Developing a Severe Weather Alerting System

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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DEVELOPING A SEVERE WEATHER ALERTING SYSTEM

Abstract

The problem is the City of Milton does not have an early warning system for severe weather. The purpose of this research is to identify early warning systems that will alert the community of impending severe weather incidents. Descriptive research methodology was used to answer the following research questions: a) Which area in the City of Milton is most vulnerable to severe weather? b) What are the current methods available on a national level to warn the citizens of Milton? c) What are the current methods available on a local level to warn the citizens of Milton? d) What are the key identified early warning systems that should be incorporated in the community to alert the citizens of severe weather incidents? It was found that topography has an effect on the severity of storms. The research indicated that most people are unaware of the severe weather alerting systems available in their area and different age groups seek information from different sources. It was also found that community leaders need to diversify their severe weather alerting systems in order to reach a diverse community. Interviews with weather experts were conducted, in addition to, an interview with a communications manager following the winter weather event that hit Atlanta, Georgia in 2014. It was found that having one on one communication with residents and sharing the information was effective. Having a redundant severe weather alerting system is needed to reach a community of different ages and backgrounds. The City of Milton needs to implement a severe weather alerting system, utilizing national and local resources, along with an educational component to effectively warn citizens of impending severe weather.

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DEVELOPING A SEVERE WEATHER ALERTING SYSTEM

Introduction

The problem is the City of Milton does not have an early warning system for severe weather. The purpose of this research is to identify early warning systems that will alert the community of impending severe weather incidents. The National Oceanic and Atmospheric Administration (NOAA) classify severe weather as any weather event that threatens life and/or property (National Weather Service [NWS] 4.1). Tornadoes are among the list of severe weather events with increasing frequency and severity. From 1991 – 2010 the United States averaged 1253 tornadoes per year, thirty of those tornadoes touched down in the State of Georgia (Lupo, 2013).

Descriptive research will be used to describe methods utilized to notify people of severe weather. Questionnaires will be used to gauge the effectiveness of weather alerting systems in areas of the country prone to severe weather and assess the attitudes and/or opinions of communities currently using severe weather alerting and their effectiveness. The research will describe severe weather alerting systems currently available. The following research questions will be answered: a) Which area in the City of Milton is most vulnerable to severe weather? b) What are the current methods available on a national level to warn the citizens of Milton? c) What are the current methods available on a local level to warn the citizens of Milton? d) What are the key identified early warning systems that should be incorporated in the community to alert the citizens of severe weather incidents? Research will be completed by utilizing journals, books, newspaper articles, magazine articles, personal interviews, surveys, federal reports and national websites.

Background and Significance

The City of Milton incorporated as a city in 2006, which includes 38 square miles of low-density suburban/rural development with a pocket of high-density and mid-rise commercial buildings in the extreme southeastern part of the city and a population of 35,015 (U.S. Census Bureau, 2014). Two small areas of the city make up the business district along with multi-family homes. There are four elementary schools, two middle schools, two high schools and three private schools. The schools and the greatest population density are all located in the southeastern and south central regions of the city. Monday through Friday, during school hours, these areas of the city pose the greatest risk to human life in the event of severe weather.

Each year thousands of people are impacted by severe weather (i.e. severe thunderstorms, hale and tornadoes). According to NOAA, during the period from 1991 – 2010, the average annual number of tornadoes touching down in the State of Georgia reached 30 (Appendix A). Preliminary data from 2012 shows there were more than 450 weather related fatalities and nearly 2,600 injuries related to severe weather nationwide (Ready. gov., n.d.).

Tornado Alley is considered to cover the Great Plains states and neighboring states from Texas, Oklahoma, to the Dakotas. According to NOAA these states had the highest number of tornado touch downs from 1980 – 2009 with the exception of three tornadoes, which occurred outside the demarcated area known as *Tornado Alley*. Severe weather has extended outward from the Great Plains to the east coast, including the State of Georgia. These storms included hail storms causing billions of dollars in property damage from 2000 – 2011. The states with the highest amount of damage were outside the area known as *tornado alley* ("Tornado and Hail Risk," 2012). From 2009 – 2013, the City of Milton experienced 246 severe thunder storms,

165 lightning strikes and 3 tornadoes (National Climate Data, 2013). From 2008 – 2012 tornadoes across Georgia caused 500 million dollars in damage and killed 23 people (Tornado History, n.d.).

More than 30 counties and cities varied in the way they notified residents of approaching severe weather. Experts agree that there is not one solution for warning the public. Hall County, Georgia has one of the most robust systems in place serving 185,000 residents. This system includes 21 outdoor sirens, automatic call-out system for landlines and a voluntary notification system, which sends messages to cell phones. A neighboring county with over 800,000 residents has no outdoor sirens or any social media call-out or texting systems in place. Each community determines their own threat level and the funding they want to allocate toward warning their community of impending severe weather, balancing risk vs benefit (Sarrio & Stevens, 2013, March).

The City of Milton has one dedicated emergency warning system used to communicate with the citizens other than those provided by the traditional media outlets. The municipalities within our contiguous boarders have mass notification systems that service their residents. Several cities provide more than one severe weather warning system, increasing notification percentages.

City of Milton Emergency Management encourages residents to purchase NOAA weather radios. These radios are useful for emergency notification of severe weather. According to a survey of city residents, 25% of city residents have a severe weather radio (Appendix B). This number is higher than the national average of 5 – 10 percent who owns a severe weather radio.

However, severe weather radios can create complacency and apathy due to the broad area of coverage and the perception of false alerts (Wolf, 2009).

Emergency managers and community leaders realize the need to communicate with the public before, during and after an emergency. With the decline of the landline phone and new technologies available today, alternate means are available to warn people of an emergency on the telephone, mobile device, web and social media. Emergency managers should have available to them a system that reaches as many people and quickly as possible while utilizing the latest technologies available.

The City of Milton utilizes a phone text-based program system that sends a message to citizens in minutes, alerting them to severe weather and advising of any specific instructions. This program offers a mapping feature, which can be useful to residents by allowing them to visualize areas in the city that may be affected and the proximity to their home, family or place of business. This system marketed as the Code RED system, is also used by the police department for Amber Alerts, traffic emergencies and by the public works department for road closures and utility issues. However, the diversity of this system can also lead to residents becoming complacent when a severe weather alert is activated. The Code RED system requires residents to voluntarily sign up to receive these alerts. As of January 2014, 10,318 residents have signed up to receive these phone based messages.

