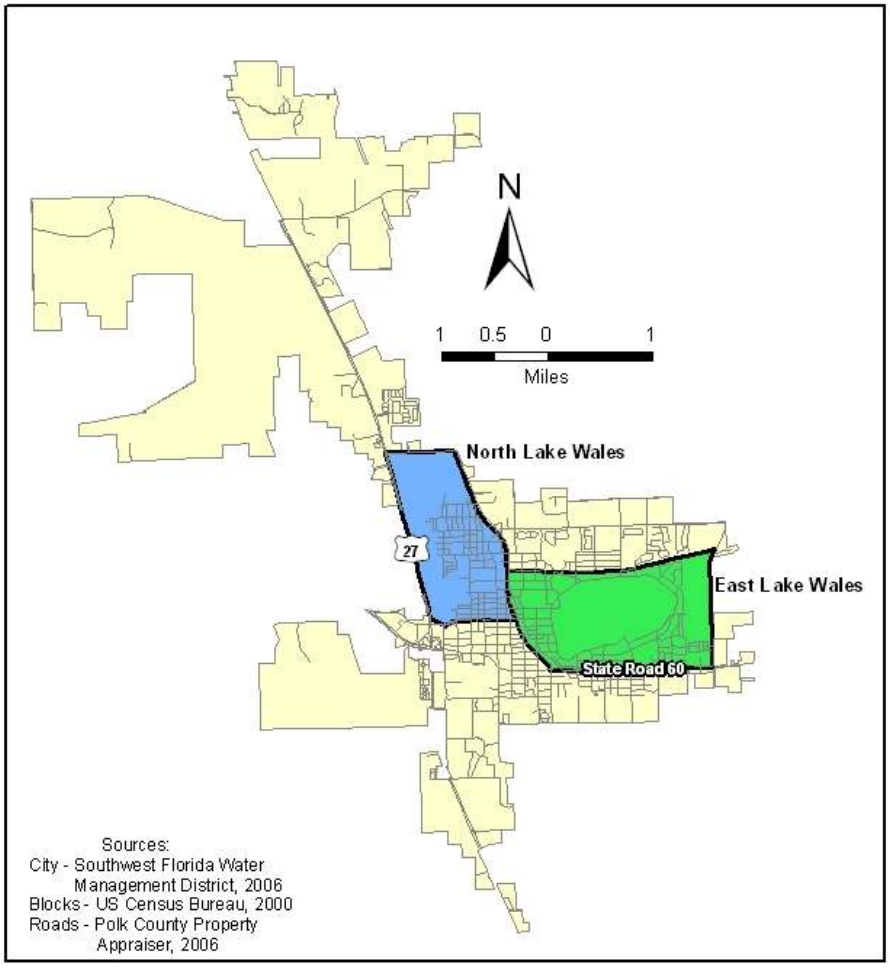

Figure 6.1: Study Area: Sampling Blocks

Of the two block groups selected one was in Eastern Lake Wales and the other was in Northern Lake Wales. Two major roadways helped to delineate the boundaries of the sampling areas. State Road 60 was the southern border of the East Lake Wales sampling area and US Hwy 27 was the western border of the North Lake Wales sampling area.

Identifying streets within the selected neighborhoods was dictated by access. Once on the selected streets, a coin was tossed to decide which side to survey (heads was assigned to be the even street addresses and tails was

assigned the odd street addresses). The goal was to survey an adult from every third house. Whoever was residing in the house who was at least 18 years of age and who had had the most recent birthday was the desired participant for the questionnaire survey. This approach was used to help keep the interviewee sample regarding gender random. When someone from the third house could not be interviewed, the fourth house was used, and then every third house from this location was selected.

A total of 76 questionnaire surveys were conducted by going door to door in Lake Wales during December 2006 and January 2007. Five individuals declined to participate.

Questionnaire Survey Design

The questionnaire survey had three sections (Appendix A). The first section contained questions related to the public's perceived views of forecasting, warning and response, such as what they think should be done and on what timescale. The second section contained questions about the persons' actual response, such as what they actually did when warnings were issued and what they did during and after the event. The survey concluded with a section collecting demographic information, including the independent variables of age, gender, socio-economic status, and level of education.

As previously stated, the questionnaire survey contained both closed and open ended questions. The closed ended questions were designed as nominal,

ordinal, and range based questions using a five-point Likert scale. In the open ended questions, the interviewee was free to respond as desired. Using both closed and opened questions allowed for a variety of data to be collected.

A pilot study was conducted in early December 2006 with a sample population in Lakeland, Florida to check for the validity and effectiveness of the survey questions. Eighteen residents of Lakeland were used for the pilot study. Lakeland residents were chosen for the pilot study because of convenience and because they were also affected by the same three hurricanes of 2004, just not as severely. Since the residents of Lakeland were also affected, it was thought that they would have similar responses to the surveyed population in Lake Wales. Within this pilot study the structure and clarity of the questions were evaluated as well.

Data Analyses

These data were analyzed using the Statistical Package for the Social Sciences (SPSS). A non-parametric test, particularly the Mann-Whitney Test was employed, because most of the data were in nominal and ordinal format and also because of the relatively small sample size. Nonparametric tests are often used in place of parametric tests when certain assumptions, such as normality, about the underlying population are questionable. Nonparametric tests may be, and often are, more powerful in detecting population differences when certain

assumptions are not satisfied. All tests involving ranked data were nonparametric.

The Mann-Whitney Test is one of the most powerful nonparametric tests for comparing two populations. It assesses whether the difference in medians between two samples of observations is statistically significant. This test does not require the assumption that the differences between the two samples are normally distributed. Many times the Mann-Whitney Test is used in place of the two sample t-test when the normality assumption is questionable. This test can also be applied when the observations in a sample of data are ordinal data rather than direct measurements (Easton and McColl, 1997). In addition, other descriptive statistics were also used to analyze the demographic data collected in this research.

Chapter Seven: Results

Introduction

This section contains descriptions of the data collected in the questionnaire survey (Appendix A). The data from the questionnaire survey are presented in tabular form using numerical and percentage totals. Descriptive information is also provided.

The survey questionnaire contained three sections. The first two sections were to garner individuals' perceptions, opinions, and responses and the third and final section contained demographic data collection questions. Seventy-six questionnaire surveys were completed; five individuals declined to participate.

