Evaluating stakeholder preparation and public early warning for tornadoes and other severe weather events in Cherokee County, North Carolina

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Abstract

The problem was that citizens and visitors to Cherokee County, North Carolina were in danger from tornadoes and other severe weather events. The purpose of this applied research project was to provide information which would help stakeholders be better prepared for tornadoes and other severe weather events in Cherokee County. The evaluative research method was utilized to study stakeholder preparedness and the most effective means of public emergency notification. The research questions addressed were: 1) What pre-incident planning and actions should be taken by stakeholders in Cherokee County to be best prepared for tornadoes or other severe weather incidents? 2) What methods of communication are currently utilized in Cherokee County to notify stakeholders of impending severe weather conditions? 3) What are the most efficient methods to notify stakeholders of Cherokee County about impending severe weather events? 4) How can existing methods of emergency notification be improved or enhanced to more rapidly and efficiently notify stakeholders of impending severe weather events?, and 5) What means of public emergency notification systems currently being utilized by other jurisdictions could provide a greater degree of safety from severe weather events for stakeholders of Cherokee County? Procedures included research of public and private entities concerned with tornado safety and early warning capabilities, a survey of NOAA weather radio reception and cellular phone coverage in Cherokee County, and personal communications with county public safety officials. Results indicated nocturnal tornadoes are more deadly and opportunities for adequate warning are minimized at night for stakeholders without access to NOAA weather radio or other reliable warning systems. Recommendations were to promote use of multiple weather warning systems including NOAA weather radio, Cherokee County Emergency Management CodeRED telephone notification system and social media platforms, and outdoor warning sirens.

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.

Signed_____

Robert V. Barton

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Introduction

Cherokee County is the westernmost county in the State of North Carolina (N.C.) and is bordered by the State of Tennessee to the west and the State of Georgia to the south in the southern portion of the Appalachian Mountains. The county is named in honor of the history and traditions of the Native American people known as the Eastern Band of the Cherokee and was established in 1839, shortly after the majority of the people of the Cherokee Nation were forcibly moved to Oklahoma along the Trail of Tears (Cherokee Chamber, 2014).

The Town of Murphy began as a small trading post at the confluence of the Hiwassee River and the Valley River in south, central Cherokee County in 1835. Murphy was incorporated in 1851 and became the seat of county government (Town of Murphy, 2015).

According to the Cherokee County Chamber of Commerce (2014), the county encompasses 466 square miles with 300,100 acres of land and water area. The United States Department of Agriculture-Forest Service manages 92,363 acres while 6000 acres of the area of the county is tribal land of the Eastern Band of the Cherokee. A substantial portion of the county lies within the Nantahala National Forest. The topography of Cherokee County varies in elevation from 1, 170 feet above sea level to 5, 149 feet above sea level.

Two man-made lakes, Hiwassee and Apalachia, were formed in the county as a result of the construction of two dams by the Tennessee Valley Authority (TVA) in the late 1930's and early 1940's. Hiwassee Lake encompasses 6090 acres and is 22 miles long with over 163 miles of shoreline. Apalachia Lake covers 1100 acres and is 9.8 miles long with 31 miles of shoreline (Cherokee Chamber, 2014).

United States Census data from July, 2014 lists the estimated population of Cherokee County at 27,141 (Cherokee Chamber-Population, 2014). The 2013 estimated population of the

Town of Murphy, which is the county seat, is 1,618 (Quick Facts, 2015). The estimated population of Cherokee County in 1974 was 17,100 (U.S. Census, 1982).

Although a very rare occurrence in the mountainous region of western N.C., Cherokee County has experienced eight separate tornadic events between 1974 and 2012. In April, 1974 and again in March, 2012, Cherokee County was severely impacted by tornadoes, one of which caused four fatalities in and near the Town of Murphy.

On April 3 and 4, 1974, a tornadic event which is a part of a storm system that would come to be called the Super Tornado Outbreak occurred.

> It was the worst tornado outbreak in U.S. history with 148 twisters touching down in 13 states. Before it was over 16 hours later, 330 people were dead and 5,484 were injured in a damage path covering more than 2,500 miles (National Oceanic and Atmospheric Administration-Super Outbreak, 1999).

On Friday, March 2, 2012 tornadic activity again struck eastern Tennessee, western North Carolina, and other parts of the southeastern United States. According to the Times News (2012), “Cherokee County officials continue to assess the damage from a tornado that destroyed businesses and homes but injured no one”. Several communities in Cherokee County including Hiwassee Dam, Wehutty, Texana, Murphy, and Peachtree were impacted by this tornado (R. Caldwell, personal communication, June 10, 2015).

The problem is that citizens and visitors to Cherokee County are in danger from tornadoes and other severe weather events.

The purpose of this applied research project is to provide information which will help stakeholders be better prepared for tornadoes and other severe weather events in Cherokee County. The focus of the project will be to identify pre-incident planning and actions need to be

taken by stakeholders to prepare for severe weather events and to enhance early warning notification of such events to improve safety.

The evaluative research method will be utilized to study the current level of stakeholder preparedness and the most effective means of emergency notification for severe weather events and to recommend ways to improve stakeholder safety.

Research questions which will be addressed in this applied research project are:

1. What pre-incident planning and actions should be taken by stakeholders in Cherokee County to be best prepared for tornadoes or other severe weather incidents?
2. What methods of communication are currently utilized in Cherokee County to notify stakeholders of impending severe weather conditions?
3. What are the most efficient methods to notify stakeholders of Cherokee County about impending severe weather events?
4. How can existing methods of emergency notification be improved or enhanced to more rapidly and efficiently notify stakeholders of impending severe weather events?
5. What means of public emergency notification systems currently being utilized by other jurisdictions could provide a greater degree of safety from severe weather events for stakeholders of Cherokee County?

Background and significance

During the Super Outbreak of April 3 and 4, 1974, Cherokee County experienced extensive damage, particularly in the Bealtown section of the Town of Murphy. As a result of the storm, there were four fatalities and 26 injuries (Cherokee County Emergency Management, 2013).

> North Carolina had two separate periods of severe activity. The first wave struck between 8:00 and 10:00 p.m. CDT. At least three tornadoes caused seven deaths and many injuries in the extreme western counties. The communities of Stecoah (Graham County) and the Bealtown section of Murphy (Cherokee County) were in the paths of these storms. About 9:00 a.m. CDT the following morning, Cherokee County again had tornado activity. Brief touchdowns were reported at Marble and Brasstown. At the same time, 140 miles to the east northeast, a skipping tornado injured several persons and caused damage south of Lenoir (Caldwell County) (Public Affairs, 1999).

In the spring of 1974, public safety services were substantially less prepared to serve the needs of the county than they would be when the next major tornado event would impact the county in 2012. According to W.C. King (2009), who is the Cherokee County Fire Marshal, in 1974, there were only three fire departments in Cherokee County. These departments were the municipal, volunteer fire departments of the Town of Andrews and the Town of Murphy and the Valleytown Rural Fire Department (VRFD). The Andrews Volunteer Fire Department (AVFD) protected the city limits of the Town of Andrews while the VRFD provided fire protection for the remainder of the Valleytown Township surrounding the Andrews town limits and continuing west to within just a few miles of the Murphy town limits. The Murphy Volunteer Fire Department (MVFD) provided fire protection services for the Town of Murphy, as well as fire response to unincorporated areas of Cherokee County not covered by the VRFD district, which equates to approximately two thirds of Cherokee County (W.C. King, personal communication, June 18, 2015).

During the early months of 1974, the town council members of the Town of Murphy had been discussing a plan which would restrict MVFD firefighters, fire trucks, and equipment from

leaving the corporate limits of the town to provide fire protection in any if the rural communities. At that time, the Town of Murphy owned two fire engines and allowed the older truck to respond to fires in other areas of the county which could be 25 miles outside of Murphy. In addition, all equipment used by the MVFD was town property with no contribution from the county (W.C. King, personal communication, June 18, 2015).

The contention of the town council members was that the town was in a severe liable situation if a fire occurred in town while resources and manpower provided by the taxpayers of the town were fighting a fire in the county (Cherokee Scout, 1974, a, March 14). A few weeks after the tornadic event of April, 1974, the Murphy town council established a deadline of midnight on September 15 as the time at which the MVFD and its equipment would no longer respond to fire emergencies outside the corporate limits of the Town of Murphy (Cherokee Scout, 1974, c, May 23).

The Andrews Rescue Squad and the Cherokee County Rescue Squad had both been in existence for approximately ten years at the time of the April, 1974 tornado and members of both volunteer squads “worked diligently, along with rescue squads from neighboring counties, to help the residents of Murphy recover from the immediate impact of the storm by searching for victims and providing first aid and transport for the injured” (Cherokee Scout, 1974, April 11).

Emergency medical service in Cherokee County was in its infancy at the time of the deadly tornado of 1974. The county commissioners had been contracting with a private entity to provide ambulance service for the county. They were in discussion about providing the service as a county operated function due to their dissatisfaction with the current level of service (King, 2009). According to articles from the spring of 1974 in the Cherokee Scout, which was and is still the local newspaper serving Murphy and the majority of Cherokee County, County

Commissioner Boring was quoted as saying “we are not sure how far we want to get into the ambulance service business” (Cherokee Scout, 1974, May 9).

In 1974, emergency management in the form that is understood presently was still several years into the future for Cherokee County, and the nation as a whole. According to the history of the Federal Emergency Management Agency, “The 1960s and early 1970s brought massive disasters requiring major federal response and recovery operations by the Federal Disaster Assistance Administration, established within the Department of Housing and Urban Development” (FEMA, 2015). In the early 1970s, “more than 100 federal agencies were involved in some aspect of disasters, hazards and emergencies” (FEMA, 2015). In 1979, President Carter evoked Executive Order 12127 which “merged many of the separate disaster-related responsibilities into the Federal Emergency Management Agency (FEMA)” (FEMA, 2015).

In the State of North Carolina in 1974, emergency management functions were operated by State Civil Preparedness which had formerly been called Civil Defense (Cherokee Scout, b, 1974, April 11). At that time, Cherokee County did not have an organized office or entity with the function of addressing emergency management functions. The Cherokee County Emergency Management Agency (CCEMA) was developed as a division of the county’s Emergency Services Department in 1982 (King, 2009).

From the law enforcement perspective, the Cherokee County Sheriff’s Department, which is now called the Cherokee County Sheriff’s Office, the Andrews Police Department, and the Murphy Police Department were in operation at the time of the 1974 tornado and worked tirelessly alongside troopers of the North Carolina State Highway Patrol to help search for

victims, provide first aid care, and provide security and law enforcement services during the recovery from the storm (Cherokee Scout, b, 1974, April 11).

Just as emergency services in Cherokee County were not well prepared to mitigate a wide spread disaster like a tornado in 1974, the notification of the public of impending severe weather was very difficult due to weather forecasting capabilities of the time and the lack of reliable means of alerting stakeholders. Geographically, Cherokee County is located almost equidistant from the cities of Chattanooga and Knoxville, Tennessee; Atlanta, Georgia; and Asheville, North Carolina. In the same year, television reception in the county was restricted to only a few channels that could be received via antenna from one or more of these cities. There were also two AM radio stations in Murphy, N.C. in 1974; however, their broadcast range did not cover the entire county (W.C. King, personal communication, June 18, 2015).

On Friday, March 2, 2012, several communities in Cherokee County including Hiwassee Dam, Wehutty, Texana, Murphy, and Peachtree were impacted by tornadic storms (R. Caldwell, personal communication, June 10, 2015).