One of the goals of the U.S. Fire Administration's Executive Analysis of Community Risk Reduction is to develop a community risk reduction program. Based on the changing weather patterns, severity of storms and that Georgia is now considered a fragment of tornado alley, a

severe weather warning system that reaches the citizens of the City of Milton will meet the goal of the United States Fire Administration to improve local planning and preparedness.

Literature Review

The literature review will look at the most vulnerable areas to severe weather in the City of Milton by identifying the most populous areas and topography as it compares to other communities in the United States that are vulnerable to severe weather. The research will also review best practices available to warn citizens of impending severe weather on a national level as well as methods available on a local level. The literature review will identify early warning systems available for the community to effectively warn citizens of the possibility of impending severe weather.

The City of Milton is the northernmost city in Fulton County, Georgia. This area is known as the Piedmont region with an elevation that ranges from 300 feet above sea level to 2000 feet above sea level (Georgia-Topography, 2010). Atmospheric conditions must be right for tornadoes to spawn. According to a report by Benton (2013), who noted that Dr. K. Knupp from the University of Alabama's Severe Weather Institute and Radar and Lightening Laboratory believes three other factors contribute to the formation and strength of tornadoes: gravity waves, topography and surface roughness. The belief is that tornadoes can intensify when stretched or squeezed between slopes and will rise and fall with the topography. Gravity waves are energy pushed within the atmosphere and when they come in contact with storms, a tornado can spawn. Mountains and valleys are also believed to increase the strength of a tornado. As a tornado approaches a mountain, the system would slow down and decrease in strength, as the tornado crosses the mountain top and comes down towards the valley, the tornado strengthens. Surface

roughness, similar to what is found in areas of higher elevation and mountainous areas, is believed to increase the intensity of tornadoes. The Mountain Wave Theory researched by the NWS service found that mountain waves or wind increases when it exceeds 20 mph and is 30 degrees perpendicular to mountain ridges (Benton, 2013).

Television has been the primary means for the transmission of severe weather warnings, utilizing weather radar systems and the ability to explain the path and potential impact of severe weather. The severe weather outbreak on February 5 and 6, 2008, in the Mid-South and Tennessee Valley, was forecast six days prior to the outbreak. The threat of tornadoes was predicted four days in advance. Most of the fatalities occurred during night time hours when people were asleep and not watching television. Notification of severe weather relied on phone calls from family and friends, severe weather radios and tornado sirens. Forecasters were able to give residents a 17 minute lead time before the tornadoes touched down (Hayes 2009).

The Emergency Alert System (EAS) is a national public warning system that sends warnings to the public via television broadcasts, cable network satellite and wireless communication. The alerts are sent out through state and local authorities to specific areas affected by an emergency. The EAS gives the President of the United States access to the American people within 10 minutes during a national emergency. The EAS is used when other means of communication to the nation are not available (Federal Communications Commission [FCC], n.d.).

NOAA utilizes a national network of radio stations that broadcast continuous weather information from the nearest NWS office on the all hazards radio network, which operates 24

hours a day, 7 days a week. Studies have shown that only 5 – 10 percent of the population own a weather radio (Wolf, 2009).

National weather radios are available in most stores; NOAA recommends the radio carries the *Public Alert* logo. These radios meet technical standards, have battery back-up and alert tones. Another feature is the onscreen display of information in English, Spanish and French. Weather radios are available to people that are hearing impaired. The signal is converted into a visual, audio or mechanical form. Examples of these would be alerting devices that vibrate, bed shakers, pillow vibrators and strobe lights. NOAA weather radio is a source to weather and public information and one of many ways to stay informed about severe weather. The NWS only sends out weather alerts for fast moving events that require immediate response (National Weather Service, [NWS], n.d.).

The Federal Emergency Management Association (FEMA) has developed a warning system used to warn communities of natural disasters, the Integrated Public Alert and Warning System (IPAWS), is location specific. Authorities follow protocols to send an alert to IPAWS where it is authenticated and validated by a national standard. The message is forwarded to the emergency alerting system, commercial mobile alert system, internet, state and local alert systems and the NWS. These agencies then forward the message via cell phone, emergency alert systems, severe weather radios, sirens, internet, social media, and electronic messaging boards ("Integrated Public, Alert," 2012).

Wireless Emergency Alerts (WEA), a function of IPAWS, sends free text messages to WEA enabled cell phones within range of imminent and dangerous severe weather as well as America's Missing Broadcast Emergency Response (AMBER) alerts. WEA alerts for Georgia

come from the Georgia Emergency Management Agency and Office of Homeland Security. The Atlanta-Fulton County Emergency Management Agency, which serves the City of Milton, submitted an application in November 2013 for IPAWS (Federal Emergency Management Agency [FEMA], Ready, n.d.).

The Georgia Emergency Management Agency (GEMA) did not use the IPAWS system, who had received federal approval to use during the winter storm of January 2014, which struck the City of Atlanta and the surrounding area, paralyzing commuters for hours. People could have received alerts on their cells phones in specific geographic locations once the problems were first identified. It was noted that the system was in place but never tested or configured for weather and traffic alerts (Schneider, 2014).

Sarrio and Stevens (2013) reported that many residents consider tornado sirens a primary means of warning people of a tornado. Tornado sirens are limited to sounding an alarm when emergency officials determine the threat is imminent. However, they provide no additional information. People require confirmation and turn to the media, social media, friends and family for confirmation. People become desensitized when tornado sirens are activated and nothing happens. Tornado sirens are meant to alert people who are outdoors. The NWS recommends that when a tornado siren is heard, people should find shelter and seek additional information from local media. For those people at work, school or in their homes, the NWS recommends they monitor their weather radios. Tornado sirens can be used not only during tornado threats but when a thunder storm producing winds greater than 70 mph or when large hail, one inch or larger is detected. There is no nationwide protocol to activate sirens, the responsibility falls on local officials to develop and implement guidelines for their communities. Severe weather warning sirens are vulnerable to the elements, which could result in power outages, damage from

strong winds, hail and lightening. Warning systems typically operate by AC power with a battery back-up or solar power. Having redundant systems in place to warn people of severe weather is needed; these may include weather radios, media and social media ("Tornado Warning Sirens," n.d.).

The public's response to warnings of severe weather has been considered complacent and indifferent. During the tornado outbreak of 2008, 57 people died and over 350 people were injured. People confirmed they received warnings from NOAA all-hazards radios, outdoor sirens, family and friends (Hayes, 2009).

A person's past experience with tornadoes and other severe weather that did not result in damage or injury results in non-action during future events. Failure to act is also caused by the misunderstanding of information being disseminated by weather experts and community officials. Emergency warnings are not being communicated accurately and people have not been educated on the potential risks. The public's perception of the risk and the credibility of the warnings are some reasons for non-action ("Addressing the Issues," 2013, pp.5).