The demographic data are provided first in order to make the results more understandable. Next, the first main section of the questionnaire survey contained questions pertaining to individuals' perceived views of hurricane warnings and responses. Included in this section were such questions as whether or not participants felt like they knew what to do in the event of a hurricane warning and gauging how likely individuals are to evacuate their home in the event of a hurricane warning. Finally, the second section of the

questionnaire survey contained questions about what individuals actually did in response to the hurricane warnings issued during the 2004 hurricane season and what they thought about the warnings and responses taken.

Questionnaire Survey Demographics

This section of the questionnaire survey was used to collect demographic information on gender, age, education, and income of the survey participants. Of the total participants surveyed, 28 (36.8%) were male and 48 (63.2%) were female. Also, 48 (63.2%) respondents indicated their race as white, 23 (30.3%) as black, and 5 (6.6%) as Hispanic. The following three tables (7.1, 7.2, and 7.3) describe the age, education, and income levels of the respondents to the questionnaire survey. Education level refers to the highest level of education obtained by the participant. The income levels represent annual household income.

Table 7.1: Age of Respondents

Age (years)	N	Percent
18-24	4	5.3
25-34	8	10.5
35-44	16	21.1
45-54	17	22.4
55-64	13	17.1
65-74	11	14.5
75 and up	7	9.2
Total	76	100.0

Appendix A: Question 21

The age of respondents ranged from 18 to over 75 years with a median of 45 to 54 years (Table 7.1). The age makeup of the respondents was comparable to that of the city of Lake Wales, which has 24.3% of its residents who are 60 years old or older. Formal education of respondents ranged from 9th grade to graduate level and professional degrees as a whole. The vast majority, over 82%, have high school diplomas or higher (Table 7.2). The percentage of adults with no high school diploma is larger within the city of Lake Wales (26.9%) (US Census Bureau 2000) compared to the data found with the questionnaire survey (17.1%).

Table 7.2: Education Level of Respondents

Level of Education	N	Percent
9th Grade	13	17.1
High School Diploma or Equivalent	29	38.2
Some College, no Degree	14	18.4
Associate's or Technical Degree	9	11.8
Bachelor's Degree	9	11.8
Graduate or Professional Degree	2	2.6
Total	76	100.0

Appendix A: Question 22

Income ranged from under $10,000 to over $60,000 annually (Table 7.3). However, there is a larger percentage (36.8%) of households earning $50,000 annually or more within the surveyed population compared to the 2000 census data, which reported 22.6% of households earning $50,000 annually or more in Lake Wales.

Table 7.3: Income Level of Respondents

Annual Income ($)	N	Percent
Under 10,000	1	1.3
10,000 – 19,999	6	7.9
20,000 – 29,999	14	18.4
30,000 – 39,999	12	15.8
40,000 – 49,999	13	17.1
50,000 – 59,999	8	10.5
60,000 and Over	20	26.3
No response	2	2.6
Total	76	100.0

Appendix A: Question 24

Table 7.4 indicates the relationship between the education level and annual household income of the respondents. As a general trend, as the level of formal education raises so does the annual household income.

Table 7.4: Income vs. Education

Income $1000s	Education						
	9th Grade	HS or equiv.	Some college	Assoc. degree	Bach. Degree	Grad. Degree	Total
<10	1	0	0	0	0	0	1
10-19	4	2	0	0	0	0	6
20-29	5	8	1	0	0	0	14
30-39	1	8	2	1	0	0	12
40-49	2	5	6	0	0	0	13
50-59	0	4	3	1	0	0	8
>60	0	2	2	6	8	2	20
Total	13	29	14	8	8	2	74

Area

The following information refers to the spatial characteristics of the participants by area to illustrate some of the differences between the two sampling areas. East Lake Wales refers to the eastern portion of the city north of State Road 60, near and around Lake Wailes. North Lake Wales refers to the

northern portion of the city just east of US Hwy 27. There were 54 individuals surveyed in the East Lake Wales area and 22 surveyed in the North Lake Wales area. The North Lake Wales study area had a higher percentage of women as compared to East Lake Wales (Table 7.5). In addition it is shown that the East Lake Wales study area has a slightly younger percentage of respondents (Table 7.6). Also, in East Lake Wales 57.5% of the respondents have some level of education beyond a high school diploma, while only 13.6% of the respondents in North Lake Wales have beyond a high school diploma (Table 7.7). Finally, East Lake Wales has higher annual income levels overall (Table 7.8), seventy-four percent of the respondents in East Lake Wales earn at least $40,000 annually in contrast to North Lake Wales where only 4.5% earn $40,000 annually.

Table 7.5: Gender of Respondents by Area

	East		North		Total	
Gender	N	Percent	N	Percent	N	Percent
Male	21	38.9	7	31.8	28	36.8
Female	33	61.1	15	68.2	48	63.2
Total	54	100.0	22	100.0	76	100.0

Table 7.6: Age of Respondents by Area

	East		North		Total	
Age	N	Percent	N	Percent	N	Percent
18-24	4	7.4	0	0.0	4	5.3
25-34	5	9.3	3	13.6	8	10.5
35-44	14	25.9	2	9.1	16	21.1
45-54	11	20.4	6	27.3	17	22.4
55-64	8	14.8	5	22.7	13	17.1
65-74	8	14.8	3	13.6	11	14.5
75 and up	4	7.4	3	13.6	7	9.2
Total	54	100.0	22	100.0	76	100.0

Table 7.7: Education Level of Respondents by Area

	East		North		Total	
Education	N	Percent	N	Percent	N	Percent
9th Grade	6	11.1	7	31.8	13	17.1
High School Diploma or Equivalent	17	31.5	12	54.5	29	38.2
Some College, no Degree	11	20.4	3	13.6	14	18.4
Associate's or Technical Degree	9	16.7	0	0.0	9	11.8
Bachelor's Degree	9	16.7	0	0.0	9	11.8
Graduate or Professional Degree	2	3.7	0	0.0	2	2.6
Total	54	100.0	22	100.0	76	100.0

Table 7.8: Income Level of Respondents by Area

	East		North		Total	
Income ($)	N	Percent	N	Percent	N	Percent
Under 10,000	0	0.0	1	4.5	1	1.3
10,000 – 19,999	2	3.7	4	18.2	6	7.9
20,000 – 29,999	3	5.6	11	50.0	14	18.4
30,000 – 39,999	7	13.0	5	22.7	12	15.8
40,000 – 49,999	12	22.2	1	4.5	13	17.1
50,000 – 59,999	8	14.8	0	0.0	8	10.5
60,000 and Over	20	37.0	0	0.0	20	26.3
No response	2	3.7	0	0.0	2	2.6
Total	54	100.0	22	100.0	76	100.0

Section 1: Perceived Views of Warning and Response

The first main section of the questionnaire survey contained questions relating to individuals' perceived views of hurricane warnings and responses. Table 7.9 contains the results of how likely the respondents surveyed in Lake Wales are to take any sort of action after a hurricane warning is issued for their area. Any sort of action refers to any action the residents deem necessary in the

wake of a hurricane warning. In addition, Table 7.10 shows whether or not the individuals feel like they know what action to take during a hurricane warning. Ninety-one percent of the respondents reported that they are likely or very likely to take some sort of action after hearing a hurricane warning. Also, 86.8% of the respondents reported that they know what action to take when a hurricane warning is issued.