> Cherokee County officials continue to assess the damage from a tornado that destroyed businesses and homes but injured no one.
>
> County spokesman Doug Clement said Monday that an initial assessment shows the twister Friday night destroyed five homes and five businesses. He says 37 homes and 20 businesses had major damage, while 40 homes and 21 businesses suffered minor damage (Times News, 2012).

Between April 2, 1974 and March 2, 2012, the United States National Oceanic and Atmospheric Administration (2012) has documented eight individual tornado events which have impacted Cherokee County with half of them occurring between April 2 and April 4, 1974. Of

these eight events, three were classified on the Fujita (F) Scale as F0 tornadoes which had 3-second gust speeds of 45-78 miles per hour (mph) while three others were classified as F1 tornadoes with 3-second gust speeds of 79-117 mph. Cherokee County experienced two separate tornadoes on April 3, 1974 and the one which occurred at 8:25 p.m. Eastern Standard Time was classified as an F4 tornado with 3-second gust speeds of 210-261 mph (Storm Prediction Center, 2015).

Prior to the March 2, 2012 tornado which impacted Cherokee County, the Fujita Scale was replaced by the Enhanced Fujita (EF) Scale and the storm which struck on this date was classified as an EF2 tornado with 3-second gust speeds of 111-135 mph. Fortunately, the only tornado in Cherokee County between 1974 and 2012 which caused injuries and/or fatalities was the F4 storm of April 3, 1974 (National Oceanic and Atmospheric Administration, 2012).

By the spring of 2012, public safety services in Cherokee County had been substantially expanded, partially as a result of the devastating tornado of April, 1974 and partially due to changes which were occurring in the various communities of the county. At that time, many citizens and community leaders were deciding there was a need to enhance fire protection capabilities in the rural areas of Cherokee County. According to King (2009), citizens in several of the rural communities of the county were beginning to realize the need to develop fire protection services within their locales and were researching the process necessary to develop volunteer fire departments in North Carolina.

In 2015, emergency services are provided to the citizens and visitors of Cherokee County by a combination of volunteer and career public safety personnel. Fire and rescue services are provided predominately by volunteer personnel while emergency medical services (EMS), emergency management, and law enforcement services are provided by career personnel.

According to King (2009), fire protection services are provided by thirteen volunteer fire departments, some of which operate multiple stations within their response districts. The fire departments of the Town of Andrews and the Town of Murphy are municipal departments governed by the town councils of the respective towns. The other eleven fire departments in Cherokee County serve rural communities as incorporated, nonprofit organizations governed by separate boards of directors for each department which contracts with the county to provide fire services.

Rescue services, including vehicle stabilization and extrication, water and wilderness rescue, confined space rescue, and other types of technical rescue in Cherokee County are currently provided by two volunteer rescue squads and one of the volunteer fire departments. The Andrews Rescue Squad serves the eastern portion of the county while the Cherokee County Rescue Squad serves the majority of the central and western portions of the county from two stations. The Hiwassee Dam Volunteer Fire Department (HDVFD), which is located in the northwestern area of the county recently began providing primary rescue services within the HDVFD district. Several other fire departments within the county are considering expanding the services they provide to include technical rescue (W.C. King, personal communication, June 18, 2015).

Emergency medical service at the paramedic level is provided by career and part-time employees who operate from three stations which are located in the eastern, central, and western portions of the county. Emergency management services are coordinated by a career director and a part-time administrative assistant (Cherokee County, 2015).

Law enforcement is provided in unincorporated areas of the county by the Cherokee County Sheriff’s Office (CCSO) by an elected Sheriff and a combination of career and part-time

deputy sheriffs and other support personnel. The Town of Andrews and the Town of Murphy each employ a Chief of Police along with police officers and support personnel to provide law enforcement services to their respective citizens. Officers of the CCSO, Andrews Police, and Murphy Police work together to try to keep the peace and enforce state and local laws and ordinances within the county and towns. Mutual aid assistance is provided to both towns and the county by several state and federal law enforcement agencies as needed (R. Caldwell, personal communication, June 10, 2015).

In regards to the MVFD, Barton (2014) wrote:

> In 1909, a resolution by the Town Council of Murphy, N.C. established fire limits within the town, which in turn, led to the establishment of the Murphy Volunteer Fire Department (MVFD) to provide fire protection for the residents and businesses of the town. For the past 105 years, the MVFD has been dedicated to the protection of life and property of citizens and visitors of the Town of Murphy and the surrounding area of Cherokee County. Since its inception, the MVFD has provided fire service as a completely volunteer firefighting force. Today, the department provides fire suppression services, public education and fire prevention programs, rescue support, hydrant maintenance, and an all-hazard response to natural and man-made disasters in a 22 square mile response area in Cherokee County including the city limits of Murphy and a rural response area called the Murphy Rural Fire District. The MVFD also provides automatic aid for the six independent fire districts which adjoin the city limits or the department's rural fire district by being dispatched simultaneously for any reported fire in neighboring districts. Mutual aid, in which the fire department responds to assist any of the other

seven fire departments within Cherokee County, is provided by the MVFD as requested on a per incident basis.

In 2014, the MVFD transitioned from a department with a totally volunteer staff to a paid-per-call system of fire service. In addition, the department began to employ existing MVFD firefighters on a part-time basis to provide day time response support for the paid-per-call staff who still have difficulty providing adequate staffing levels for emergency calls during normal working hours (A.J. Lovingood, personal communication, June 15, 2015).

This applied research project was completed as a requirement of Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM), which is the third year course of the Executive Fire Officer Program (EFOP) at the National Fire Academy (NFA) in Emmitsburg, Maryland. According to the NFA course detail for EAFSOEM:

> The course is designed to prepare senior staff officers in the administrative functions necessary to effectively manage the operational component of a fire/rescue department. Some of the areas covered are risk assessment, incident documentation, media/political considerations, standards, legal mandates, capability assessment, damage assessment, emergency operations, Integrated Emergency Management System, Multi-Agency Coordination Systems including the Emergency Operations Center, and emergency information systems. Throughout the course, students are presented with a series of senior-staff-level issues that require extensive analysis and action. The actions implemented are applied to a mock community in order to evaluate the effectiveness of these decisions relative to the fire and rescue department's operational readiness. The course is very intense and uses lecture, case study, simulation, scenario, and student participation as instructional media (United States Fire Administration, 2015).

This project links directly to the EAFSOEM course due to the fact that the primary goal of emergency management, as well as all other facets of public safety services including EMS, fire, law enforcement, and rescue services is the protection of the lives of all stakeholders, including the general public and public safety personnel. The problem is that people who live in, work in, or visit Cherokee County are in danger from the effects of severe weather conditions which provides a valid reason for completing this research project to help provide better preparation for future weather related events.

The United States Fire Administration (USFA) has established five operational goals. This applied research project links specifically to two of these goals. First, USFA goal number one is to: Reduce risk at the local level through prevention and mitigation. Prevention of injuries and deaths caused by tornadoes, or other severe weather events, is the primary desired outcome of this research project. Effective mitigation of an event which may occur is the secondary desired outcome.

The second USFA goal which links to this project is number two which states: Improve local planning and preparedness. The research information learned from this project will guide local planning to help provide public education about tornadoes and how the citizens and visitors may become better prepared for storms which are likely to occur in the future. The anticipated result of the project will be an entire county community which is better enabled to prevent injuries and deaths from tornadoes due to pre-incident preparedness and enhanced early warning notification capability.

The significance of this project is for people who live, work, study, visit, or travel through Cherokee County to be better prepared to survive extreme weather related events like tornadoes through pre-incident planning and reliable access to early warning of potential life

threatening weather events. Planning and preparation are critical for survival of tornadoes due to the fact that when an event is imminent, there is no time to develop a plan for safety. Likewise, enhancing the capability to receive as much advance notice of impending severe weather as possible helps ensure that safety plans may be initiated in time to prevent or minimize injury or death from the storm.

Conversely, lack of preparation and planning and lack of awareness of impending danger from severe weather conditions could lead to negative impacts for stakeholders, including severe injury or death as a result of a tornado or other type of severe storm.

Although not related specifically to deaths resulting from fire, this project is linked to at least three USFA operational objectives including: 1) The USFA will undertake programs that will help reduce the loss of life in the 14 years and younger age group by 25 percent over 5 years; 2) The USFA will undertake programs focused on reducing the loss of life to those 65 years and older; and 3) The USFA will focus on reducing the number of firefighter deaths by 25 percent over 5 years. Since the very young and older adults are the least capable of protecting themselves from severe weather events, planning, preparation, and access to early warning of impending storms will help minimize injuries and deaths from extreme weather events in these age groups. Likewise, if the general population is better protected from the effects of severe weather, fire and other public safety personnel will experience safer working conditions.

Literature Review

The National Oceanic and Atmospheric Administration (NOAA) defines a tornado as “A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground” (Tornadoes 101, 2011). Tornadoes may occur in each of the 50 United States and may occur at any time of the year and at any time of the day. Annually in the United States, there

are approximately 1200 tornadoes which are responsible for about 6o fatalities per year (Tornadoes 101, 2011).

Many of the tornadoes which occur in the United States occur in an area of the central part of the country east of the Rocky Mountains in an area called “Tornado Alley.” According to the National Oceanic and Atmospheric Administration:

> Tornado Alley is a nickname invented by the media for a broad area of relatively high tornado occurrence in the central U.S. Various Tornado Alley maps look different because tornado occurrence can be measured many ways: by all tornadoes, tornado county-segments, strong and violent tornadoes only, and databases with different time periods. Please remember, violent or killer tornadoes do happen outside “Tornado Alley” every year (Severe Weather 101, n.d.).

Rice (2011) wrote:

> According to the Storm Prediction Center in Norman, Okla., Tornado Alley is a nickname for the area with relatively high tornado occurrence in the central USA, which includes much of northern Texas, Oklahoma, Kansas, Nebraska and South Dakota. Dixie Alley includes parts of Arkansas, Tennessee, Mississippi, Louisiana and Alabama.
>
> More recently, the term “Dixie Alley” has been introduced into the discussion of tornado occurrences and severity due to the significant number of tornadoes which occur annually in the United States southeastern region, including many states in the Deep South. “With more than 750 reports of tornadoes so far this year in the USA, new research out this

> month finds that the fabled "Tornado Alley" of the Plains may actually not be ground zero for twisters" (Rice, 2011).
>
> According to a new study led by meteorologist Grady Dixon of Mississippi State University, residents of the so-called Dixie Alley may witness the most tornadoes, since tornadoes tend to be on the ground longer in the South. In fact, the research found that the most tornado-prone area in the country is Smith County, in southeastern Mississippi.
>
> By focusing on the path length of past tornadoes — not just the sheer number of tornadoes but how long they stay on the ground — Dixon and his study co-authors found that there is a greater likelihood of tornadoes hitting parts of Dixie Alley than Tornado Alley (Rice, 2011).

Nocturnal tornadoes which are those that occur between sunset and sunrise in any particular location account for a higher percentage of fatalities. According to Ashley, Krmenec, and Schwantes (2008):

> In a geographic synthesis of tornado fatalities, Ashley (2007) suggested that one of the primary reasons the American South has a greater fatality rate than other high-risk regions is because tornadoes in the South tend to occur during cool and transition seasons (as also illustrated by Brooks et al. 2003), when day length is at a minimum. Ashley established that from 1985 to 2005 approximately 25.8% of U.S. tornadoes occurred between sunset and sunrise, while a much greater proportion (42.5%) of tornado fatalities happen at night.