With all the advancements in forecasting, radar systems, social media and specialized emergency warning applications, people need confirmation from multiple sources and they require to see the threat for themselves. This need for self-confirmation may cause a delay in people reacting (Sarrio & Stevens, 2013, pp. A14). Even with the explosion of cell phones, smart phones and social media, there will be times when people are not connected. These are the times when other means of notifying people of impending severe weather is needed.

The assessment of the February 2008 tornadoes of by the U.S. Department of Commerce (2009), NOAA identified that terminology used by the weather forecast office during the Super

Tuesday tornadoes was not forceful enough for people to heed the warnings. More significant terminology should be used when severe weather warnings are issued, i.e., “extremely dangerous”, “life threatening situation”. Using stronger terminology by meteorologists may lead to people taking warnings more seriously and reacting quicker (Hayes 2009, pp.10).

According to a survey completed by Federal Signal, (2012), people are unaware of the emergency alert and notification systems available to them. People 65 and older showed the highest level of public safety awareness with 20 percent of the males fully prepared vs. 8 percent of the women surveyed. While 64 percent of married couples showed a high level of awareness, only 46 percent of single people are prepared. Those surveyed indicated that 27 percent were not aware their community had an emergency warning siren system, 56 percent did not know when the sirens were tested and 70 percent were unaware of the sound made by a siren. Of the people that were aware of the warning sirens, 47 percent would be motivated to take some type of action when a siren is activated (Federal Signal, 2013, pp. 8).

The NWS is trying to determine why people do not heed the warnings of approaching severe weather. On “Super Tuesday” in February 2008, 82 tornadoes raced across nine states killing 57 people and injuring 350 while causing $400 million in property damage. The report found that two-thirds of the people lived in mobile homes and 60 percent of those did not have access to a shelter. The other significant finding was people did not believe that bad things could happen to them, “optimism bias” and chose not to heed the warnings (“Why People Don’t,” 2009).

An online survey conducted by Zogby International in 2012 revealed that, of the 2059 adults who responded, many people continue to be complacent about severe weather warnings

that required action. The survey went on to show that 56 percent of people believe they had the knowledge to take the appropriate action in the event of impending severe weather. In reality, only 34 percent had the knowledge necessary to prepare and act in the event of serve weather. The survey also showed that 71 percent of people were unsure if they had personal alerting and notification systems in their area (Federal Signal, 2012).

An earlier survey conducted by Zogby International in November 2010, revealed that 26 percent of the people surveyed would prefer to receive emergency warnings via the telephone, 18 percent by text message and 15 percent by sirens. Those people surveyed in the age group 18 – 29 years old, 36 percent preferred to be notified by the television and 29 percent via text messaging (Federal Signal, 2010).

The NWS has gained the public's confidence in weather forecasting mainly due to the flow of information shared with the public. Information is disseminated days in advance and updated as the weather event approaches a community. Forecasting and warning systems used to alert the public depends on the type of approaching weather system. Hurricane watches and warnings are issued days in advance, allowing the public to make the appropriate preparations. Tornadoes can spawn in a matter of minutes and watches and warnings are issued once the NWS identifies the threat. The national average for tornado warning lead time is 13 minutes. The national false alarm rate for tornadoes is 75 percent, which is due to the lack technology and trained observers/spotters (Stensrud, 2009).

With the decline in land-lines, cell phone usage has increased 26 percent between 2005 and 2013, with 56 percent of those being smart phones. Since cell phones have become a primary

means of receiving information, “community leaders should consider utilizing this as a tool to reach their residents” (Rainie, 2013).

Social media is being used more today during emergencies to communicate vital information. During the 2010 earthquake in Haiti, social media was first used to notify people during a disaster. Within one week of the earthquake in Haiti, 13 percent of Americans under the age of 30 years old received their information about the earthquake via social media (“Crisis Emergency Risk,” 2012).

During Hurricane Sandy in 2012, emergency managers used social media to share important information to residents. They also monitored information on social media networks to track damage reports and identify areas requiring immediate assistance. This two-way communication allowed leaders to correct false information being distributed maliciously (Durso, 2014).

On Sunday, May 22, 2011 an EF-5 tornado struck the City of Joplin, MO. The city of Joplin used social media to communicate emergency information to the public. The National Weather Service (NWS) issued a tornado watch for Joplin at 2:40 PM indicating conditions were favorable for tornadoes. At 6:17 PM EDT the NWS issued a tornado warning for the City of Joplin. Tornado sounded sirens at 6:17 PM and again at 6:31 PM. At 6:41 PM the tornado touched down with winds over 200 mph. The lessons learned identified that social media should be used to communicate emergency information to the public (“The Response to the 2011 Joplin,” 2011).

People turn to social media as their first source of information, which may include You Tube, Flickr, Twitter and Facebook. Officials should consider social media as a resource and not

a distraction from more formal means of communicating with people. With the increasing popularity of social media, traditional media outlets are using social media as a resource for information. The attraction to social media is the interaction and two-way communication where people can ask questions and quickly receive responses. This information is then shared with many followers, reaching a wide audience ("Social Media," 2012, Chapter 9, pp. 256).

A survey conducted by the American Red Cross in 2010 revealed that nearly three out of four people surveyed over the age of 18 used at least one social media network: Facebook had 58 percent, You Tube 31 percent, My Space 24 percent and Twitter with 15 percent. The survey also indicated that 29 percent of the people relied on social media to get emergency information. Television news and radio remained the primary means of obtaining emergency information, 66 percent and 43 percent, respectively ("More Americans," 2012).

Employees should also be included in the social media circle. This is useful if severe weather is forecast to strike and additional resources are, or will, be needed. Social media should be monitored for vital information, which increases situational awareness and the ability to respond to questions in a timely manner. Knowing the make-up of a community will assist in identifying which social media tools that will be most useful during an emergency. For example; Facebook is most utilized by young mothers, it is free and it requires minimal technical skills. Social media should not replace traditional means of communicating with the public, but used to supplement current systems in an effort to reach as many people as possible. Building credibility using social media will build trust within a community when an emergency message is transmitted. Regular use of social media before the threat of severe weather builds relationships as well as developing proficiency in the use of the system ("Social Media," 2012, Chapter 9, pp. 291).

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Severe weather warnings come from many sources; people evaluate the information based on the source and their perception of the trustworthiness of the source. The information should be clear and concise, including the potential impact and personal risk concerns. Messages should include official information and the source of the information (Lindell, 2011).