Table 7.9: Warning - Public Action

Scale	N	Percent
Very Unlikely	0	0
Unlikely	1	1.3
Undecided	6	7.9
Likely	45	59.2
Very Likely	24	31.6
Total	76	100.0

Appendix A: Question 1

Table 7.10: Know What Action to Take

Scale	N	Percent
Yes	66	86.8
No	0	0.0
Not Sure	10	13.2
Total	76	100.0

Appendix A: Question 2

Table 7.11 illustrates the respondents' likelihood to evacuate their homes in the event of a hurricane warning. As reported in the table, only 17.1% are likely or very likely to evacuate. Reasons given as to why people would not evacuate their homes included that the individuals felt like they already lived in a safe and well built home, that it was too expensive to evacuate, they had no transportation to evacuate, or were reluctant to leave because of dependents and/or pets.

However, the most common response (38.2%) about evacuation was that the participants were undecided about whether or not they would evacuate. Some reported that they would base the decision of whether or not to evacuate on the intensity of the storm and on advice from others.

Table 7.11: Likelihood to Evacuate

Scale	N	Percent
Very Unlikely	18	23.7
Unlikely	16	21.1
Undecided	29	38.2
Likely	9	11.8
Very Likely	4	5.3
Total	76	100.0

Appendix A: Question 3

This section of the questionnaire survey concluded with a question that asked residents whether or not they were residing in Lake Wales during the 2004 hurricane season. If the respondents indicated that they were living in Lake Wales during that time then they were asked to answer the questions in the second section of the survey, because these were the individuals who likely had personal experience with a hurricane forecasting, warning and response system.

Section 2: Actual Warnings and Response

In the second section of the questionnaire survey, the questions pertained to the participants' actual responses, behaviors, and opinions about the hurricane warnings issued during the 2004 hurricane season. Sixty-six of the 76

individuals surveyed resided in Lake Wales during the 2004 hurricane season and hence responded to the questions related to actual warnings and responses.

Tables 7.12, 7.13, and 7.14, respectively, show how the participants rated the amount of information they received from officials in the warning messages, the perceived accuracy of information coming from officials in the warnings, and rated how well the respondents understood the information they received from officials in the warnings. The majority of the participants (78.8%) felt as if the amount of information was just the right amount (Table 7.12). Also, most of the participants, 78.8%, felt as if the accuracy of the information was either good or very good although 18% thought it was “okay” (Table 7.13). Finally, the majority of the participants (67.1%, Table 7.14) either somewhat agreed or completely agreed that they understood the information provided to them in the warnings. Very few (3.9%) disagreed with the statement.

Table 7.12: Amount of Information

Scale	N	Percent
Not Enough	0	0.0
Almost Enough	6	9.1
Just the Right Amount	52	78.8
Almost Too Much	7	10.6
Too Much	1	1.5
Total	66	100.0

Appendix A: Question 7

Table 7.13: Accuracy of Information

Scale	N	Percent
Poor	0	0.0
Okay	12	18.2
Good	32	48.5
Very Good	20	30.3
Excellent	2	3.0
Total	66	100.0

Appendix A: Question 8

Table 7.14: Understood Information

Scale	N	Percent
Completely Disagree	0	0.0
Somewhat Disagree	3	3.9
Neutral	12	15.8
Somewhat Agree	41	53.9
Completely Agree	10	13.2
Total	66	100.0

Appendix A: Question 9

All 66 individuals residing in Lake Wales during the 2004 hurricane season and participating in the questionnaire survey stated that they took some sort of action in response to the hurricane warnings. Also, most believed they took the correct response after receiving the hurricane warnings (81.8%, Table 7.15), and that they are likely or very likely (64.4%) to repeat the same response next time (Table 7.16). Overall, most agreed that they had had enough time to take action (Table 7.17) before the event occurred. However, some residents reported that they had less time to prepare for Hurricane Charley as compared to the latter two hurricanes, Frances and Jeanne. Residents also seemed to recall more detail about Hurricane Charley, where they seemed to discuss Hurricanes Frances and Jeanne collectively.

Table 7.15: Correct Response

Scale	N	Percent
Yes	54	81.8
No	1	1.5
Not Sure/Don't Remember	11	16.7
Total	66	100.0

Appendix A: Question 12

Table 7.16: Will Repeat Same Response

Scale	N	Percent
Very Unlikely	0	0.0
Unlikely	1	1.5
Undecided	16	21.1
Likely	27	35.5
Very Likely (5)	22	28.9
Total	66	100.0

Appendix A: Question 13

Table 7.17: Time to Take Action

Scale	N	Percent
Completely Disagree	0	0.0
Somewhat Disagree	1	1.5
Neutral	6	7.9
Somewhat Agree	42	55.3
Completely Agree	17	22.4
Total	66	100.0

Appendix A: Question 11

Several questions elicited information about hurricane impacts and damage (Table 7.18). Ninety-five percent of the respondents reported experiencing some type of loss due to the hurricanes. The most common type of damage reported among the respondents was roof damage followed by fence and vehicle damage. Many residents reported their roofs having to be partially or fully replaced. Most residents also reported that it took up to a week or more for power to be restored to their homes and businesses after the storms. Also,

61.9% or the respondents reported other types of damage such as broken windows, garage door damage, and other types of damage around their homes.

Table 7.18: Loss and Damage

Loss Questions	Yes	No
Experience Loss	95.3%	4.7%
Roof Damage	76.2%	23.8%
Fence Damage	9.5%	90.5%
Vehicle Damage	11.1%	88.9%
Other Damage	61.9%	38.1%

Appendix A: Question 6

Aid

Table 7.19 summarizes whether or not individuals received aid or help after the events. All types of aid were included in this question, be it monetary help or structural items such as a blue tarp to cover roof damage.