According to McKay (2012):

> Americans have a false sense of security when it comes to disasters, and should they become victims, most haven't taken steps to help themselves during the first few days after one strikes. Experts say either the preparedness message isn't getting across, or the wrong message is being sent.

The United States Federal Emergency Management Agency (FEMA) cites being informed as the first line of defense when confronted with a natural or man-made disaster.

> Emergency preparedness is not just for Californians, Midwesterners, and Gulf Coast residents. Most communities may be impacted by several types of hazards during a lifetime. Americans also travel more than ever before to areas with different risks than at home. Knowing what to do before, during, and after and emergency is a critical part of being prepared and make the difference when seconds count (Ready.gov, 2014).

LaCount (2011) wrote:

> The United States has more severe weather than any other nation on the planet (Steinberg & Potter, 1998). The threats of tornadoes, hail storms, severe thunderstorms, blizzards, hurricanes and other severe weather plaque the United States annually. In recent years, there has been a steady increase in tornadoes and damaging weather. One notation with the increase is that given the increase in events, there has been a steady decline in death related to storms. As stated in the article *Weather Alert Systems for the PSAP,* the primary reason for the decline in deaths are the improvements in weather forecast and warnings as well as the dissemination of the information to the public (Potter & Steinberg, 1998.) The changes in technologies have significantly made forecasting and dissemination of severe weather information better than ever.

The Dane County Department of Emergency Management (DCDEM) located in Madison, Wisconsin provides a multi-tiered public warning system designed to provide citizens and visitors with several means of notification of emergency situations which may impact the county. According to the DCDEM Emergency Warning webpage, "The Dane County warning system consists of multiple components. We recognize that no one application can provide warning to all citizens. As a result, we take a systematic approach, understanding the advantages and limitations of each component" (DCDEM, n.d.).

The mediums utilized by the DCDEM to notify stakeholders of emergency situations in Dane County include a system of 134 outdoor warning sirens, NOAA weather radio, smart phone alerts, telephone notifications, email and social media posts, and local broadcast media outlets (DCDEM, n.d.). According to DCDEM, "The telephone notification system is not used to disseminate weather alerts and severe weather warnings. The warning areas are typically too large, and the time durations too short for an effective delivery of the message" (Dane County, n.d.).

The American Red Cross (ARC) posts substantial information regarding preparation and mitigation measures which are designed to help people prepare for severe weather incidents and to make their families as safe as possible from natural disasters, including tornadoes.

> Tornadoes are violent by nature. They are capable of completely destroying well-made structures, uprooting trees and hurling objects through the air like deadly missiles. A tornado is a violently rotating column of air extending from the base of a thunderstorm down to the ground. Tornado intensities are classified on the Fujita Scale with ratings

between F0 (weakest) to F5 (strongest). Although severe tornadoes are more common in the Plains States, tornadoes have been reported in every state (Red Cross, 2015).

The Red Cross (2015) defines actions to take during a tornado watch as:

Tornadoes are possible in and near the watch area. Review and discuss your emergency plans, and check supplies and your safe room. Be ready to act quickly if a warning is issued or you suspect a tornado is approaching. Acting early helps to save lives!

The ARC recommended actions during a tornado warning are “A tornado has been sighted or indicated by weather radar. Tornado warnings indicate imminent danger to life and property. Go immediately under ground to a basement, storm cellar or an interior room (closet, hallway or bathroom)” (Red Cross, 2015).

According to the Federal Emergency Management Agency:

Tornadoes are nature’s most violent storms. Spawned from powerful thunderstorms, tornadoes can cause fatalities and devastate a neighborhood in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. Every state is at some risk from this hazard. Some tornadoes are clearly visible, while rain or nearby low-hanging clouds obscure others. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible. Before a tornado hits, the wind may die down and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

In regards to sources from which most people acquire information about impending severe weather, Ashley, Krmenec, and Schwantes (2008) wrote, “A recent poll (Harris Interactive 2007) illustrates that 61% of those surveyed acquired their weather forecasts from local television news or The Weather Channel, with an additional 23% of those surveyed acquiring weather forecasts from Internet sources.”

The NWS operates a nation-wide network of radio transmission sites which provide continuous weather information, including watches and warnings of impending severe weather situations, from the nearest NWS office through a system called NOAA Weather Radio All Hazards, or NWR (National Weather Service, n.d., a).

> During the 1980s, NWS began investigating a new signaling technique to replace the single tone signal used by NWR. When transmitted on NWR, the single tone signal would turn on all NWR consumer receivers within range of an NWR transmitter. An audio message following the tone alerted the consumer to a weather announcement. This signaling technique alerted more people than might be necessary. NWS wanted to have a system that would target specific messages to a specific area. NWS studies resulted in the development of a digital coding system called, "Specific Area Message Encoding" (SAME) or Weather Radio SAME or WR-SAME. WR-SAME specified that a digitally coded signal be transmitted before the single tone signal. The digital signal contained codes for the type of weather event, the location(s) and the valid time period of the message. A complete message consisted of the digital codes, the single tone signal, the audio message and an End of Message digital code. A special NWR consumer receiver could be programmed to respond to messages by the type of event and location. NWS

would begin to deploy WR-SAME in the early 1990s (Partnership for Public Warning, 2014).

Cherokee County, NC uses a system called CodeRED, which is operated by Emergency Communications Network, to provide emergency warnings and notifications to the residents, businesses, and other stakeholders. The system uses data in the county's 911 database to contact stakeholders during emergency situations in which the expedient transfer of critical information to the public is critical. According to the Cherokee County Emergency Management website:

> Cherokee County utilizes the CodeRED Emergency Notification System - an ultra high-speed telephone communication service for emergency notifications. This system allows us to send critical communications, to all or targeted areas within the County in case of an emergency situation that requires immediate action. This system is capable of dialing the entire County within minutes. It delivers a recorded message from the Emergency Management office describing the situation and any instructions for immediate or future action. The message will play when answered by a live person or an answering machine and makes three attempts to connect to each number. If you opt-in for text message and/or email alerts those will also be sent (Cherokee County Emergency Management, 2015).

Procedures

The research for this project began in the spring of 2014 while the author completed the pre-course assignment for Executive Analysis of Community Risk Reduction (EACRR). Information gathered during this assignment eventually led to the production of an in-class presentation in EACRR on tornado awareness and safety in the Town of Murphy and Cherokee

County, North Carolina. The information learned during this process justified further research to help provide a safer community for the citizens and visitors of the region.

Research was conducted at the Learning Resource Center (LRC) at the National Fire Academy; the Murphy Public Library; and the library at Tri-County Community College in Murphy, North Carolina. The internet was also used to locate information regarding the topic and to assist in researching federal, state, and local government resources, as well as private industry and other sources, to discover historical data regarding tornadoes and information about tornado awareness, preparedness efforts, and early warning systems. Federal, state, and local governmental websites regarding emergency preparedness and public notification systems were utilized to learn best practices related to severe weather threats, particularly from tornadoes, to help better prepare stakeholders in Cherokee County for future potentially deadly weather events or other disaster situations.

Personal communications including email correspondence, phone conversations, and in-person conversations were conducted with local government officials in Cherokee County, North Carolina including R. Caldwell, who is the CCEMA Director; Cherokee County Fire Marshal W.C. King; and Chief A.J. Lovingood of the Murphy Volunteer Fire Department.

An email request for information regarding the CodeRED system utilized by Cherokee County as a method of notifying citizens and visitors of emergency information was presented to CCEMA Director Caldwell. The questions posed were:

- Is there a maximum of phone numbers that may be entered into the system?
- How many numbers are currently listed in the system?
- Is there any way to distinguish land line phones from cell phones in the system?

- Do we have any idea the percentage of county residents and businesses who are currently enrolled in the CodeRED System?
- From the time the county receives a tornado warning, how long does it take for the information to be entered and sent out via CodeRED?
- Once a county-wide message is sent out via CodeRED, how long does it take for the system to notify all persons or businesses in the list?
- If more numbers are added, will the time frame to alert citizens county-wide increase substantially?

In reply, Director Caldwell forwarded the request for information to Tiffany Menchaca, who is a Client Support Specialist for Emergency Communications Network. Ms. Menchaca provided detailed information about the mass notification system which included specific answers to the questions. In addition, she provided substantial additional information which helped the author gain a better understanding of the system and its capabilities.

The Murphy Public Library maintains a microfiche collection of issues of the Cherokee Scout newspaper dating back many decades. Newspaper articles dating from January, 1974 through June, 1974 were researched for information about events immediately preceding and following the devastating tornado event experienced by Cherokee County and the Town of Murphy in April of that year.

The websites of the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), the Federal Emergency Management Agency (FEMA), the American Red Cross, and others related to tornado and severe weather preparedness and emergency planning were researched to learn best practices for preparation, mitigation, and recovery from severe weather incidents, including tornadic events.

The NOAA website was also researched to learn the geographic areas of Cherokee County which are projected to receive a reliable strength radio signal from the NOAA Weather Radio All Hazards transmitter identified as WWG82 located near the Cherokee-Graham county line in southwest Graham County, N.C. “The coverage statistics and maps are calculated using a computer model and station data assuming ideal conditions” (NOAA Weather Radio, n.d.). NOAA Weather Radio All Hazards transmitters in adjoining Fannin County, Georgia (KX175) and Chattanooga, Tennessee (WXK48) were researched to learn what, if any, areas of Cherokee County, were projected to receive adequate radio reception to provide a reliable warning for severe weather incidents.

In order to substantiate or refute the computer projected reliable coverage of Cherokee County by weather radio transmitter WWG82, the author visited each of the twenty fire stations, three rescue squad stations, and three EMS stations within the county to learn if a reliable radio signal of adequate strength to activate a weather alert /all hazards radio is receivable at each of these stations. The test of adequate signal strength at each public safety station, as well as on the roadways connecting the stations throughout the county, was conducted using a public safety grade hand-held radio with a flexible, rubber covered antenna tuned to a channel programed to the frequency of the WWG82 transmitter which is 162.525 MHz. Beginning in the southeastern portion of Cherokee County at the main campus of Tri-County Community College (TCCC), the author drove first to public safety stations located in the eastern region of Cherokee County. Next, the author drove to fire, rescue, and EMS stations in the southern, western, northern, and central areas of the county ending back at the beginning point at TCCC. During the entire trip, which was accomplished in one day in order to conduct the test under similar weather conditions at all locations, the radio was constantly monitoring WWG82 to identify areas of poor or

nonexistent radio coverage while traveling between individual stations. Upon arrival at each station, the author noted WWG82 reception ability and quality near the main entrance of each station and documented the results on an Excel spreadsheet which had been prepared prior to the test (Appendix A).

Due to limitations of existing radio equipment, no actual survey of NOAA Weather Radio All Hazards radio reception was conducted in Cherokee County for transmitters KX175 located in Blue Ridge, Georgia or WXK48 from Chattanooga, Tennessee.

Cellular phone coverage was also tested at each public safety station near the main entrance by visualizing the number of bars a signal strength the cell phone was receiving and/or by making a call from each location. Likewise, this information was documented on the spreadsheet.

Results

According to the Dane County, Wisconsin Department of Emergency Management website:

> Following significant storm events, people often report that the storm hit “with no warning.” This is tragic, but it is only very rarely true. Major storm events are usually preceded by a Watch issued hours in advance, and a Warning issued when dangerous weather is imminent. Advance warning time is available, if people receive the information and take appropriate action (DCDEM, n.d.)