Community leaders and emergency managers have a responsibility to identify hazards and monitor those for the possible impact to their communities. The health and safety of the community at risk should be evaluated and monitored (National Fire Protection Association [NFPA], 2013, 5.2.2.2).

A plan should be developed to warn people of possible severe weather threats. These should include stakeholders, employees, community leaders and the media (NFPA, 2013, 6.4.1). Determining how a community should be notified requires developing a system that is reliable, redundant and interoperable. Systems should be tested on a regular basis and the community should be informed of the notification systems available to them (NFPA, 2013, 6.5.2).

An effective mitigation plan could reduce the number of people injured or killed, in addition to a reduction in property damage, as well as reducing the need for additional resources and first responders. Local governments have the primary responsibility for developing strategies to lessen the threat of death and injury due to severe weather outbreaks. Good decisions regarding mitigation are born from history and education. Local governments have different levels of risk and the means to address those risks, one size does not fit all ("Recommendations for an Effective," 2009).

On Sunday, January 26, 2014 at 12:07 PM, the NWS issued a hazardous weather outlook for the State of Georgia, which included the metro Atlanta area. At 3:12 PM the NWS issued a

winter storm watch for counties south of Atlanta. By 4:53 AM Monday, January 27, 2014, the NWS expanded the winter storm watch to include the Atlanta Metro area. At 7:01 PM, the Georgia Department of Transportation issued a press release warning drivers to stay off the roads unless absolutely necessary. On Tuesday, January 28, 2014, at 3:38 PM, the NWS updated their forecast, predicating up to two inches of snow in the metro Atlanta area. On Wednesday, January 29, 2014, at 8:53 AM, the Georgia Department of Transportation encouraged people to stay off the roads. The snow began to fall by 11:15 a.m. and by 12:30 p.m. employees in the metro Atlanta area decided to go home. Less than one hour later, there were numerous accidents and traffic gridlock. By the afternoon, people were abandoning their cars and walking. By nightfall, children were stranded on buses and drivers were stuck miles from home. Hundreds of students spent the night at schools and hundreds of adults spent the night in the office or at local businesses.

The delay in warning the public of severe weather resulted in motorists and school buses with children being stranded on highways. People were forced to sleep in their cars or abandon their vehicles and walk; students were forced to remain at schools. The State of Georgia was criticized for reacting slowly to the NWS warnings, which were issued by the local media. The NWS did not utilize the severe weather radio system to notify people. The State of Georgia's multi-million dollar electronic sign system flashed useless messages. The state's mobile app gave wrong information about road conditions (Chapman, Edwards, & McCaffey, 2014).

According to Wright (2014), "Our social media tools completely revolutionized our ability to communicate with residents in a crisis." The highest web traffic seen before this weather event was 78,616 followers. During and following this weather event the number of followers rose to approximately 90,000 and gained nearly 500 new users on Facebook and Twitter (Appendix D).

City of Milton residents were asked to respond in 2014 to a survey. Of those who responded, 79 percent have a severe weather radio, 100 percent have a cell phone, 86 percent receive Code RED alerts, 36 percent receive weather alerts from the local media apps and 50 percent have a severe weather plan (Appendix B).

According to the National Fire Academy course Executive Analysis for Community Risk Reduction (EACRR), risk prevention requires identifying potential hazards within a community. The City of Milton cannot prevent severe weather, however, risk mitigation can be addressed through awareness of severe weather, sharing of credible information and taking action to reduce the risks (NFA, 2011).

Procedure

The procedures followed for this applied research paper included a literature review, a survey and interviews. The literature review began with identifying regions of the City that are more vulnerable to severe weather than others areas within the City of Milton. Research continued with how topography affects severe weather.

A review of severe weather warning systems was completed on systems available on a national level, as well as a local level, to warn people of approaching severe weather. This research included how people reacted to different types of alerts and a review of the most effective alerting systems. Research evaluated current methods of warning like television, national alerting systems, social media, cell phone apps, tornado sirens and how people reacted to the different methods used during severe weather alerting. Research also delved into people's perceived levels of awareness prior to severe weather events, why people ignore warnings, and why people must have a confirmation of severe weather before reacting.

The research explored what the City of Milton currently does to alert people of impending severe weather. An online survey was conducted to determine people's level of preparedness and reaction to severe weather alerts in the City of Milton. The survey reached 173 people on the City of Milton Fire Department's Facebook page, asking followers eight questions about their level of awareness and methods of alerting used (Appendix C).

The use of traditional notification vs social media, including tornado sirens and their usefulness during the severe weather alerting phase, was researched. An interview with the City of Milton's Communications Manager, Jason Wright, who also serves as the City's Public Information Officer (PIO) was conducted at Milton's City Hall. A series of questions were asked about the effectiveness of social media to warn residents of the severe weather conditions during and after the most recent winter weather event of January 2014 (Appendix C).

A second interview was conducted via email with Melody Magnus, meteorologist from the National Weather Service. Two questions were asked regarding the use of the severe weather radio system during winter weather events. The questions were asked to determine why this system was not utilized during the recent winter event (Appendix D).

The third interview conducted was via email with NOAA Severe Weather Expert, John T. Ferree. A series of questions were forwarded to Mr. Ferree to determine what NOAA is doing now and looking towards the future to warn people of severe weather on a national level (Appendix E).

The fourth interview conducted was via email with Allison Chinchar, meteorologist with 11 Alive News in Atlanta, Georgia. A series of questions was presented to determine the qualifications of meteorologists, consistency of information, how technology plays a role in

severe weather warning and people's reaction to severe weather warnings on a local level (Appendix F).

A review of an after action report from the 2011 Joplin, MO tornado was completed. Severe weather hit Georgia from 2008 thru 2012; the warning systems in place during that time period were examined along with how other communities alerted residents.

Results

Which area in the City of Milton is most vulnerable to severe weather?

The City of Milton is located in what is referred to as the Metro Atlanta area, on the northern end of Fulton County. The State of Georgia is broken down into four geographical regions: Valley and Ridge, Blue Ridge, Piedmont and Coastal Plain. The City of Milton lies within the Piedmont region where elevations ranging from 300 feet to 2000 feet above sea level. Benton (2013), reported that topography affects weather systems. Severe weather, including tornadoes can intensify when squeezed between slopes and changes in topography. Higher elevations, which include mountainous areas, are believed to increase the intensity of tornadoes. A study completed by the NWS compared mountain waves to those of boulders in a moving river. The boulder causes the moving water to be more turbulent as it flows down on the other side of the boulder. Vertical wind increases with height as the wind moves parallel to the mountains.