Table 7.19: Did you Receive Aid?

Scale	N	Percent
Yes	44	66.7
No	22	33.3
Total	66	100.0

Appendix A: Question 14

Of those claiming to have received aid, most said it came from the federal government and FEMA (Federal Emergency Management Agency). However, some did not know or did not remember where their aid came from, but most felt (75%) that the aid was at least somewhat appropriate (Table 7.20).

Table 7.20: Aid Appropriate

Scale	N	Percent
Completely Not Appropriate	0	0.0
Not Appropriate	1	2.3
Neutral	10	22.7
Appropriate	33	75.0
Completely Appropriate	0	0.0
Total	44	100.0

Appendix A: Question 16

Responses were more varied among participants when asked how they rated the post-event information they received (Table 7.21). Over 33% rated the information okay or poor, while 30% said it was very good or excellent. However, even though the responses were varied with regard to the rating of post-event information (Table 7.21), most residents, 87.8%, were either neutral or agreed to some extent that officials acted quickly enough during the post-event period (Table 7.22).

Table 7.21: Rating of Information Post-Event

Scale	N	Percent
Poor	1	1.6
Okay	20	31.7
Good	23	36.5
Very Good	18	28.6
Excellent	1	1.5
Total	63	100.0

Appendix A: Question 17

Table 7.22: Timeliness of Officials Post-Event

Scale	N	Percent
Completely Disagree	1	1.5
Somewhat Disagree	7	10.6
Neutral	22	33.3
Somewhat Agree	33	50.0
Completely Agree	3	4.5
Total	66	100.0

Appendix A: Question 18

Hurricane Season

Overall, of the 66 individuals who participated in section two of the questionnaire survey, 45 (68.2%) correctly identified that hurricane season begins June 1st and runs through November 30th. Another common response was that hurricane season occurs in the summer months. This is encouraging in that most of the people surveyed know when hurricane season is and, therefore, they already know what time of the year they needed to be prepared for such events.

Chapter Eight: Data Analyses and Discussion

This research examined five research questions in the context of different demographic variables that were hypothesized to influence one's perception and response to hurricane warnings.

1. Does age affect how a person responds to a warning?
2. Do males and females respond differently to warnings?
3. Does level of education affect how a person responds to a warning?
4. Does socioeconomic status affect a person's ability to respond to a warning?
5. Does place or location affect a person's ability or willingness to respond to a warning?

The descriptive analyses section provided details about the participant's responses to the questionnaire survey. However, more in-depth analysis is required to explore these relationships.

In order to effectively answer the research questions and respond to the hypotheses, the responses are organized by the different research question variables, of age, gender, level of education, socioeconomic status, and area. Again, the statistical significances for the questions in the survey were found using the Mann-Whitney Test.

In the following tables the mean refers to the average response of the participants on the appropriate likert scale. Refer to the questionnaire survey (Appendix A) for the questions with the corresponding scale.

Age

Within this section the differences in responses by age are examined. Specifically this section addresses the research question: Does age affect how a person responds to a warning? The hypothesis was that older people are more likely to try to respond positively to a warning than younger people. Responding positively in this case means to respond more appropriately (i.e. taking a correction action in response to a warning). It was found that when separating the age category into those age 18 to 54 and 55 and older there were some significant differences in the responses. The median was used to separate the respondents into these two groups.

The first group of questions was concerned with perceived views and behaviors. When asked whether or not the respondents would take any sort of action in response to a hurricane warning, there was no significant difference found (Table 8.1). Both groups were equally likely to take some sort of action in response. However, when asked if they knew what action to take in response to the warning, the two age groups were significantly different but only at the 0.1 level of significance. With this it was found that the older group reported more often that they knew what action to take in response to a hurricane warning. This

may be the case because older individuals may have more experience with hurricane warnings or they were merely more confident in their own abilities. Also, it was found that there was no significant difference with regard to the two age categories and evacuation. Most of the respondents reported that they are either unlikely to evacuate their home or undecided about the issue. It would appear, then, that other factors enter into evacuation decisions.

Table 8.1: Age – Perceptions

Survey Question	18-54	55 and older	p-value	Sig.
	Mean	Mean		
Warning-Public Action	4.22	4.19	.99	No
Know what action to take	-	-	.10	Yes*
Evacuation	2.51	2.58	.87	No

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Next, the respondents were asked about their opinions surrounding the information they received from officials before the events in the form of watches and warnings during the 2004 hurricane season (Table 8.2). There was no significant difference found between the two age groups regarding the amount of information they received. Both age groups reported that the amount of information they received was just the right amount. However, significant differences exist between the two age group's opinions about the accuracy of this information and whether or not they felt they understood the information in the warnings. Significant differences exist at the 0.05 and 0.1 levels, respectively. The younger group gave higher marks overall to these two questions and felt as if the accuracy was better and that they understood the information better as compared to the older group. The older group may have rated these two

categories lower because they were more dependent on action by officials and their assistance. In addition, the older group did report experiencing more loss and receiving more aid from officials after the events in comparison to the younger group.

Table 8.2: Age – Information

Survey Question	18-54	55 and older	p-value	Sig.
	Mean	Mean		
Amount of information	3.05	3.03	.97	No
Accuracy of information	3.32	3.00	.10	Yes*
Understand information	4.00	3.72	.10	Yes*

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

The following group of questions addresses whether or not the residents took action for the 2004 hurricane season warnings and how they rated their own response (Table 8.3). No significant difference was found in whether or not the residents took action in response to the hurricane warnings issued. It was unanimous that all respondents did something after the warnings were issued. This is consistent with the earlier result, that when residents are faced with a hurricane warning they do plan to take action. There was also no significant difference in whether or not respondents felt like they took the correct response; most were confident that they did take the correct response. However, when asked whether or not they had enough time to take any action they felt necessary, the younger respondents were more likely to say they had enough time. The two group's responses were significantly different at the 0.01 level. Again, the older respondents may be more dependent on others to help them prepare causing them to rate the time issue differently. In addition, the likelihood

of residents to take the same response next time differed significantly as well. The younger group reported that on average they were more likely to take the same response next time as compared to the older group. Older respondents may not have been as satisfied with the actions they took, especially if they required outside help.