According to Rice (2011), in regards to the term “Dixie Alley”, research indicates that tornadoes which occur in the southeastern portion of the United States tend to remain on the ground longer than tornadoes in some other parts of the country due to the time of the year these storms are most likely to occur in the southern states.

> The reason tornadoes tend to be on the ground longer in the Southeast, Dixon says, is not so much based on geography or topography but the fact that the Southeast tends to see tornadoes in early spring, when the atmosphere spawns more long-lasting and faster-moving tornadoes.
>
> By the time the Plains gets its active tornado season in May, he says the atmosphere isn't as volatile, so the tornadoes often aren't as long-lived or as fast-moving.
>
> As an example, Dixon said that of the 1,700 tornadoes in Colorado that researchers measured, the average path length was 1 mile, whereas the 1,600 tornadoes in Mississippi had an average path length of 5 miles (Rice, 2011).

Tornadoes which occur during periods of darkness between sunset and sunrise produce greater numbers of fatalities as compared to tornadoes which occur during daylight hours when most are awake and more likely to receive notification of impending severe weather.

> Nocturnal tornadoes appear to be particularly hazardous to humans as evidenced by recent killer tornadoes and tornado outbreaks. As an example, 80 tornado fatalities occurred during 2007, with 59 (or 73.8%) of those fatalities taking place between sunset and sunrise; moreover, 19 of 26 (or 73.1% of) 2007’s killer tornadoes occurred at night. Nocturnal tornado events enhance human vulnerability and reduce the success of mitigation activities for several reasons (Ashley, Krmenec, & Schwantes, 2008).

If tornado warnings are issued during the overnight period, particularly from midnight to sunrise, the numbers of people who receive the warning information is significantly lower than those who receive notification during daylight hours while at school, work, or at some other location in proximity to some means of weather information. Furthermore, when people are at

home, they may be in greater danger from tornadic or other severe storms due to the fact that their residence is likely less sturdy in construction than places of employment or educational facilities (Ashley, Krmenec, and Schwantes, 2008).

Ashley, Krmenec, and Schwantes (2008) continue:

> Even if a warning is provided, the public is less likely to receive that warning at night due to normal sleeping patterns (Monk et al. 2000). In addition, the public has a tendency to be in more vulnerable housing and building structures (e.g., mobile or "manufactured" and single-family homes) during the night in comparison to safer locations (e.g., school or place of work in steel or reinforced-concrete buildings) during the day (Simmons and Sutter 2005a; Ashley 2007). Ashley (2007) found that 69.2% of all tornado fatalities from 1985 to 2005 occurred in either mobile or permanent homes, illustrating the enhanced vulnerability of these particular housing structures.

The CodeRED system is utilized by Cherokee County to notify stakeholders of emergency information to help provide the greatest degree of safety possible for citizens and visitors of the county. As a result of personal communication with T. Menchaca, representing Emergency Communications Network, an enhanced understanding of the CodeRed system in Cherokee County was achieved by the author through the answers to questions originally proposed to CCEM Director Caldwell.

The first question about the CodeRED system was: Is there a maximum of phone numbers that may be entered into the system?

Menchaca (personal communication, June 3, 2015) replied:

> There is no limit on the number of phone lines that can be registered to CodeRED. This goes for both the system's database and individual home addresses. For instance, an

apartment complex may have (1) physical address, but have hundreds of residents. Each resident may enter as many phone lines as they needed and the system will never cap out.

The second question was: How many numbers are currently listed in the system? According to Menchaca (personal communication, June 3, 2015), “Cherokee County currently has 16,476 registered numbers.”

The third question was: Is there any way to distinguish land line phones from cell phones in the system? “There is no way for us to determine how many of the phone numbers registered are land lines and cell phones. We do not have the resident specify this during enrollment” was the reply from Menchaca (personal communication, June 3, 2015).

The fourth question posed about the Cherokee County CodeRED system was: Do we have any idea the percentage on county residents and businesses who are currently enrolled in the Code Red System? Menchaca (personal communication, June 3, 2015) replied, “Of the 16476 phone numbers registered, the system has determined that 9604 phone numbers are from residential enrollment, 561 phone numbers are from business enrollment, and the remaining 6311 were not specified.

From the time the county receives a tornado warning, how long does it take for the information to be entered and sent out via CodeRED was the fifth question posed regarding the Cherokee County system. “CodeRED Weather Warning is automated and requires no human intervention. Therefore, warnings are issued immediately after an alert has been issued by the National Weather Service” (Menchaca, personal communication, June 3, 2015).

The sixth question regarding the Cherokee County emergency notification system was: Once a county-wide message is sent out via CodeRED, how long does it take for the system to

notify all persons or businesses in the list? Manchaca (personal communication, June 3, 2015) stated:

> According to our records, the last county-wide all call was issued in February of 2015 and it took approximately 41 minutes to complete. Please note that our system will run through the calling list and any individuals not reached on the first round will be called an additional 2 times in hopes of reaching those residents. Therefore, the initial round of calls is often received within moments of the original launch, whereas, the redial to non-connects may add additional time to the completed launch.

The seventh and final question regarding the CodeRED system was: If more numbers are added, will the time frame to alert citizens county-wide increase substantially?

According to Manchaca (personal communication, June 3, 2015):

> We always recommend that a resident register as many lines as possible. This increases the chances of them receiving the information in a timely manner. For instance, if a land line is the only phone number registered and the resident is not home at the time the call is launched, the resident may not receive their notification until they return. Therefore, having a mobile device registered will give them an extra opportunity to receive that critical information.

Since most people rely on media outlets such as television and radio, as well as sources available on the internet, for the majority of their weather information, most are unlikely to receive notification of tornadoes or other types of severe weather events during hours when they are asleep.

> These information-seeking activities are used to acquire life-saving warnings while awake and it is therefore expected that vulnerability would be higher during the overnight

> hours when most persons are sleeping and not seeking warning or forecast information. We believe that this is a safe assumption considering that a relatively small proportion of American households have, or use, the National Weather Service's (NWS) All Hazards Weather Radio, equipped with a tone alarm to alert and awaken persons during tornadoes. To what degree the public uses the All Hazards Weather Radio in their place of residence for nocturnal warnings is unknown, but we feel prudent with the assumption that it is more than likely less than 5% of the covered population. In addition, there will always be a segment of the All Hazards Weather Radio user population that will simply sleep through the tone alert for a variety of reasons (e.g., volume of tone alert too low, "heavy" sleeper) (Ashley, Krmenec, & Schwantes, 2008).

According to the National Weather Service (NWS) map indicating computer-projected coverage of Cherokee County by NOAA Weather Radio All Hazards transmitter WWG82 (Appendix B), persons who possess a radio capable of receiving the frequency of 162.525 Mhz should be able to receive broadcasts from WWG82 with a signal strength capable of creating an alert on radios which are programmed for that function in all areas of Cherokee County, with the exception of some areas in the extreme northwestern part of the county along the Tennessee state line. In particular, the computer model predicts very limited effective coverage of WWG82 in the northwest corner of the county which includes the Shoal Creek Township encompassing approximately twenty percent of the total square mileage of Cherokee County and contains portions of the unincorporated communities of Hiwassee Dam, Violet, Unaka, and Grape Creek (W.C. King, personal communication, June 18, 2015).

Another area in which inadequate coverage of WWG82 is projected includes a small area in the extreme southwest corner of the county in the Wolf Creek Fire District, which is located in

the Hothouse Township of Cherokee County. This area is bordered on the west by Tennessee and to the south by Georgia. Both the extreme northwest and southwest regions of Cherokee County are quite mountainous with sparse population (R. Caldwell, personal communication, June 10, 2015).

Cherokee County also receives NOAA Weather Radio All Hazards coverage from transmitter KX175 which is located in Blue Ridge in Fannin County, Georgia (Appendix C) and transmits on the frequency of 162.475 (KX175, n.d.). This transmitter is projected to provide coverage for the southwest area of Cherokee County in the Hothouse Township, however, the map indicates very little to nonexistent weather radio coverage in the northwest region of Cherokee County.

Southeastern Tennessee counties which adjoin Cherokee County are covered to some degree by NOAA Weather Radio All Hazard transmitter WXK48 on the frequency 162.550 which is located in Chattanooga, Tennessee (WXK48, n.d.). This transmitter provides projected coverage of only the western portion of Polk County, Tennessee which borders Cherokee County on its western border. The map for transmitter WXK48 does not project any substantial weather radio coverage for northwest Cherokee County (Appendix D).

Within Cherokee County, there are a total of twenty six fire, rescue, or EMS stations located within the two municipalities and several rural communities of the county. The majority of these public safety stations are located within the areas of greatest population in all of the respective communities (R. Caldwell, personal communication, June 10, 2015).

For this reason, the decision was made to research and document the existence, or lack thereof, of a radio signal from NOAA transmitter WWG82 which would be adequate to provide

alerts to specific radio devices for impending severe weather for the majority of people who live or work in or visit Cherokee County.

At one hundred percent of the fire, rescue, and EMS stations in Cherokee County, NOAA Weather Radio All Hazards transmitter WWG82 was clearly received by a public safety grade hand held radio operated by the author. Although the equipment utilized was not capable of decoding a tone activated alert signal broadcast by the NWS, the open radio signal of the transmitter was clear and static free which indicated that the signal was quite likely strong enough at each of the stations to operate a properly functioning weather alert radio device receiving the appropriate warning tone and voice message. In addition to radio reception at each of the public safety stations, the author was able to constantly monitor and understand the voice radio signal being transmitted from WWG82 while in transit from one station to another throughout the county. The only exception was the Hiwassee Dam Access Road from the TVA Hiwassee Dam to the Violet Community and then Joe Brown Highway from Violet to the Unaka Fire Department in the extreme northwestern portion of Cherokee County. Radio reception of the WWG82 transmitter was clear and understandable with the portable radio located in a cup holder in the ash tray area of the vehicle in all areas of Cherokee County except for those areas in the extreme northwest region on the Hiwassee Dam Access Road and Joe Brown Highway (Barton, 2015).

At the same time while conducting the radio reception study, cellular phone coverage at Cherokee County public safety stations was also documented by the author. At nineteen stations, or 73%, cellular service was available. The six stations, or 27%, without cellular phone service were located either in the northwest region of the county or in the extreme eastern portion of the county. The four stations in northwest Cherokee County with no cellular phone service were the

Wehutty and main stations of the Hiwassee Dam Fire Department, the Unaka Fire Department, and Cherokee County EMS Station 3. The eastern Cherokee County public safety stations which had no cellular phone service were the Topton and Junaluska stations of the Valleytown Rural Fire Department (Barton, 2015). Cherokee County covers 466 square miles (Cherokee Chamber, 2014) of very rural territory and there were several roadways, or portions of roads connecting the various public safety stations in which there was no cellular service noted during the travel from one public safety station to another while conducting this survey.

Research question one asked: What pre-incident planning and actions should be taken by stakeholders in Cherokee County to be best prepared for tornadoes or other severe weather incidents?

In order to be best prepared to survive the occurrence of a tornado, or other incidents of severe weather in Cherokee County, stakeholders must take time to learn best practices for making their families, businesses, work places, houses of worship, or any other meeting places as safe as possible from the ravages of storms. It is the responsibility of Cherokee County emergency services professionals, public leaders and elected officials, and all groups or individuals concerned about public safety to support public education and assistance with pre-incident planning and preparation for severe weather events likely to impact the citizens and visitors to Cherokee County.