The questions presented to Allison Chinchar were in regard to procedures for warning people of severe weather and if and how they differ from region to region. She explained that a winter storm warning for Ohio would not be same as a winter storm warning in Georgia. The

impacts would be different: two inches of snow in Atlanta would paralyze the city where as for a city in Ohio it would be an everyday winter event. She then explained that there is no difference in the case of tornado warnings; they are the same throughout the country.

The City of Milton encompasses 38 square miles, which is entirely within the Piedmont region. During the period from 1991 – 2010 on average, 30 tornadoes per year touched down in Georgia. Topography appears to have an impact with the increase in severe weather activity in north Georgia, including the City of Milton. From 2009 through 2013 the City of Milton experienced 246 severe thunder storms, 165 lightning strikes and 3 tornadoes.

Tornado alley was considered an area within the Midwest and the Great Plains where tornadoes are more prevalent. With the increase in severe weather and tornado outbreaks, the State of Georgia is now considered a fragment of tornado alley. NOAA data indicates from 1980 – 2009, the highest number of tornadoes occurred outside of the established area known as tornado alley. The severe weather extended towards the east coast, including the State of Georgia.

The City of Milton's population is over 35,000 residents, with the highest density in the southeastern and central region of the city. This area of the city is also home to 11 schools, a business district and numerous multi-family homes. During a severe weather event, this area of the city would be the most vulnerable during the day time and night time hours.

What are the current methods available on a national level to warn the citizens of Milton?

The questions presented to Mr. Ferree were to determine where people should go to obtain information about impending severe weather. He advised that television has long been the

primary means of communicating weather information to people. Secondly, he advised severe weather radios were the best means of alerting the public, especially during night time hours. Tornado sirens are best for people who are outdoors.

Weather radar systems have improved over the years with Doppler radar and weather satellites. However, television is only effective when people are tuned in. The tornadoes that hit the Tennessee Valley in 2008 occurred at night when people were asleep and not watching television.

The EAS, is a national public warning system that sends warnings and alerts via television, radio and cable networks warning people of an emergency. This system relies on people being tuned into their televisions and/or radios and used only when this is the only means of communicating with the nation.

The NWS has an all hazards radio system that alerts people to severe weather. The radio does not require someone to turn it on, the radio will activate once the NWS initiates a weather warning. The system will work as designed as long as the radio is plugged in and the owner maintains the batteries in the event of a power outage. Ownership of severe weather radios is in the five to ten percent range of the overall population, leaving many people to rely on other means of receiving severe weather warnings mainly during the nighttime hours.

A warning system was designed by FEMA, used to warn communities of the possibility of natural disasters. The Integrated Public Alert and Warning System (IPAWS) is a location specific emergency alerting system, which allows a message to be forwarded to an emergency alerting system, mobile alert system, internet, state and local alerting systems. These local agencies then forward the alerts to people possibly affected by the impending severe weather.

What are the current methods available on a local level to warn the citizens of Milton?

The residents of Milton rely on local media and local government to warn them of impending severe weather. Many residents consider tornado sirens as a primary means of warning people of severe weather. Cities and counties that border the City of Milton have tornado sirens. These sirens can be heard by some city residents living in close proximity to the sirens in neighboring jurisdictions. However, there are no sirens within the City of Milton. There are also no national standards or protocols for when to activate tornado sirens; this is at the discretion of the municipality. While these sirens may benefit some Milton residents, the majority of the residents will not hear the sirens. Meteorologist Allison Chinchar explained that for up to the minute information on severe weather, people should turn to social media and local television stations. During night time hours, people should rely on tornado sirens and severe weather radios.

The City of Milton has invested in the Code RED alerting system, which has the ability to alert residents of severe weather. The system is also used by the police department to report missing children, road closures, along with the public works department reporting water interruptions, and trees down. The system requires the resident to sign up to receive alerts; approximately 33 percent of Milton residents have signed up for this program.

Many smart phone applications (apps) are available to alert people of impending severe weather, but not everyone has a smart phone. People who have this capability can download free weather apps from organizations such as the NWS, Red Cross and Weather Channel.

What are the key identified early warning systems that should be incorporated in the community to alert the citizens of severe weather incidents?

The research revealed there are many systems and methods to communicate severe weather emergencies to the residents of Milton. One system is not sufficient to communicate with the residents. People 65 and older showed the highest level of public safety awareness, with married people having the second highest awareness level. Terminology used by the NWS was not strong enough to motivate people to react to severe weather warnings. Mr. Ferree was asked if severe weather terminology was standardized. He advised the NWS will issue a weather statement but some of the wording is editable by local forecasters. A system has been developed for tornado warnings that include specific statements to be used when broadcasting those types of warnings. Ms. Chinchar advised that while the NWS will issue a severe weather statement, local meteorologists may make small changes to the message to benefit the viewers. She added that not everyone will understand the terminology used by the NWS. On a local level, meteorologists will decide what changes should be made before sharing the information with the public.

People have become complacent to weather warnings. This has led to people not reacting to warnings, which has resulted in injury and even death. People need confirmation; they need to see for themselves that danger is approaching. Not everyone reacts to a particular warning in the same way.

Another question asked of Mr. Ferree was, “Does new technology lead to complacency when use for alert the public, specifically cell phones.” He advised the new cell phone app for severe weather, WEA, needs improvement. It should be location specific, “if you receive a warning, you are in the warning area.” More research and fine tuning is needed to improve this system, false alerts could lead to complacency and people turning off or deleting the app from their smart phone. Furthermore, he noted not everyone owns a smart phone. He followed up

with saying the severe weather radio system should be improved upon. Ms. Chinchar believes that the younger generation will rely more on Twitter than on television meteorologists.

With the decline in land-line phones and the increasing usage of smart phones, people now utilize social media as a primary means of communication. A survey conducted by the American Red Cross revealed that social media (e.g. Facebook, Twitter, Nixle) is used by three out of four people. During Hurricane Sandy in 2012, social media was primary means of communication used by emergency managers to get up to date information, relay information and correct misinformation. Most recently, during the snow storm that paralyzed the City of Atlanta in January 2014, the City of Milton utilized social media to communicate with residents on road conditions.

Systems available to warn people of impending severe weather include television, tornado sirens, severe weather radios, cell phone apps, social media, family and friends. The available systems will reach a diverse community.

Discussion

The State of Georgia experienced severe weather and tornado damage in the amount of 500 million dollars from 2008 – 2012. During this same time period, 23 deaths were related to severe weather (Tornado History, n.d.). Municipalities throughout the State of Georgia handle severe weather warning differently and experts agree there is not one solution for warning the public of impending severe weather (Sarrio & Stevens, 2013, March).