Table 8.3: Age – Action and Response

Survey Question	18-54	55 and older	p-value	Sig.
	Mean	Mean		
Take any action	-	-	.10	No
Time to take action	4.30	3.93	.01	Yes***
Correct Response	-	-	.60	No
Repeat Response	4.22	3.86	.06	Yes*

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

The final questions related to the information available to residents and the timeliness of officials after the events in 2004 (Table 8.4). For these two questions there were no significant differences found in the responses. According to the survey, both age groups felt that the information provided after the events was adequate and that officials, for the most part, did act quickly enough.

Table 8.4: Age – Post-event

Survey Question	18-54	55 and older	p-value	Sig.
	Mean	Mean		
Rating of information/post-event	2.97	2.96	.98	No
Officials quick enough post-event	3.43	3.48	.95	No

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

In summary, it was found that both younger and older residents appear to respond favorably to hurricane warnings and that there was no significant difference in their response. However, the younger group gave more favorable ratings to the actions and information surrounding the warnings. However, there were no significant differences in responses regarding to post-event information and action. Therefore, both age groups do respond to hurricane warnings. This is an encouraging result in that individuals do listen and heed the warnings given by officials. However, when trying to respond to the warnings, older individuals may require the help of others, making the process more difficult for them and causing them to not rate the actions and information surrounding the warnings as high.

Gender

Gender is the next variable hypothesized to have a possible affect on perception and response to hurricane warnings. When examining the differences in responses with gender, there were no significant differences found when residents were asked if they would take any action in response to a hurricane warning and whether or not they know what action they should take (Table 8.5). Respondents reported that they did plan to take action when a hurricane warning was issued and felt like they did know what action to take when faced with a hurricane warning. This then does not support the hypothesis that females are more likely to respond to a warning message than males. However, a

significance difference at the 0.05 level was found when asked about whether or not respondents would evacuate their homes. Males actually reported that they were more likely to evacuate their homes. Initially, this was surprising since the literature suggests that males invariably seek to 'fight' the disaster while females first seek safety. However, this may be because women, with the added responsibility of caregiver (Morrow 1999), may be more reluctant to evacuate in order to stay home with their dependents. This aspect, however, warrants further research in order to determine if this is actually reflective of the study areas.

Table 8.5: Gender – Perceptions

Survey Question	Male	Female	p-value	Sig.
	Mean	Mean		
Warning-Public Action	4.21	4.21	.95	No
Know what action to take	-	-	.36	No
Evacuation	3.06	2.73	.07	Yes*

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

There were no significant differences in how males and females rated the information they received in the 2004 hurricane season warning messages (Table 8.6). Both males and females similarly rated the information in the warnings regarding the amount and accuracy of the information and whether or not the respondents felt they understood the information. Therefore, both males and females seem to perceive this information similarly.

Table 8.6: Gender – Information

Survey Question	Male	Female	p-value	Sig.
	Mean	Mean		
Amount of information	2.93	3.00	.22	No
Accuracy of information	2.93	3.19	.83	No
Understand information	3.60	3.88	.81	No

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

There were also no significant differences found in whether or not males and females took any action and if they felt it was the correct response (Table 8.7). Again, respondents reported that they took some sort of action in response to the warnings issued during the 2004 hurricane season. There were also no differences when asked if they felt as if they had to time take action; most agreed that they had the time to take the action they deemed necessary. There was, however, a significant difference found at the 0.1 level in whether or not respondents would repeat the same action they took for the 2004 season for subsequent hurricane warnings. Females reported that they were slightly more likely to take the same actions for the next warnings as compared to males. From the hypothesis, even though both males and females respond to hurricane warnings, because of having the added responsibility of caregiver women may be better prepared to respond, therefore being more confident that they can take the same response for the next warning. This, however, is in contrast to Morrow (1999), who states that women typically have access to fewer resources making them less able to respond appropriately. Again, this needs further study.

Table 8.7: Gender – Action and Response

Survey Question	Male	Female	p-value	Sig.
	Mean	Mean		
Take any action	-	-	.10	No
Time to take action	3.90	4.14	.68	No
Correct Response	-	-	.37	No
Repeat Response	3.60	3.95	.10	Yes*

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

The final set of gender questions, examining post-event information and action, found no significant differences (Table 8.8). Males and females rated the information provided by officials post-event and whether or not officials responded quickly enough after the events similarly.

Table 8.8: Gender – Post-event

Survey Question	Male	Female	p-value	Sig.
	Mean	Mean		
Rating of information/post-event	3.03	3.02	.47	No
Officials quick enough post-event	3.56	3.43	.84	No

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

In summary, there was no significant difference between male and female responses in how they perceived and responded to hurricane warnings. The responses given in the survey were relatively similar. Therefore, the hypothesis stating that females are more likely to respond to warning messages than males cannot be substantiated within this context. However, with females having stronger place attachment and caregiver responsibilities (Morrow 1999), they are less likely to evacuate.

Level of Education

Level of education was also hypothesized to have an affect on one's perception and response. In this analysis the respondents were divided into two groups, those with a high school diploma or less, and those with more than a high school diploma. When examining perceived views, as consistent with previously reported findings, there was no significant difference found between the two groups in whether or not residents plan to take action when a hurricane warning is issued (Table 8.9). There was also no difference statistically in whether or not residents know what action to take in a warning situation; most agreed that they did know what action to take. However, there was a significant difference, at the 0.01 level, found in the decision of whether or not respondents plan to evacuate in a hurricane warning. Those with more than a high school diploma were less likely to evacuate their homes than those with a lower level of formal education. Level of education is usually correlated with socioeconomic status or income; therefore, those with more than a high school diploma may reside in areas and in dwellings where evacuation is not necessary. Furthermore, their access to resources would be greater than those with less education.

Table 8.9: Education – Perceptions

Survey Question	HS Diploma or less	More than HS Diploma	p-value	Sig.
	Mean	Mean		
Warning-Public Action	4.14	4.29	.38	No
Know what action to take	-	-	.30	No
Evacuation	2.81	2.21	.02	Yes**

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

In the next section, pertaining to the actual content of the 2004 warning messages, there was no significant difference found related to the amount of information the respondents received (Table 8.10). In contrast, when asked how they rated the accuracy of the information and whether or not the respondents understood the information, there were significant differences at the 0.01 and 0.05 levels, respectively. The group with more than a high school diploma rated the accuracy of the warning messages higher than those with lower levels of formal education. In addition, the group with more than a high school diploma reported that they understood the information more compared to the group with a high school diploma or less. This supports the hypothesis that those with a higher level of education will understand what the warning message says and what action needs to be taken more often than the group with a high school diploma or less. Of course, the suggestion here is that they truly comprehend the information. Another hurricane warning will test this assumption.