According to the American Red Cross (ARC), there are several basic steps to take to make ready for severe weather events. First, the ARC recommends that persons stay informed about changing weather conditions prior to and during periods of severe weather, particularly during tornado watches and warnings, by listening to local weather broadcasts and/or NOAA weather radio transmissions for the local area (Red Cross, 2015).

The Red Cross (2015) recommends becoming familiar with severe storm warning systems available in the community. Communities have different ways of warning residents about tornados. Some locales utilize sirens to alert people who are outdoors of impending severe weather. Others may utilize a combination of phone systems, social media sources, media broadcasts, mass texting systems, or other means to alert stakeholders of impending severe weather. NOAA weather radio alert monitors are a very reliable means of receiving severe weather information immediately as watches and warnings are initiated by the NWS if stakeholders have sufficient radio reception strength from an NWS transmitter (Red Cross, 2015).

Another pre-incident action that is recommended by the ARC is picking a safe room in your home where household members and pets may gather during a tornado. This should be a basement, storm cellar or an interior room on the lowest floor with no windows. Consideration should be given to reinforcing the chosen safe room to the greatest degree possible and removal of diseased or damaged limbs from nearby trees should be initiated. In addition, stakeholders should practice periodic tornado drills so that everyone knows what to do if a tornado is approaching (Red Cross, 2015).

Tornadoes may approach with little or no warning, thus stakeholders must be prepared to watch for tornado danger signs which can include: Dark, often greenish clouds which is a phenomenon caused by hail; Wall cloud which is an isolated lowering of the base of a thunderstorm; Cloud of debris; Large hail; Funnel cloud which is a visible rotating extension of the cloud base; and/or a roaring noise (Red Cross, 2015).

The United States Federal Emergency Management Agency (FEMA) recommends various actions for people to take when a tornado is eminent or occurring dependent upon where

a person is located when the threat of a tornado realized. If a person is in a structure like a "residence, small building, school, nursing home, hospital, factory, shopping center, high-rise building, the person should go to a pre-designated shelter area such as a safe room, basement, storm cellar, or the lowest building level" (FEMA, n.d., During a tornado). If there is no basement, go to the center of an interior room on the lowest level (closet, interior hallway) away from corners, windows, doors, and outside walls. "Put as many walls as possible between you and the outside. Get under a sturdy table and use your arms to protect your head and neck" (FEMA, n.d., During a tornado).

Persons who are in a high-rise building when a tornado is approaching should "go to a small interior room or hallway on the lowest floor possible" (FEMA, n.d., During a tornado). People who are inside trailers or mobile homes when a tornado is approaching should "Get out immediately and go to the lowest floor of a sturdy, nearby building or a storm shelter. Mobile homes, even if tied down, offer little protection from tornadoes" (FEMA, n.d., During a tornado).

People who are outside with no shelter should:

- Immediately get into a vehicle, buckle your seat belt and try to drive to the closest sturdy shelter.
- If your vehicle is hit by flying debris while you are driving, pull over and park.
- Stay in the car with the seat belt on. Put your head down below the windows; cover your head with your hands and a blanket, coat or other cushion if possible.
- If you can safely get noticeably lower than the level of the roadway, leave your car and lie in that area, covering your head with your hands

- Do not get under an overpass or bridge. You are safer in a low, flat location.
- Never try to outrun a tornado in urban or congested areas in a car or truck. Instead, leave the vehicle immediately for safe shelter.
- Watch out for flying debris. Flying debris from tornadoes causes most fatalities and injuries (FEMA, n.d., During a tornado).

According to the National Weather Service (n.d., b), in order to help stakeholders prepare for the dangerous conditions produced by tornadic storms, the National Weather Service provides the following recommendations:

- During any thunderstorm, listen to local news or a NOAA Weather Radio to stay informed about tornado watches and warnings and check the Weather-Ready Nation tips.
- Know how your community sends warning. Some communities in tornado prone areas have sirens. Others depend on media and smart phones to alert residents to severe storms.
- Pick a tornado safe room in your home such as a basement, storm cellar or an interior room on the lowest floor with no windows. Make sure all members of your family know to go there. Don't forget pets if time allows.
- Conduct a family tornado drill regularly so everyone knows what to do if a tornado is approaching.
- Consider having your safe room reinforced. You can find plans for reinforcing an interior room to provide better protection on the Federal Emergency Management Agency web site.
- Take CPR training so you can help someone hurt during a tornado.

- Include the phone number for your local power company in your cell phone so you can report outages.
- Have a family plan that includes an emergency meeting place and related information.

Research question two asked: What methods of communication are currently utilized in Cherokee County to notify stakeholders of impending severe weather conditions?

The National Weather Service operates transmitter WWG82 on Joanna Bald near the Cherokee-Graham County line in far western North Carolina and transmits current weather information around the clock. Severe weather watches and warnings originating at the NWS offices in Morristown, Tennessee and Greenville, South Carolina are broadcast on WWG82 for several counties in the western region of the state (WWG82, n.d.). Cherokee County receives strong signal reception in all areas of the county, with the exception of the extreme northwestern region of the county were Cherokee County borders the Tennessee counties of Monroe and Polk (Barton, 2015).

Stakeholders who operate weather alert radios, or other radio reception equipment capable of receiving the frequency of 162.525 MHz, may receive weather notifications immediately as they are issued by the NWS. In addition, people who possess NWR radio devices which include Specific Area Message Encoding (SAME) technology may program their device to activate only for specific locations such as a single county. Persons with SAME technology capable radios may also choose from various watches or warnings which are relevant to their particular locale (SAME, n.d.).

Cherokee County local government also utilizes several methods to notify citizens and visitors of threats from severe weather and other types of disaster which pose a threat to public safety. According to information on county's website, the public is notified of threats and

warnings via the CodeRED telephone system which is administered by Emergency Communications Network, LLC. The CodeRED system is capable of sending recorded voice messages, as well as text messages, to all phone numbers which are entered into the system. The CCEMA also utilizes social media resources to disseminate weather information and warnings via a county Facebook account (Cherokee County Emergency Management, 2015).

An unofficial means of public notification involves the county public safety radio communication system. During periods of impending severe weather, including tornado warnings issued for Cherokee County, public safety departments receive notification from the dispatch center via radio dispatch. Due to the fact that many county residents have access to scanner-type radios, a large percentage of the general public receives emergency weather information simultaneously with public safety response personnel (R. Caldwell, personal communication, June 10, 2015).

In April, 2014, the Town of Murphy, installed a siren to alert citizens within the immediate area of situations in which a tornado warning has been issued for Cherokee County. The siren was formerly the primary means of notifying the town's volunteer firefighters of a fire incident, however, the unit had not been used for fire responses in almost thirty years. The renovated siren is radio activated by the county emergency communication center upon notification of a tornado warning (Cherokee Scout, 2014).

Residents and visitors of Cherokee County have access to three local radio stations which transmit in the general area of the town limits of Murphy and the surrounding area. Two of these radio stations also stream broadcasts onto the local cable television network which expands the local radio coverage to substantially more residences. Likewise, television stations in Chattanooga, Tennessee; Asheville, North Carolina; and Atlanta, Georgia also broadcast weather

information for Cherokee County on a regular basis and provide emergency information when severe storms are likely to impact the area (R. Caldwell, personal communication, June 10, 2015).

Finally, residents throughout Cherokee County, with the exception of the extreme northwest region of the county, may receive radio transmissions from the NOAA Weather Radio All Hazards transmitter WWG82 to operate tone activated weather radio devices (WWG82, n.d.).

Research question three asked: What are the most efficient methods to notify stakeholders of Cherokee County about impending severe weather events?

One of the most reliable methods to notify the majority of stakeholders of Cherokee County about impending severe weather conditions is the use of a radio capable of receiving weather radio/all hazards alerts from the National Weather Service/National Oceanic and Atmospheric Administration.

> NOAA Weather Radio All Hazards (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from the nearest National Weather Service office. NWR broadcasts official Weather Service warnings, watches, forecasts and other hazard information 24 hours a day, 7 days a week.
>
> Working with the Federal Communication Commission's (FCC) Emergency Alert System, NWR is an "All Hazards" radio network, making it your single source for comprehensive weather and emergency information. In conjunction with Federal, State, and Local Emergency Managers and other public officials, NWR also broadcasts warning and post-event information for all types of hazards – including natural (such as earthquakes or avalanches), environmental (such as chemical releases or oil spills), and

public safety (such as AMBER alerts or 911 Telephone outages) (National Weather Service, n.d.).

Other means of providing early warning of severe storms likely to impact Cherokee County include the CodeRED system and the Emergency Management Facebook social media page which are operated by the county emergency management agency (R. Caldwell, personal communication, June 10, 2015).

Another indirect method of public notification of danger from tornadic activity is the public reception of the county's public safety radio system via scanner-type radios. These radio frequencies are utilized by fire, rescue, EMS, and law enforcement agencies to receive dispatches and communicate during operations (R. Caldwell, personal communication, June 10, 2015).

The Town of Murphy operates still another method of severe weather notification via a siren which provides outdoor warning for portions of the town during tornado warnings issued for Cherokee County (R. Caldwell, personal communication, June 10, 2015).

Research question four asked: How can existing methods of emergency notification be improved or enhanced to more rapidly and efficiently notify stakeholders of impending severe weather events?

Emergency management officials in Cherokee County utilize several methods to provide notification of impending severe weather to stakeholders within the county. Active methods include the CodeRED telephone system and social media via posts on the CCEMA Facebook page and a passive method involves area stakeholders who monitor county public safety communication frequencies via scanner-type radios. The Town of Murphy, in conjunction with CCEMA, operates a single warning siren within the town limits (R. Caldwell, personal communication, June 10, 2015).

Local radio stations provide weather warnings through the Emergency Alert System (EAS) and cooperate with CCEMA officials to help keep stakeholders in the county informed about changing weather conditions and emergency preparedness, mitigation, and recovery information. NOAA Weather Radio All Hazards transmitter WWG82 provides continuous weather condition information and severe weather watch and warning information to the majority of stakeholders within Cherokee County (R. Caldwell, personal communication, June 10, 2015).

Although each of the methods used to provide notification of impending severe weather in Cherokee County are already quite effective, most may be improved or enhanced to more rapidly and effectively warn county residents, business owners, and visitors of threatening weather situations.

According to Manchaca (2015), the CodeRED system operated in Cherokee County may be expanded by adding an unlimited number of landline and mobile phone numbers which could possibly reach every stakeholder within the county in a relatively short amount of time when severe weather threatens the area.

Likewise, social media via the CCEMA Facebook page is a very effective method of providing severe weather notification, as well as general safety related information, to a large segment of the county's population in an almost instant time frame. Many people who live, work, attend school or college, or visit Cherokee County have access to Facebook, or other mediums of social media, and could be quickly informed of changing weather conditions and threats. As with access to the CodeRED system, the social media presence of the CCEMA may become much more effective if more stakeholders become aware of the service and decide to "Like" the agency's Facebook page, thus allowing the individual to receive posts.