Tornado alley is no longer considered an area just in the Midwest or Great Plains, it has moved farther eastward, including the state of Georgia ("Tornado and Hail Risks", 2012). With

the State of Georgia now considered within tornado alley and the City of Milton's topography contributing to the intensity of storms, more than one severe weather warning system would be needed to alert the residents of Milton (Benton, 2013, pp B4).

Nationally, there are several severe weather warning systems available. This includes the Emergency Alert System (EAS), which is a national broadcast system. NOAA uses a network of radio stations to broadcast continuous weather information from the nearest NWS office. This requires people to purchase a radio and maintain the radio with fresh batteries in the event of a power failure (NOAA, n.d.).

A survey of Milton residents indicated that 79 percent of those respondents own a severe weather radio (Appendix C). FEMA developed a warning system to be used by emergency managers to warn people of natural disasters. The Integrated Public Alert and Warning System (IPAWS) does not require people to sign up, rather the system will forward messages via the internet, cell phone providers and message boards to people in a geographical area affected by the emergency ("Integrated Public, Alert", 2012). The State of Georgia received federal approval to use the IPAWS system in 2012. However, the Georgia Emergency Management Agency (GEMA) did not use this system during the snow event that paralyzed the City of Atlanta and surrounding communities in January 2014 (Schneider, 2014).

Wireless Emergency Alerts (WEA) is a system offered by NOAA and has the capability to send free text messages to cell phones alerting people of severe weather. The WEA program is location specific, if a cell phone is within the area where a severe weather alert is being issued, that cell phone will receive the alert. The owner of the cell phone does not have to sign up to receive the message nor does the owners have to download an app (FEMA, Ready, n.d.).

DEVELOPING A SEVERE WEATHER ALERTING SYSTEM

Tornado sirens are considered a primary means of warning people of a tornado and sometimes of severe weather, depending on local protocol (Sarrio & Stevens, 2013, pp. A14). Tornado sirens have their limits, they are meant to alert people who are outdoors but question whether people inside hear the siren and take action. Having more than one system to alert people of severe weather are needed ("Tornado Warning Sirens", n.d.).

People's failure to act when severe weather threatens a region has led to injuries and casualties ("Super Tuesday Tornado", 2008, pp. 4). People rely on clear accurate communication in order to react to severe weather. Some people need additional confirmation and they must see it for themselves (Sarrio & Stevens, 2013, pp. A14).

Many people believe they are ready for severe weather and will take the appropriate action when needed. A survey indicated that most people were not prepared to act in the event of severe weather and most were not aware of a severe weather notification system in their area ("Addressing the Issues", 2013, pp.8). The NWS issues watches and warnings of severe weather, while tornadoes can occur in minutes. The national lead time for tornado warnings is 13 minutes, with a false alarm rate of 75 percent (Stensrud, 2009, pp.5). The lack of severe weather preparedness and high false alarm percentages can lead to complacency by the public ("Addressing the Issues", 2013, pp.5).

Cell phone usage has increased by 26 percent between 2005 and 2013; just over half of those were smart phones. Cell phones have become the primary means of obtaining information, a tool that should be used by local leaders to disseminate important information (Rainie, 2013).

Social media has become a primary means for sending important information to the public during emergencies. This began with the 2010 earthquake that occurred in Haiti (Cerc. social

media, and, mobile media devices, chapter 9). During Hurricane Sandy in 2012, emergency managers use social media to distribute information and correct false information (Durso, 2014). Social media should supplement traditional means of communicating with the public.

Recommendations

The City of Milton needs to develop a severe weather warning system that will reach the entire community. This would include local television, tornado sirens, severe weather radios, social media and automated phone messaging alerts. Additionally, the City needs to implement an educational program on severe weather alerting and preparedness. The research showed that many people do not know what actions to take in the event of severe weather and the type of resources available to them.

The City of Milton does not have tornado sirens. A process should begin to identify the siren systems available and funding for a system that will provide citywide coverage. An operational procedure should be developed in harmony with neighboring jurisdictions along with an educational program for residents. This program should also be brought to the schools in Milton during Georgia's severe weather awareness week. This will be an opportunity to educate children at an early age on severe weather.

The weather experts indicated that, along with tornado sirens, a severe weather radio should be purchased by residents for night time use. The survey conducted for this research indicated that of the residents who replied, most do not have a severe weather radio. Severe weather radios should be included in educational programs.

Social media should be included in all emergency notification plans; the studies support this action in order to reach a diverse community. Social media will also give city leaders the opportunity to communicate one on one with residents, giving specific instructions to people with various needs.

Phone message alerting systems are useful; this requires the resident to sign up in order to receive the recorded messages. The City of Milton is currently using Code RED, with only 33 percent of the residents currently signed up to receive messages. A campaign should be implemented to advertise the program, along with educational programs about the Code RED system.