Table 8.10: Education – Information

Survey Question	HS Diploma or less	More than HS Diploma	p-value	Sig.
	Mean	Mean		
Amount of information	2.97	3.14	.24	No
Accuracy of information	2.97	3.46	.007	Yes***
Understand information	3.71	4.11	.02	Yes**

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

The next group of education related questions was divided into whether or not the residents took action for the 2004 hurricane season warnings and how they rated their own response (Table 8.11). No significant difference was found in whether or not the residents took action in response to the hurricane warnings issued. It was unanimous that all respondents did something after the warnings were issued. This is consistent with the first response of residents reporting that they would take action when faced with a hurricane warning. However, when residents were asked whether or not they had time to take action, if they felt they took the correct response, and if they would repeat the same response for the next warning, there was a significant difference at the .01 level for all three questions. Those individuals with more than a high school diploma gave a higher score to the question about time to take action as opposed to those with less than a high school diploma. Also, those with more than a high school diploma more often reported that they felt they took the correct response and that they would repeat the same response next time. Again, this may result from those having more than a high school diploma being more able to correctly understand and act appropriately in response to a hurricane warning.

Table 8.11: Education – Action and Response

Survey Question	HS Diploma or less	More than HS Diploma	p-value	Sig.
	Mean	Mean		
Take any action	-	-	1.00	No
Time to take action	3.92	4.43	.001	Yes***
Correct Response	-	-	.006	Yes***
Repeat Response	3.79	4.43	.001	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

There were no significant differences found regarding to post-event information and action by officials (Table 8.12). Both groups rated the information from officials post-event and the timeliness of officials, similarly. Both groups felt that the information available to them after the hurricanes was good and the respondents had a neutral to good rating about the timeliness of the officials after the events.

Table 8.12: Education – Post-Event

Survey Question	HS Diploma or less	More than HS Diploma	p-value	Sig.
	Mean	Mean		
Rating of information/post-event	2.95	3.00	.81	No
Officials quick enough post-event	3.45	3.46	.66	No

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

In summary, there were significant differences found when examining the respondents by education levels. These differences particularly were shown in how the individuals understand and perceive the information provided to them and how they apply it to take action for an impending hurricane. With this, one's

level of education does seem to impact their perceptions and responses to hurricane warnings. However, it remains to be seen whether these statements regarding the respondents' knowledge base will be effective when the next hurricane strikes.

Socioeconomic Status

An additional research question and hypothesis examined socioeconomic status or income and related perception and behavior in regards to hurricane warnings. The respondents were placed into one of two categories based on the median: those whose annual household income is less than $40,000, and those whose annual household income equals or exceeds $40,000.

The first group of questions pertained to individual's perceptions (Table 8.13). As consistent with the previous sections, most individuals reported that they would take action when a hurricane warning is issued and that they know what action to take when a hurricane warning is issued. The only significant difference found (at the 0.01 level) between the two groups was in whether or not they would evacuate their homes. Those earning $40,000 annually or more reported being less likely to evacuate their homes. This may be due to the fact that those earning less than $40,000 annually may reside in mobile homes and less well constructed homes and need to evacuate for safety. Those of lower socioeconomic status may also reside in more vulnerable locations (Morrow 1999).

Table 8.13: Socioeconomic Status – Perceptions

Survey Question	Less than $40,000/annually	$40,000/annually or more	p-value	Sig.
	Mean	Mean		
Warning-Public Action	4.09	4.29	.21	No
Know what action to take	-	-	.38	No
Evacuation	3.06	2.12	.001	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Next, there was no significant difference found related to the amount of information the respondents received in the form of warning messages (Table 8.14).

Table 8.14: Socioeconomic Status – Information

Survey Question	Less than $40,000/annually	$40,000/annually or more	p-value	Sig.
	Mean	Mean		
Amount of information	2.93	3.15	.11	No
Accuracy of information	2.93	3.38	.008	Yes***
Understand information	3.60	4.09	.003	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

However, there were significant differences found, at the 0.01 level, in the perceived accuracy of the messages and how well respondents reported understanding the messages. The higher income group seemed to believe the warning message information was more accurate. In addition, the higher income group also reported that they understood the information better compared to the lower income group. However, as previously stated socioeconomic status and

level of education are often correlated; therefore, one would expect the higher income group to understand the warning messages better.

Next, all of the participants reported taking some sort of action in response to the hurricane warnings. Hence, there was no significant difference found (Table 8.15). However, when asked about the time to take action, whether or not they felt like they took the correct response, and whether or not they would repeat the same response again, there were significant differences between the two groups at the 0.01 level. Those in the group earning $40,000 or more annually felt as if they had more time to take their action in response to the hurricane warnings. In addition, the same group was more confident that they took the correct response and also reported being more likely to take the same response next time. This is consistent with the hypothesis that those with higher socioeconomic status have access to the resources needed to take appropriate and timely action and response.

Table 8.15: Socioeconomic Status – Action and Response

Survey Question	Less than $40,000/annually	$40,000/annually or more	p-value	Sig.
	Mean	Mean		
Take any action	-	-	1.00	No
Time to take action	3.90	4.32	.009	Yes***
Correct Response	-	-	.000	Yes***
Repeat Response	3.60	4.44	.000	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

There was no significant difference found, based on socioeconomic status, in the respondents' rating of post-event information. However, there was

a significant difference at the 0.1 level in the timeliness of officials after the events of the 2004 hurricane season (Table 8.16). The respondents earning $40,000 or more annually were more satisfied that officials took quick enough action after the events. Again, those earning less than $40,000 annually may have been more dependent on the help offered by officials, possibly making them more critical of response time.

Table 8.16: Socioeconomic Status – Post-Event

Survey Question	Less than $40,000/ annually	$40,000/ annually or more	p-value	Sig.
	Mean	Mean		
Rating of information/post-event	2.83	3.03	.35	No
Officials quick enough post-event	3.30	3.56	.10	Yes*

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Overall, socioeconomic status does seem to be a factor influencing responses to hurricane warnings and the events that take place after the event. Those with higher socioeconomic status, in general, were more satisfied with the warning information and general information before and after the events.