Although not an official means of notifying citizens and visitors of impending severe weather situations, Cherokee County expends substantial public resources to operate and maintain public safety radio systems which provide communication for the county's EMS, fire/rescue, and law enforcement agencies. Many residents of the county operate radio scanners which are capable of monitoring emergency service communications. A substantial number of stakeholders in Cherokee County are aware that public safety agencies and responders are routinely notified of severe weather events threaten stakeholders in Cherokee County. For residences and businesses which do not possess a public safety frequency scanner, Cherokee County fire and EMS dispatch frequencies may be monitored by anyone with internet access via the website of the local radio station WKRK located in Murphy, North Carolina (R. Caldwell, personal communication, June 10, 2015).

Research question five asked: What means of public emergency notification systems currently being utilized by other jurisdictions could provide a greater degree of safety from severe weather events for stakeholders of Cherokee County?

The primary means of public emergency notification systems currently utilized by some other jurisdictions to provide a greater degree of safety from severe weather events is the county-wide use of warning sirens. Though quite common in areas considered to be a part of "tornado alley" in the central plains of the United States, these regional warning systems are not as common in the southeastern portion of the country. The citizens and visitors of Cherokee County could substantially benefit from a county-wide system of sirens which could be activated to warn persons who are in outdoor areas in the path of a potential tornadic storm.

Another means of public notification which is being used by other jurisdictions to provide notification of weather which could be dangerous is the increased use of social media

mediums. Cherokee County currently utilizes Facebook as a means of public notification, however, there are not a substantial number of stakeholders who have “Liked” the CCEMA Facebook page at the present time, and thus only a limited number of people currently receive information from CCEMA.

The addition of Instagram and Twitter accounts have allowed other jurisdictions to quickly communicate with their stakeholders. Cherokee County could utilize these new mediums to effectively communicate emergency information about impending severe weather, or other emergency situations to any stakeholders who have a smart phone, or other device capable of receiving the information.

Discussion

Since Cherokee County has experienced eight reported and documented tornado events between 1974 and 2012, it is prudent to assume that these events are likely to occur again in the future. Based on recorded history of tornado events by the NWS which dates back to 1950, Cherokee County has likely been quite fortunate to have experienced only four fatalities and fewer than thirty reported injuries as a result of tornadoes; however, as the county continues to grow in population, the threat of injuries and/or deaths from violent weather events could increase significantly.

The DCDEM recommends that all stakeholders in Dane County, Wisconsin utilize as many of the emergency notification mediums available as possible because no single method of receiving critical, and potentially lifesaving, information which is always completely effective.

> The warning system can only be effective if you actually receive the information. There are a great deal of warning devices and methods available to you. We recommend

that you take advantage of as many of them as possible. No single warning method is perfect and no warning method can be guaranteed never to fail

Have a back-up! By relying on one single method, such as the sounding of the outdoor warning sirens or the receiving information solely from broadcast meteorologists, you risk missing a warning if that system fails. By taking a systematic approach and getting information from more than one source, you are much more likely to receive the warning, even if there is a failure in one of the components (DCDEM, n.d.).

The DCDEM also makes the following recommendations for stakeholders in Dane County:

- Do something to assure that you are able to receive warning information when issued.
- Have a backup. (Nothing works perfectly, 100% of the time.)
- Purchase and use a weather alert radio if you don't already have one.
- Rely on the sirens only for outdoor warning.
- Verify that the Wireless Emergency Alert feature is enabled on your smart phone.
- Set up a weather warning app on your smart phone.
- Turn to broadcast radio or television for details and follow-up information.
- Follow us on Twitter (@DaneCountyEM) and like us on Facebook (Dane County Emergency Management)

The term “Dixie Alley” is relatively new to the discussion of tornadoes which occur in the United States. Specifically, the study by Dixon proposes the concept that tornadoes which occur in several of the states in the southeast may remain on the ground longer than storms

which occur in other parts of the country. Conversely, at least one other expert in the field is not convinced the research is accurate.

> Harold Brooks, a research meteorologist at the National Severe Storms Laboratory in Norman, says path length data of past tornadoes used by Dixon and his co-authors may not be accurate. Data on tornadoes that actually touch down "is the most reliable part of the data set," he says. "Path length data is more variable."
>
> "I don't trust those details," says Brooks, who was not part of the study (Rice, 2011).

Since there is not a maximum number of phone numbers that can be added to the CodeRED system in Cherokee County, all stakeholders should be instructed to add their landline phones numbers as well as cellular numbers to the system to help provide a wider array of warning methods to provide the greatest possibility that all stakeholders receive emergency notifications in a timely manner.

According to Menchaca (personal communication, June 3, 2015), there are currently just over 16,000 individual phone numbers entered into the CodeRED system in Cherokee County and this number includes residential and commercial landline phones as well as cellular phones. The CodeRED system automatically enters publicly listed landline numbers from the county 911 database, however cellular phones and unlisted landline numbers must be requested to be added to the system by the phone owner. In Cherokee County, as with many locations, many people are discontinuing their landline telephone service and depend upon their cellular phone as their primary mode of telecommunication. At the present time, there are several locations in Cherokee County in which cellular phone service is marginal or nonexistent, thus the ability to receive emergency notification of impending severe weather events, or other emergency situations may

be difficult even though the majority of residents and visitors to Cherokee County possess a cellular phone.

Based on Emergency Communications Network information from Menchaca (personal communication, June 3, 2015), there is no way to discern the total number of phone numbers which are cellular units compared to the number of land line phones which are entered in the company's CodeRED system. This situation indicates that even though in excess of 16,000 phone numbers are currently entered into the system, there are a substantial portion of the approximately 27,000 residents of Cherokee County whose phone numbers are not currently entered into the CodeRED database.

According to Menchaca (personal communication, June 3, 2015), 10,165 residential and business phone numbers are registered in the Cherokee County CodeRED system with an additional 6311 phone numbers that cannot be specifically identified as either residential or business numbers.

Since the CodeRED system is automated, notification of stakeholders begins immediately after a weather warning has been issued by the National Weather Service for all, or a portion of Cherokee County, dependent upon what portion of the county's area is included in the warning. This feature allows for warning information to be disseminated instantaneously regardless how busy telecommunicators in the emergency communications center may be at the time the severe weather warning is issued.

The Cherokee County CodeRED system makes three attempts to call each number in the 911 database. Also, as a result of more advanced weather forecasting capabilities, the National Weather Service has sometimes been able to issue severe weather warnings for portions of counties, rather than the entire area of a county. Due to this fact, people in the storm path may be

warned while not spreading panic over a larger region that the storm is not likely to impact. This causes a reduction in the number of phone numbers which must be activated during a severe storm warning, thus reducing the time it takes to send out the warning at a time when just a few seconds may make a critical life or death difference. One significant drawback to this procedure is the influx of mobile phones in the past several years and the likelihood that persons may not receive notification of impending severe weather if global positioning features on their mobile phones are either not activated or the model of phone does not possesses the required technology to enable the function.

Based upon information from Emergency Communication Network during a personal communication with Manchaca (June 3, 2015), the company encourages persons to register all possible phone numbers into the CodeRED system in order to enhance the likelihood that critical weather information will be received in a timely manner to provide as much warning time as possible for people in the path of severe weather systems. Whether at their home or business on a landline phone, or via cellular service, multiple layers of warning capability provide redundancy of safety systems.

There are currently in excess of 16, 000 phone numbers entered into the Cherokee County CodeRED system, however, many of these numbers represent persons who have entered multiple numbers used by their family members landline and/or mobile phones. (Menchaca, (personal communication, June 3, 2015). The system can be expanded by promoting awareness through public education efforts and proactive programs to motivate most, if not all, stakeholders to enter their phone numbers into the system. The CodeRED systems allows participants to choose various options for system utilization including voice and/or text message notification.

System users may also select multiple filtering options which offer specific types of notifications that may be received.

The CodeRED system is a value added warning system due to the fact that Cherokee County local government pays an established fee for the service, however, additional phone numbers may be added to the system at no additional cost. According to Menchaca (personal communication, June 3, 2015), Emergency Communication Network recommends stakeholders register every telephone number operated by a family or business, whether the number be a landline or cellular, in order to increase the likelihood of receiving emergency notifications promptly.

According to National Weather Service information regarding the NOAA Weather Radio: All Hazards notification system of radio transmitters across the United States:

> NWR service to a county depends on reliable signal reception, which typically extends in about a 40 mile radius from the transmitter, assuming level terrain. Counties without NWR coverage or partial NWR coverage are indicated. Some counties or parts of counties, especially in mountainous areas, may not have reliable reception due to signal blockages or excessive distance from the transmitter (SAME, n.d.).

A comparison between the computer projected radio coverage of Cherokee County by the NOAA Weather Radio All Hazard station WWG82 (Appendix B) and results from the survey of actual reception of NOAA Weather Radio All Hazards station WWG82 at the twenty six fire, rescue, and EMS stations within Cherokee County (Appendix A) indicates very similar areas of coverage of the county from the WWG82 transmitter site. Since the public safety stations throughout Cherokee County are located, for the most part, in areas of the county where the greatest populations densities occur, it is likely that if the NOAA Weather Radio All Hazards

transmission is clearly audible at one hundred percent of these stations, the residences and businesses of the vast majority of the county's population should be able to receive adequate reception of WWG82 to make the operation of a Weather Alert All Hazard radio device a reliable mode of notification of impending severe weather. Likewise, according to the computer projected coverage of the southwestern portion of Cherokee County by the KX175 transmitter site located in Fannin County, Georgia (Appendix C) the extreme southwest corner of Cherokee County, which includes the Hothouse Township and the Wolf Creek Fire District, is projected to receive adequate radio signal strength to make Weather Alert All Hazard radios effective in this portion of the county even though the signal is not projected to provide any effective coverage to the northwestern corner of the county in the communities of Hiwassee Dam, Violet, And Unaka.

While cellular telephone service was available at 73 percent of fire, rescue, and/or EMS stations within Cherokee County, there were many areas along the roadways connecting the various stations that there was very limited or nonexistent cellular telephone service availability (Barton, 2015). Cherokee County is predominately rural and the population density is greatest near the municipalities of Murphy and Andrews and along the main thoroughfares through the county including federal highways US 19, US 64, US 74, and US 129 and North Carolina state highways N.C. 60, N.C. 141, and N.C. 294. Due to the sporadic nature of cellular phone service in many different locations within Cherokee County, it is not prudent for county citizens and visitors to rely upon their cellular phones for their primary mode of notification for impending severe weather situations (R. Caldwell, personal communication, June 10, 2015).

Conversely, the widespread use of cellular phones, and similar wireless devices, provides another layer of redundancy for the reception of weather warnings in many locations when people are not at their residence, school, or place of work, thus registering all cellular and land

line phone numbers into the Cherokee County CodeRED system is advisable. Furthermore, mobile devices may also be set up to receive weather warnings from other governmental or commercial entities which provides an even greater level of security by enhancing warning for severe weather incidents.

The ARC, FEMA, and the NWS, as well as many other sources provide critical advice and information for making preparations for severe weather events which may impact our communities at any given time. Creating the understanding with all stakeholders that these events have occurred in the past and are certainly likely to occur again in the future is a continuing challenge for public safety personnel and others who are concerned with minimizing injury or death from natural or man-made disasters. With this I mind, it is imperative that the safety message is received by the people who need the information in a manner in which is meaningful and allows the individual or group to be engaged in their own safety preparations and to be empowered and motivated to make sure adequate preparations are made. Stakeholders should also be aware that plans are more effective when they are practiced on a basis frequent enough to allow all family members, students, employees, and other stakeholders to be competent to protect themselves and others to the greatest degree possible.