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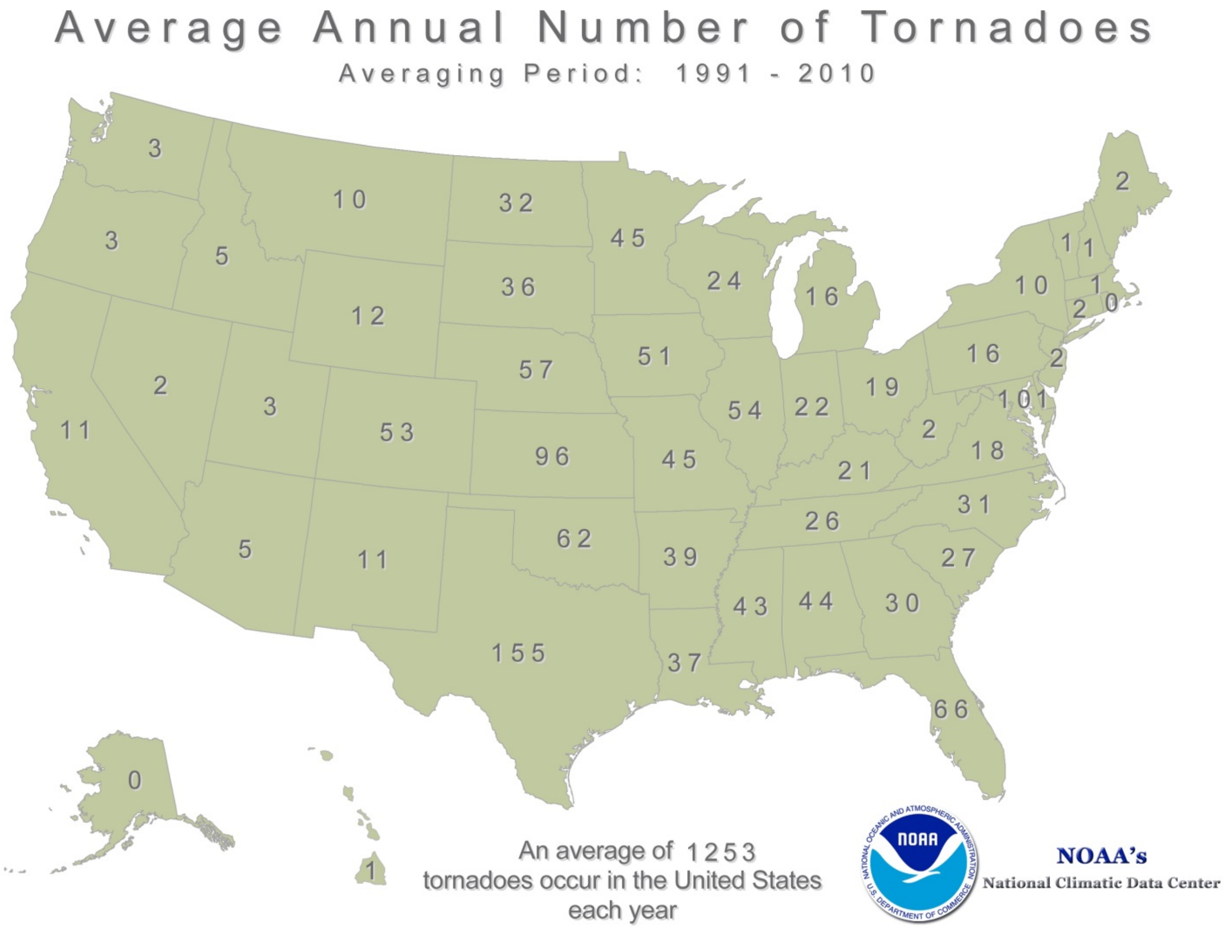
Appendix A


Average Annual Number of Tornadoes
Averaging Period: 1991 - 2010
3
10
32
2
45
3
5
11
1
36
24
16
10
1
12
2
0
51
57
16
2
2
3
54
22
19
101
11
53
2
96
45
18
21
31
26
62
5
11
39
27
43
44
30
155
37
66
0
1
An average of 1253 tornadoes occur in the United States each year
NOAA's
National Climatic Data Center

Appendix B

Severe Weather Survey

1. Are you a Milton resident?
2. Do you have a severe weather radio?
3. Do you have a cellular phone or mobile device?
4. Have you signed up for Code Red?
5. Have you signed up for weather alerts from the local weather TV stations?
6. Does your family have a severe weather plan?
7. Have you downloaded your local news station's severe weather app?
8. What is your age?

SurveyMonkey

Upgrade MiltonFire30004

Home My Surveys Survey Services Plans & Pricing + Create Survey

Severe Weather Survey

Design Survey Collect Responses Analyze Results

CURRENT VIEW

+ FILTER + COMPARE + SHOW

No rules applied

Rules allow you to **FILTER**, **COMPARE** and **SHOW** results to see trends and patterns. Learn more »

SAVED VIEWS (1)

Original View (No rules applied)

+ Save as...

EXPORTS

RESPONDENTS: 14 of 14 Export All

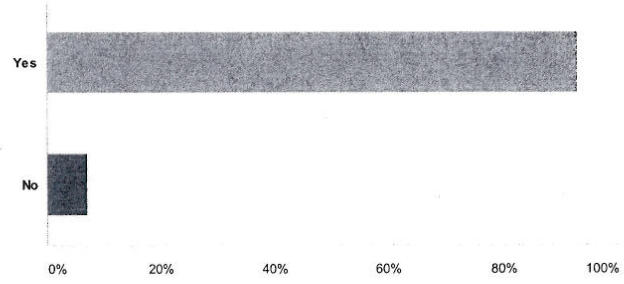
Question Summaries Data Trends Individual Responses

PAGE 1: How do Milton residents gather information regarding approaching severe weather?

Q1 Customize Export

Are you a City of Milton resident?

Answered: 14 Skipped: 0

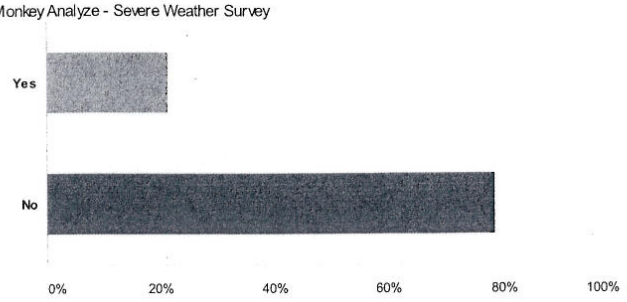


Answer Choices	Responses	
Yes	92.86%	13
No	7.14%	1
Total		14

Q2 Customize Export

Do you have a severe weather radio?

Answered: 14 Skipped: 0



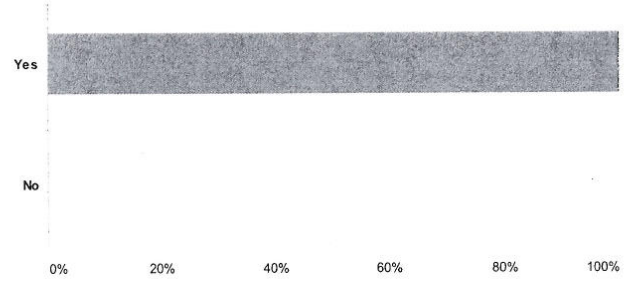
Answer Choices	Responses	
Yes	21.43%	3
No	78.57%	11
Total		14

Q3

Customize Export

Do you have a cellular phone or mobile device?

Answered: 14 Skipped: 0



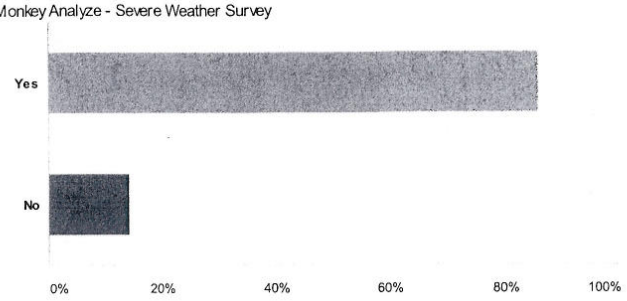
Answer Choices	Responses	
Yes	100%	14
No	0%	0
Total		14

Q4

Customize Export

Have you signed up for Code Red?