Area

When analyzed for area, some significant differences were found in some responses. However, as consistent with the previous sections, there was no significant difference found when asking respondents if they would take any

action in response to a hurricane warning (Table 8.17). In fact, the majority of residents were in agreement that they should take some sort action when a hurricane warning is issued. This again is a very encouraging result, in that people appear willing to respond to hurricane warnings. In addition, most agreed that they also knew what action to take. However, differences arose, at the 0.01 level, in the two sampling areas when asked about whether or not they would evacuate their homes. The individuals residing in the East Lake Wales sampling area reported that they were much less likely to evacuate than the residents of North Lake Wales. The main reason given from the residents in the East Lake Wales sampling area for not evacuating was that they felt they lived in a safe, well built home and would be better off staying home than trying to evacuate elsewhere.

Table 8.17: Area – Perceptions

Survey Question	East	North	p-value	Sig.
	Mean	Mean		
Warning-Public Action	4.3	4.0	.12	No
Know what action to take	-	-	.41	No
Evacuation	2.3	3.14	.005	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

There were also significant differences in the answers provided by the two sampling areas regarding the amount, accuracy, and the level to which respondents understood the information in the warning messages in 2004 (Table 8.18). The East Lake Wales sampling area expressed more satisfaction with the amount, accuracy and timeliness of information. This may be because the people residing in the East Lake Wales sampling area are more capable of

responding compared to the individuals of North Lake Wales. The East Lake Wales sampling area is more affluent and therefore has better access to the resources needed.

Table 8.18: Area – Information

Survey Question	East	North	p-value	Sig.
	Mean	Mean		
Amount of information	3.13	2.84	.036	Yes**
Accuracy of information	3.40	2.63	.000	Yes***
Understand information	4.09	3.37	.000	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Also consistent with the previous sections, all residents reported taking some sort of action in response to the hurricane warnings (Table 8.19). However, there were significant differences found in the respondents' perceptions of the time they had to take action, whether or not they took the correct response, and whether or not they would take the same response next time. The respondents in the East Lake Wales sampling area overall were more in agreement that they had enough time to take action. Also, more respondents in the East Lake Wales sampling area stated that they felt they took the correct response and would repeat the same response next time when compared to the North Lake Wales sampling area. This is in part due to the demographic factors previously discussed. The East Lake Wales sampling area appears to better able to understand and respond to hurricane warnings.

Table 8.19: Area - Action and Response

Survey Question	East	North	p-value	Sig.
	Mean	Mean		
Take any action	-	-	1.00	No
Time to take action	4.30	3.74	.002	Yes***
Correct Response	-	-	.000	Yes***
Repeat Response	4.34	3.37	.000	Yes***

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Finally, there were significant differences found between the two sampling areas in the rating of information post-event and the officials' timeliness post-event (Table 8.21). Overall, the respondents residing in the eastern study area were more satisfied with the post-event information and action by officials. Again, this may be due to the fact that the residents of the eastern study area are less dependent on what officials do; therefore, they are not as critical of these actions.

Table 8.20: Area – Post-Event

Survey Question	East	North	p-value	Sig.
	Mean	Mean		
Rating of information/post-event	3.11	2.63	.051	Yes*
Officials quick enough post-event	3.57	3.16	.025	Yes**

***Significant at .01 level (2-tailed)
**Significant at .05 level (2-tailed)
*Significant at .1 level (2-tailed)

Overall, the two sampling areas in Lake Wales elicited more significant differences than did the other variables. However, the area variable takes into account all of the other factors of age, gender, level of education, and socioeconomic status. The likelihood ratio statistic between education and area

was 19.6 and for income and area it was 44.5. These values were both significant at the .01 level. In fact, what is argued here is that area actually acts as a surrogate variable for the others. Therefore, it is not where one is located that makes a difference but yet is the composition of the people in the location itself.

Limitations

There are a few limitations within this research. One being that, within this research more women than men were surveyed. This could have been a result of the time of day the surveys were completed. The surveys were completed during the middle of the work day and those that were home at the time were the ones surveyed. Also, there were more East Lake Wales respondents than North Lake Wales respondents. This could have skewed the data some as the East Lake Wales area generally had higher education and income levels.

Also, the response taken by individuals was what they perceived to be the correct action. Therefore, the action individuals take may not always be the proper action for every situation.

In addition, the 2004 hurricane season was examined as a whole. However, Lake Wales experienced three distinct storms which could have biased the responses. Hurricane Charley occurred first and was the most severe for Lake Wales. Charley was then followed by Hurricanes Frances and Jeanne. This may have amplified the responses residents gave for this season. A survey

completed after a season of few warnings and storms may yield less significant results.

Chapter Nine: Conclusion

Within this research it was found that there are demographic factors that influence individuals' perceptions, responses, and behaviors to hurricane warnings. Individuals perceive and understand warning messages differently. This research showed how some of these factors influence individuals' perceptions, responses, and behaviors.

Key Results

There were important findings and key results found with this research.

- First, Deutscher (1973) stated that what individuals say they will do in certain situations is not always what they actually do. However, this is in contrast to what occurred in Lake Wales. The people of Lake Wales overwhelmingly said that they would respond in some way to a hurricane warning and this was reflected in the actions they reported taking during the 2004 season. This is an important result in that people do seem to understand the seriousness of such a warning. This leads to the

community overall being more prepared when faced with events such as this.

- Second, both males and females similarly rated the information provided to them in the warning messages, and both males and females reported that they did feel they had time to take the action they deemed necessary after the warnings were issued. However, this research discovered that females were less likely to evacuate their homes. This possibly comes from woman having a stronger attachment to place and having the added responsibility of caregiver, especially in times of crisis as described by Morrow (1999).
- Third, within this research it was confirmed that income and level of education were positively correlated with each other (Table 7.4). The likelihood ratio between income and level of education was 77.4, which is significant at the 0.01 level. This indicates that as income increases so does one's level of education. The results within this research also show that income and level of education influence individuals and the ways they perceive and respond to warnings. The results herein are consistent with that of Morrow (1999) that poor households have insufficient resources in order to prepare for the event.
- Finally, location produced the highest number of significant results. However, as previously mentioned, location acts as a surrogate for the other variables. Therefore, area is just reflecting a composition of all of the other variables combined.