The multiple layers of information dissemination utilized by CCEMA helps ensure that most stakeholders have the opportunity to receive notification of impending severe weather events from more than a single source. This increases the potential for people to reach a predesignated safe area prior to the arrival of the storm by providing enhanced early warning of many severe weather situations. Through information broadcast by local media outlets, county-operated functions including the CodeRED system, social media messages, and passive use of the public safety emergency communications radio network, as well as the siren operated by the

Town of Murphy, the intent of CCEMA is to make emergency notification more readily available for every stakeholder.

Although the NOAA Weather Radio All Hazards receiver is likely the most reliable method of providing notification of severe weather events due to the high quality of transmitter reception in the majority of Cherokee County, these devices are not currently operated by significant numbers of people within the county. These receivers are available as either a base-station type radio for use in homes or businesses or portable, hand-held receivers for people on the go and range in price dependent on included features.

Since tornadic activity in Cherokee County is rare, there is an apparent feeling of apathy among many stakeholders that this type of radio is unnecessary (R. Caldwell, personal communication, June 10, 2015). For a short period of time following the tornado which impacted Cherokee County in March, 2012, there was a sense of urgency among many people in the county to provide better early warning capabilities for their families, however, this degree of urgency quickly faded away as the event became further in the past (R. Caldwell, personal communication, June 10, 2015).

The most positive feature of the NOAA Weather Alert All Hazards radio is that the unit may be kept in an alert mode in which it is quiet until it receives the proper alert tone signal. This signal activates the radio at any time of the day or night and has the capability to awaken people from their sleep to provide critical warning of approaching dangerous weather or other emergency situations (National Weather Service, n.d., a).

The effort to provide notification of impending severe weather via social media resources like Facebook is an attempt by the CCEMA to reach younger, more mobile stakeholders via a communication medium which is popular with this group. This technology is used quite

frequently by many people in society due the recent advances in communication technology and the widespread use of devices such as smartphones, tablets, and other modern communication devices.

Media outlets, including local radio stations and television stations from larger cities in the region, provide up to date weather forecasts and emergency warning for severe weather situations which are or are likely to impact stakeholders in Cherokee County during hours while they are awake and tuned in to the appropriate media outlet channel. The degree of effectiveness of this method of weather notification is based on the fact that the stakeholder must be actively watching or listening to the broadcast in order to receive the notification.

Currently, there are only 1,270 people who have chosen to “Like” the CCEMA Facebook page (CCEMA, 2015). With a current population in excess of 27,000 people in Cherokee County, there is substantial opportunity to increase the number of people who have access to CCEMA Facebook posts regarding severe weather updates. Furthermore, other mediums of social media resources including Instagram and Twitter accounts could further expand the likelihood of emergency weather information reaching a greater number of stakeholders in a shorter timeframe.

In addition to social media sites, increased popularity of smart phone devices has created the ability for people to receive special weather notices through particular applications (apps) which may be loaded onto the phone. Many people in Cherokee County now carry smart phones on a regular basis, thus one more layer of rapid notification capability is available to help keep stakeholders informed about severe weather events.

Since Cherokee County taxpayer funding is spent to operate an intricate system of communication for thirteen volunteer fire departments, two volunteer rescue squads, three law

enforcement agencies, and the county emergency medical services agency, it seems practical to educate the stakeholders of the county about severe weather information which is broadcast to emergency services personnel via radio. It would be unreasonable to assume all stakeholders would wish to monitor these broadcasts on a regular basis, however, they are an excellent source of real time information when stakeholders are already aware of the threat of impending severe weather which had been learned from other sources.

In regards to the tornado warning siren located in the Town of Murphy, the number of people who benefit from warning from this siren is quite limited due to several factors including the design of the unit as well as the location of the installation. Since the siren is a renovated, antique model which projects sound in a very linear path, effective sound travels primarily in an easterly direction and does not provide an effective 360 degree warning signal (R. Caldwell, personal communication, June 10, 2015).

A very positive factor evolving from the placement of this single siren into operation has been interest created within some of the fire departments in the county to convert their sirens which are no longer used for fire responses into tornado warning devices as well. The Town of Andrews, as well as four rural fire departments, have outdoor warning sirens which could be renovated to include radio controlled activation to provide tornado warning signals at a relatively low cost. The primary problem that exists with the addition of the four sirens is that each would only provide effective warning to people who are outdoors within a range of less than one mile from the fire station where the siren is located (W.C. King, personal communication, June 18, 2015).

In addition, adding enough sirens to alert the majority of the population in Cherokee will be very expensive and likely impossible for the county to accomplish without grant funding from

the state and/or federal government. Cherokee County has applied for grant funding in previous years to develop a county-wide siren warning system, however, due to the infrequency of tornadic events the county has experienced and the relatively low population of the county, the grant requests have been denied (R. Caldwell, personal communication, June 10, 2015).

Furthermore, the siren operated by the Town of Murphy is activated by the county emergency communication center by the broadcast of a special alert tone which is transmitted on the county fire dispatch frequency when a tornado warning is issued for Cherokee County. Since the special tone has been assigned specifically for tornado warnings, it is possible to add other sirens currently in existence around the county to notify more people about issued warnings for tornadoes.

Likewise, the tornado warning tone could also be used to activate alert radios located in schools, the local college, other public buildings, or at any other location in which the occupants choose to install the needed radio equipment. In these buildings, the radio would remain silent until the alert tone is received, then occupants could monitor voice communication messages which are simultaneously being broad cast to public safety personnel.

Since Cherokee County covers an area of 466 square miles (Cherokee Chamber, 2014, Our land) and is predominantly rural in nature, the population is very sparse in various areas of the county and it would be very cost prohibitive for the county to institute a siren system designed to provide warning to the majority of the county's population.

Many people now utilize mobile phone technology in Cherokee County and CCEMA could utilize this new technology in a very cost effective manner due to the fact that the mediums are internet based and there is no special equipment needed that Cherokee County emergency management personnel do not already have available.

The organizational implications for Cherokee County regarding stakeholder preparation for tornadoes, or other life threatening man-made or natural disasters, is that emergency managers and other public safety personnel must be continually aware of best practices for preparation for various types of threats in order to provide professional and effective assistance helping all stakeholders prepare to the greatest degree prior to severe weather, or other critical situations.

Cherokee County emergency services personnel must remain vigilant in providing as many means of public notification as possible to help ensure stakeholders have the opportunity to receive critical safety information in the most expedient time frame. Likewise, public safety personnel in Cherokee County must always be seeking to utilize new technologies which will reach more stakeholders by the means that is best suited for their lifestyle and safety concerns.

Recommendations

Since there are many natural and man-mad disasters that may strike most any community, it is recommended that CCEMA and its public safety partners and allied resources promote an all hazard approach to disaster planning, mitigation, and recovery planning efforts. Specifically related to tornado awareness and preparations, it is further recommended that resources from the ARC, FEMA, and the NWS be promoted through public education programs which are designed to increase awareness about tornados and provide consistent information about tornado preparedness.

Following the example of the Dane County Department of Emergency Management in the State of Wisconsin, it is recommended that all stakeholders in Cherokee County ensure that they have the capability to receive emergency notifications of impending severe weather, or other emergency situations, through as many mediums as possible. Pre-incident planning and

preparation combined with early notification of severe weather watches and warnings provides stakeholders with the best possible opportunity to survive and more easily recover from severe weather events which may impact Cherokee County.

The primary recommendation regarding early warning notification of impending severe weather in Cherokee County is promoting the installation and use of NOAA Weather Radio All Hazards radios by as many county stakeholders as possible because this seems to be the most reliable means of warning stakeholders about potentially dangerous weather conditions. The article entitled *Vulnerability due to Nocturnal Tornadoes* by Ashley, Krmenec, & Schwantes (2008) predicted that no more than approximately five percent of American households were thought to operate a NOAA Weather Radio All Hazards device as a means of being informed about threatening weather situations at the time the article was published. It is recommended that the CCEMA, in cooperation with other Cherokee County public safety agencies, partners, and all stakeholders with a vested interest in preparation, mitigation, and recovery from the impacts of severe weather, or other natural or man-made disasters which may impact Cherokee County, develop plans and create incentives to motivate all stakeholders to install and operate a NOAA Weather Radio All Hazards receiver.

Furthermore, there will be people in Cherokee County who are unable to purchase weather alert radio devices, thus it is recommended that public safety agencies and allied partners like public health, social services, education, and others cooperate to seek grant funding or other revenue sources to help provide weather and all hazards warning radios for the portions of the population which may be the most vulnerable due to lack of early warning information.

It is also recommended that CCEMA promote the use of the CodeRED automated telephone notification system by providing public education opportunities for stakeholders. The

county currently operates the system with an “opt out” option which allows people with listed landline phones to choose to not be enrolled in the system (R. Caldwell, personal communication, June 10, 2015).

Unlisted landline phones and mobile phone devices may be added to the system by completing a short, interned based registration form available on the Cherokee County local government website. Other recommendations include supporting expanded utilization of social media sites like Facebook and adding the utilization of Twitter and Instagram accounts for use in emergency communication situations.

In regards to the CodeRED system in Cherokee County, it is recommended that public awareness and education programs be developed and presented to various groups, organizations, and individuals throughout the county to introduce and promote wider use of CodeRED to help provide more effective and efficient early warning to all stakeholders. Active involvement of all public safety departments, including EMS, fire, law enforcement, and rescue departments, will be needed to make sure residents and business owners in all municipalities and rural communities are aware of the benefits of the CodeRED system and that all stakeholders have local access to assistance needed to enter their phone numbers into the system. Partnerships between the CCEMA and other county and state departments and services including, but not limited to, public health, public housing, social services, education, division of motor vehicles, as well as various civic groups and organizations, will likely improve awareness and utilization of this added value system.

In order to increase the number of stakeholders in Cherokee County who receive notification of severe weather events which are likely to impact the area, it is recommended that a campaign to promote the CCEMA Facebook page be initiated through all county public safety

departments, county and state partners, local media resources, and other associated agencies. In addition, it is also recommended that CCEMA create Instagram and Twitter accounts to further utilize other mediums of social media and to reach greater numbers of stakeholders with weather related information. Furthermore, research into available applications for smart phone devices which would provide instant weather information and warnings for people in possession of this form of technology is recommended. Promotion of these applications for public safety purposes should take place in the same venues as the previously mentioned social media site information and education sessions.

In regards to tornado warning information broadcast to Cherokee County public safety response personnel and activation of a tornado warning siren in the Town of Murphy via the county emergency communication center, it is recommended that CCEMA and other partners develop public education programs to inform stakeholders of the availability of this information utilizing a scanner-type radio monitor or through an internet connection to the website of radio station WKRK. This information could be presented in conjunction with other outreach program information including use of NOAA Weather Radio All Hazards radios, the CodeRED system, and social media mediums for emergency weather notification.

It is further recommended to develop a program in which each school and other public building be equipped with a tone activated radio capable of receiving tornado warnings or other emergency communications directly from the county emergency communication center.

Finally, it is recommended to develop a plan to promote and support renovation of existing outdoor sirens located at some of the county's fire stations to allow them to be activated by the emergency communication center along with the siren currently operable in Murphy. A

further recommendation is made to seek funding and resources to establish a county-wide system of sirens as the population of the county continues to grow.