Answered: 14 Skipped: 0



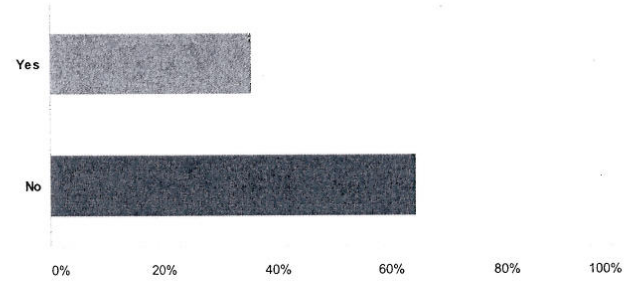
Answer Choices	Responses	
Yes	85.71%	12
No	14.29%	2
Total		14

Q5

Customize Export

Have you signed up for weather alerts from the local weather TV stations?

Answered: 14 Skipped: 0



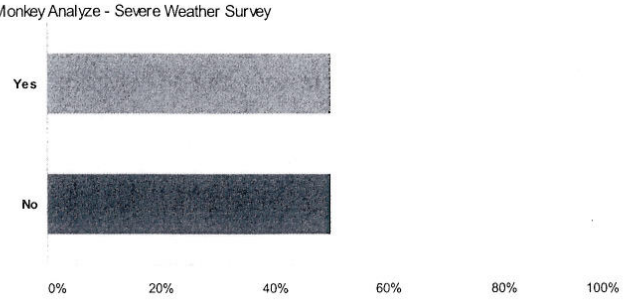
Answer Choices	Responses	
Yes	35.71%	5
No	64.29%	9
Total		14

Q6

Customize Export

Does your family have a severe weather plan?

Answered: 14 Skipped: 0



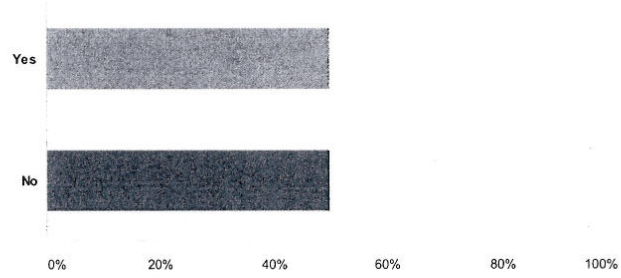
Answer Choices	Responses	
Yes	50%	7
No	50%	7
Total		14

Q7

Customize Export

Have you downloaded your local news station's severe weather app?

Answered: 14 Skipped: 0



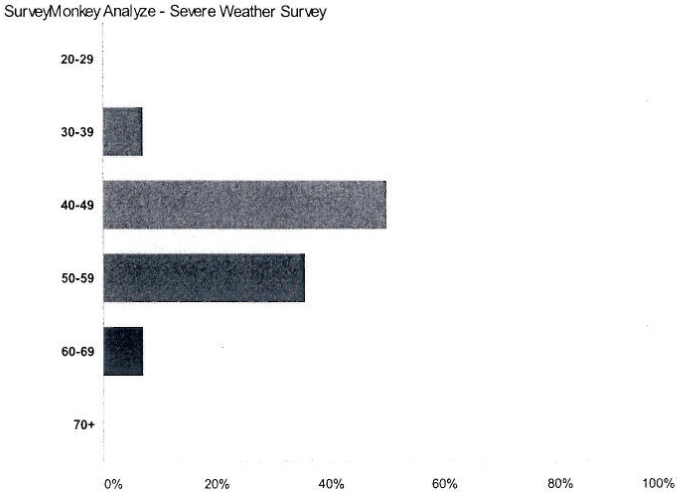
Answer Choices	Responses	
Yes	50%	7
No	50%	7
Total		14

Q8

Customize Export

What is your age?

Answered: 14 Skipped: 0



Answer Choices	Responses	
20-29	0%	0
30-39	7.14%	1
40-49	50%	7
50-59	35.71%	5
60-69	7.14%	1
70+	0%	0
Total		14

Appendix C

Personal Interview

Jason Wright

City of Milton

Communications Manager

1. How effective is social media when used to communicate with the Citizens of the City of Milton?
2. How effective is Code Red in transmitting alerts to the citizens of the City of Milton?

3.How many followers on the City of Milton's Face Book and Twitter accounts?

4.How effective was social media during the severe winter event that hit the metro Atlanta area?

Appendix D

Online Interview

Melody Magnus

Meteorologists

National Weather Service/NOAA

1. Why didn't NOAA utilize the severe weather radio system during the most recent winter weather emergency that hit the metro Atlanta area?
2. How does NOAA share severe winter weather information with the public?

Appendix E

Online Interview

John Ferree

Meteorologists

National Weather Service/NOAA

1. National Weather Service (NWS) Instruction 10-511, which provides guidance using wording and call to action statements in tornado warnings and severe weather statements (SWS) that convey appropriate urgency and action. Is this used by all meteorologists? Who determines the appropriate wording to broadcast to viewers?

2. Does the NWS have specific procedures to follow for each region? How do they differ?

3. What improvements are needed to warn the public of impending severe weather?

4. What is your vision of the future in severe weather warning?

5. Does technology add to people's complacency to act during severe weather events?

6. With improved radar and forecasting systems, people may feel they are not in harm's way since their family and home are not within the polygon , does this lead to complacency and a delay in acting?

7. With the large Atlanta metro area population, broad area warnings coming from the NWS in Peachtree City, can this lead to complacency by Milton residents?

8. Who should the community turn to for information about impending severe weather?

9. What is the best method of notifying people of severe weather during the night time hours?

Appendix F

Online Interview

Allison Chinchar

11 Alive Television

Meteorologists

1. Do you have to be a meteorologist to broadcast the weather?
2. Are all meteorologists trained to the same level?
3. National Weather Service (NWS) Instruction 10-511, which provides guidance using wording and call to action statements in tornado warnings and severe weather statements (SWS) that convey appropriate urgency and action. Is this used by all meteorologists? Who determines the appropriate wording to broadcast to viewers?
4. Does the NWS have specific procedures to follow for each region? How do they differ?
5. What improvements are needed to warn the public of impending severe weather?
6. What is your vision of the future in severe weather warning?
7. Does technology add to people's complacency to act during severe weather events?
8. With improved radar and forecasting systems, people may feel they are not in harm's way since their family and home are not within the polygon , does this lead to complacency and a delay in acting?
9. With the large Atlanta metro area population, broad area warnings coming from the NWS in Peachtree City, can this lead to complacency by Milton residents?

10. Who should the community turn to for information about impending severe weather?
11. What is the best method of notifying people of severe weather during the night time hours?