Future Implications and Practical Applications

This research provides insight into one small community and its perceptions and responses to a forecasting, warning and response system. This research also supports previous findings of how different demographic factors are related and influence individuals' behaviors (Wisner et al. 2004, Tobin and Montz 1997, Morrow 1999). In addition, the research herein supports the model Murray (1980) proposed, which includes a response sub-system that takes into account the factors that can influence an individual's response. The results of this research can be used in the future development of forecasting, warning and response systems by taking what has been found here and applying it to new models. For example, older individuals may need more time and assistance to respond to a warning. By already knowing that older individuals need more time, once a warning is issued assistance can be dispatched to those who need it. Also, those of lower socioeconomic status may not have the financial resources to adequately respond to a warning. Therefore, after a warning is issued supplies could be disbursed to those in need.

Future research should investigate additional communities and how different characteristics of individuals influence their understanding and response to warnings to determine to what extent generalizations can be made from community to community. It is hoped that this research will be able to contribute to the understanding of how different characteristics of an individual influence their understanding and response to warnings, which may have practical

applications when designing future forecasting, warning and response systems. In addition, this research was applied to a hurricane forecasting, warning and response system but could very well be applied to other hazards that can have similar lead times such as floods or volcanoes.

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Appendices

Appendix A: Questionnaire Survey

Hurricane Forecasting, Warning and Response Systems:
A Lake Wales Public Perception Study

Conducted by April Raulerson
University of South Florida

Faculty Advisor:
Dr. Graham Tobin

Introductory Statement

Hello, my name is April Raulerson and I'm a graduate student at the University of South Florida in Tampa. I am conducting surveys to collect data for my Master's Thesis. I'd like to ask you some questions about your knowledge and experience with warnings and responses from hurricanes. This study is not funded by any company or corporation, and I am not trying to sell you anything. This survey will only take 10-15 minutes of your time. These results could be published. However, your answers will be kept completely confidential and identifying information will not be collected or attached to this survey. The information obtained from this survey will only be used for statistical purposes. May I continue? Do you have any questions?

If you have any questions or would like more information, please contact my advisor, Dr. Graham Tobin, at the University of South Florida at 813-974-4808. He can also be reached through email at gtobin@cas.usf.edu.

Appendix A (Continued)

Survey Number: _____

Section 1: Perceived views of warning and response
The beginning set of questions is to determine how you feel about hurricane warnings and what you do when they are issued.

1. If a hurricane warning is issued for your area how likely are you to take action?

Very Unlikely (1)	Unlikely (2)	Undecided (3)	Likely (4)	Very Likely (5)

2. Do you know what action(s) to take if a hurricane warning is issued?

Yes	
No	
Not Sure	

3. If a hurricane warning is issued for your area how likely are you to evacuate?

Very Unlikely (1)	Unlikely (2)	Undecided (3)	Likely (4)	Very Likely (5)

4. If you do not plan to evacuate, why? (Check all that apply)

Safe and well built house	
Expense (Cost)	
Dependents	
Transportation	
Pets	
No place to go	
Other	

5. Were you living in Lake Wales during the summer and fall of 2004?

Yes	
No	

If yes, continue with survey. If no, skip section 2.

6. Did you experience any property or personal losses during the 2004 hurricane season? If so, what?

_____
_____

Section 2: Actual warnings and response
This set of questions is about how you felt about the 2004 hurricane season's warnings and responses.

7. How satisfied are you with the warnings you received?
The amount of information I received about the event was

Not enough (1)	(2)	Just the right amount (3)	(4)	Too much (5)

8. The accuracy of the information provided in the warning was

Poor (1)	Okay (2)	Good (3)	Very Good (4)	Excellent (5)

9. The warning gave me enough information so I understood what was expected to happen.

Completely Disagree (1)	Somewhat Disagree (2)	Neutral (3)	Somewhat Agree (4)	Completely Agree (5)

10. Did you take any action after you received a warning that a hurricane was approaching?

Yes	
No	
Not Sure/Don't Remember	

11. The warning was issued so I had enough time to take action.

Completely Disagree (1)	Somewhat Disagree (2)	Neutral (3)	Somewhat Agree (4)	Completely Agree (5)

12. After the warnings were issued do you believe you took the correct response and/or action?

Yes	
No	
Not Sure/Don't Know	

13. How likely are you to take the same action next time?

Very Unlikely (1)	Unlikely (2)	Undecided (3)	Likely (4)	Very Likely (5)

14. Did you receive any aid from the federal, state, or local governments after the hurricanes?

Yes	
No	
Not Sure/Don't Remember	

15. If so, what kind of aid did you receive after the hurricanes? (check all that apply)

Federal government/FEMA	
State/Local government	
Don't know who I received aid from	
Did not receive aid	

16. If you received aid, was the aid you received after the event appropriate?

Completely Not Appropriate (1)	Not Appropriate(2)	Neutral (3)	Appropriate (4)	Completely Appropriate (5)

17. How would you rate the information (e.g. about the availability of aid or assistance, directions about what to do, timeline of recovery) you received from state government officials after the hurricanes?

Poor (1)	Okay (2)	Good (3)	Very Good (4)	Excellent (5)

18. Do you believe that federal and state governments took action quickly enough after the hurricanes?

Completely Disagree (1)	Somewhat Disagree (2)	Neutral (3)	Somewhat Agree (4)	Completely Agree (5)

This question is to determine how much you know about hurricane season.

19. Which months are included in hurricane season?

_____

Section 3: Demographics
We are almost done. These last questions are simply used to gather some information about the group of people being interviewed. Again, all of this information is confidential.

20. *Gender*: Please indicate below.
Male _____
Female _____

21. *Age*: Which category best describes your age?

18 – 24	
25 – 34	
35 – 44	
45 – 54	
55 – 64	
65 – 74	
75 and above	

22. *Education*: What is the highest level of school you completed?

9th grade	
High school diploma or equivalent	
Some college, no degree	
Associate's or Technical degree	
Bachelor's degree	
Graduate or Professional degree	
Other (please describe)	

23. *Race/Ethnicity*: What do you consider to be your race or ethnicity?

Black	
Hispanic	
Native American	
Pacific Islander	
White	
Other (please describe)	

24. *Income*: Which category best describes your household income last year?

Less than $10,000	
$10,000 – 19,999	
$20,000 – 29,000	
$30,000 – 39,999	
$40,000 – 49,999	
$50,000 – 59,999	
$60,000 and above	

25. Is there anything else you would like to tell me or think I should know?

_____
_____
_____
_____

This completes the survey. Thank you so much for participating.