The primary recommendation for the emergency services organization of Cherokee County, including the CCEMA, fire and rescue departments, CCEMS, law enforcement agencies, and all allied partners concerned with public safety and emergency preparation of all stakeholders, is to be diligent in spreading the message of safety to everyone possible. Information and education are powerful tools in the effort to help stakeholders, and communities in general, become more resilient to the impact of man-made or natural disasters which may strike. By working tirelessly to provide reliable information and all assistance possible to help stakeholders take responsibility for the safety of their family, themselves, and their community, Cherokee County will be a better and safer place to live.

For the benefit of future readers, the various methods of providing early warning notification of severe weather events, or other emergency situations, to stakeholders in Cherokee County will likely continue to evolve as technology changes. Specifically, if changes occur in the county which promote the development of more reliable cellular telephone coverage for all stakeholders, mobile phones will likely become an even more important factor in early warning of potentially life threatening situations. In the future, other methods of rapid notification of impending severe weather, or other emergency situations, will likely be developed. Likewise, as more research becomes available about tornadoes, and other severe weather events, stakeholders will be better enabled to make necessary preparations to protect their lives and property prior to the occurrence of severe weather events and to be more capable of successfully recovering from such events.

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Appendix A

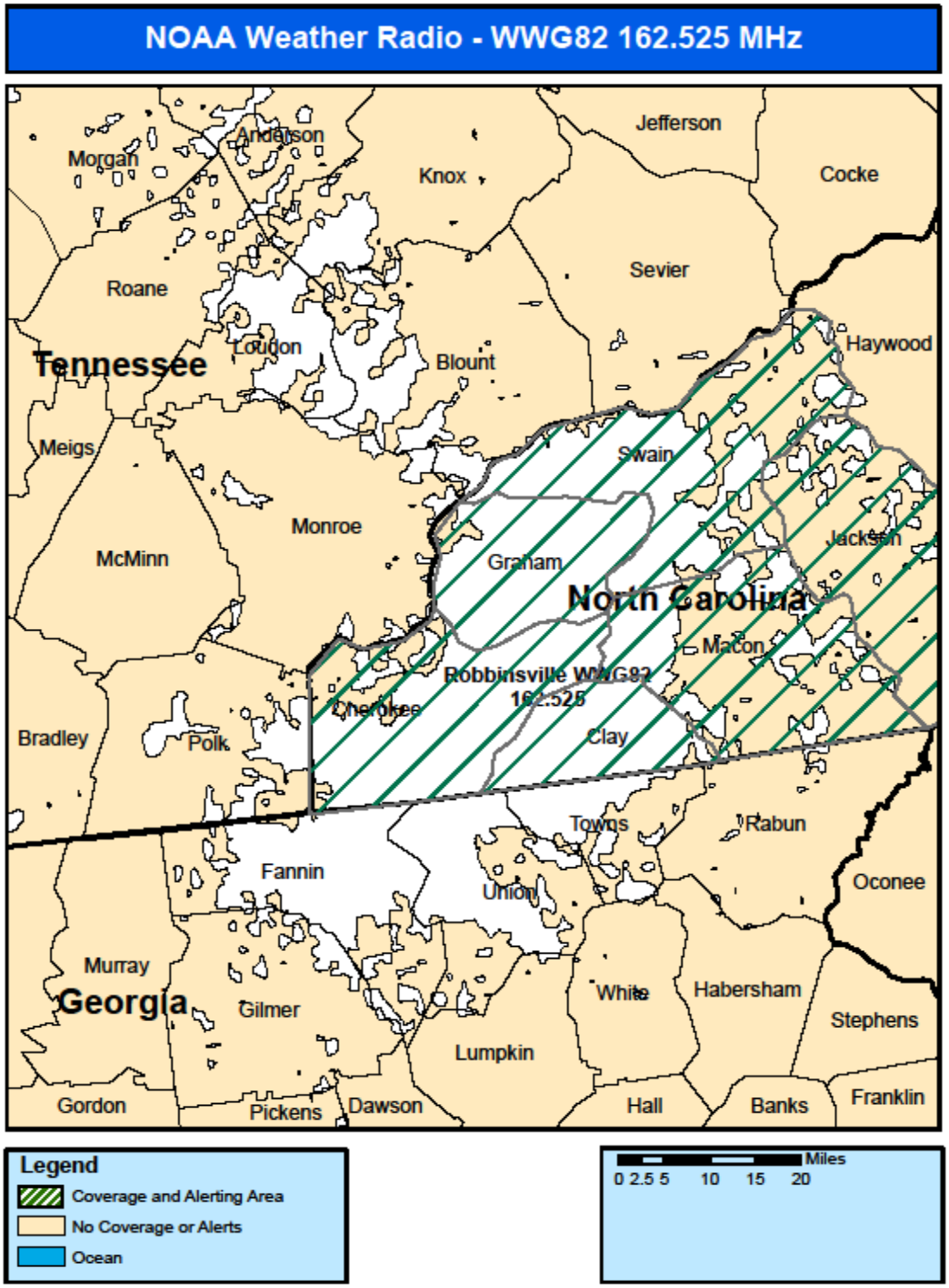
Weather Radio/Cellular Phone Coverage in Cherokee County

Department / Station	Street	City	State	WWG82 Reception	Cellular Service
Andrews FD	85 Fourth St.	Andrews	NC	YES	YES
Andrews Rescue	602 Locust St.	Andrews	NC	YES	YES
Bellview FD	2975 Blairsville Hwy.	Murphy	NC	YES	YES
Cherokee Co. Rescue Main	402 Hill St.	Murphy	NC	YES	YES
Cherokee Co. Rescue West	500 Hwy. 294	Murphy	NC	YES	YES
Culberson FD Main	173 Hardy Truett Rd.	Murphy	NC	YES	YES
Culberson FD Hwy. 60 Sub	4370 NC Hwy. 60	Murphy	NC	YES	YES
Grape Creek FD	5930 Joe Brown Hwy.	Murphy	NC	YES	YES
Hanging Dog FD	3839 Hanging Dog rd.	Murphy	NC	YES	YES
Hiwassee Dam FD Main	7812 Hwy. 294	Murphy	NC	YES	NO
Hiwassee Dam FD Wehutty	150 Wehutty Rd.	Murphy	NC	YES	NO
Hiwassee Dam FD Bear Paw	4750 Hiwassee Dam Access Rd.	Murphy	NC	YES	YES **
Martin's Creek FD	4037 Hedden Rd.	Murphy	NC	YES	YES
Murphy FD Main	1 Firehouse Lane	Murphy	NC	YES	YES
Murphy FD Natural Sp. Sub	125 Natural Springs Dr.	Murphy	NC	YES	YES
Peachtree FD	115 Upper Peachtree Rd.	Murphy	NC	YES	YES
Ranger FD	155 Little Ranger Rd.	Murphy	NC	YES	YES
Unaka FD	15015 Joe Brown Hwy.	Murphy	NC	YES	NO
Valleytown FD Main	2769 Stewart Rd.	Andrews	NC	YES	YES
Valleytown FD Marble	2190 Airport Rd.	Andrews	NC	YES	YES
Valleytown FD Topton	2212 Red Marble Rd.	Andrews	NC	YES	NO
Valleytown FD Junaluska	5321 Junaluska Rd.	Andrews	NC	YES	NO
Wolf Creek FD	18835 West US 64	Murphy	NC	YES	YES
Cherokee County EMS					
EMS Station 1	40 Peachtree St.	Murphy	NC	YES	YES
EMS Station 2	228 Main St.	Andrews	NC	YES	YES
EMS Station 3	7845 Hwy. 294	Murphy	NC	YES	NO

** There was cell service at HDFD Bear Paw Station but no coverage on Access Road prior to or after the Bear Paw Exit.

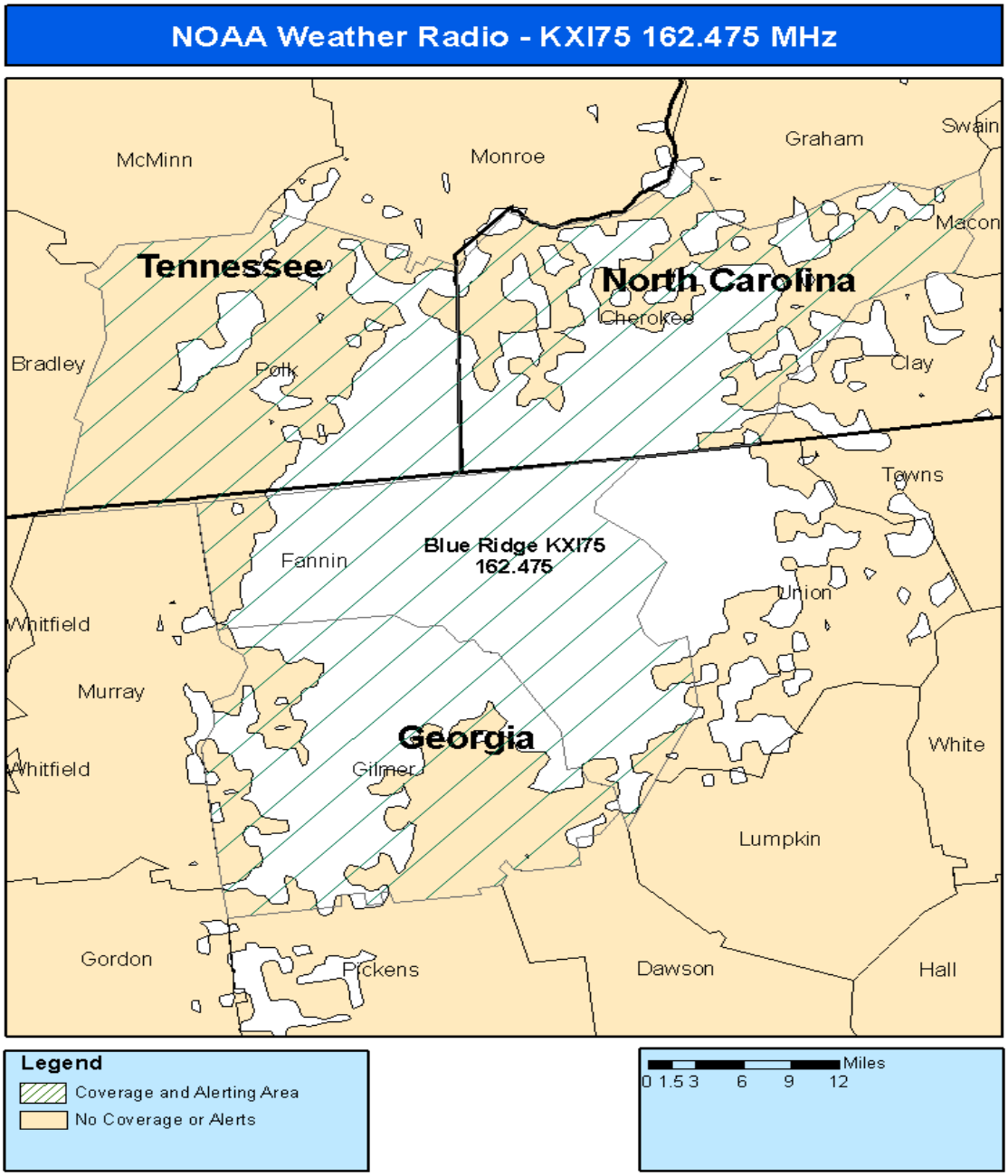
Survey took place on June 10, 2015 by traveling to each fire, rescue, and EMS station in Cherokee County, North Carolina

Appendix B



Retrieved September 10, 2015 from http://www.nws.noaa.gov/nwr/Maps/PDF/WWG82.pdf

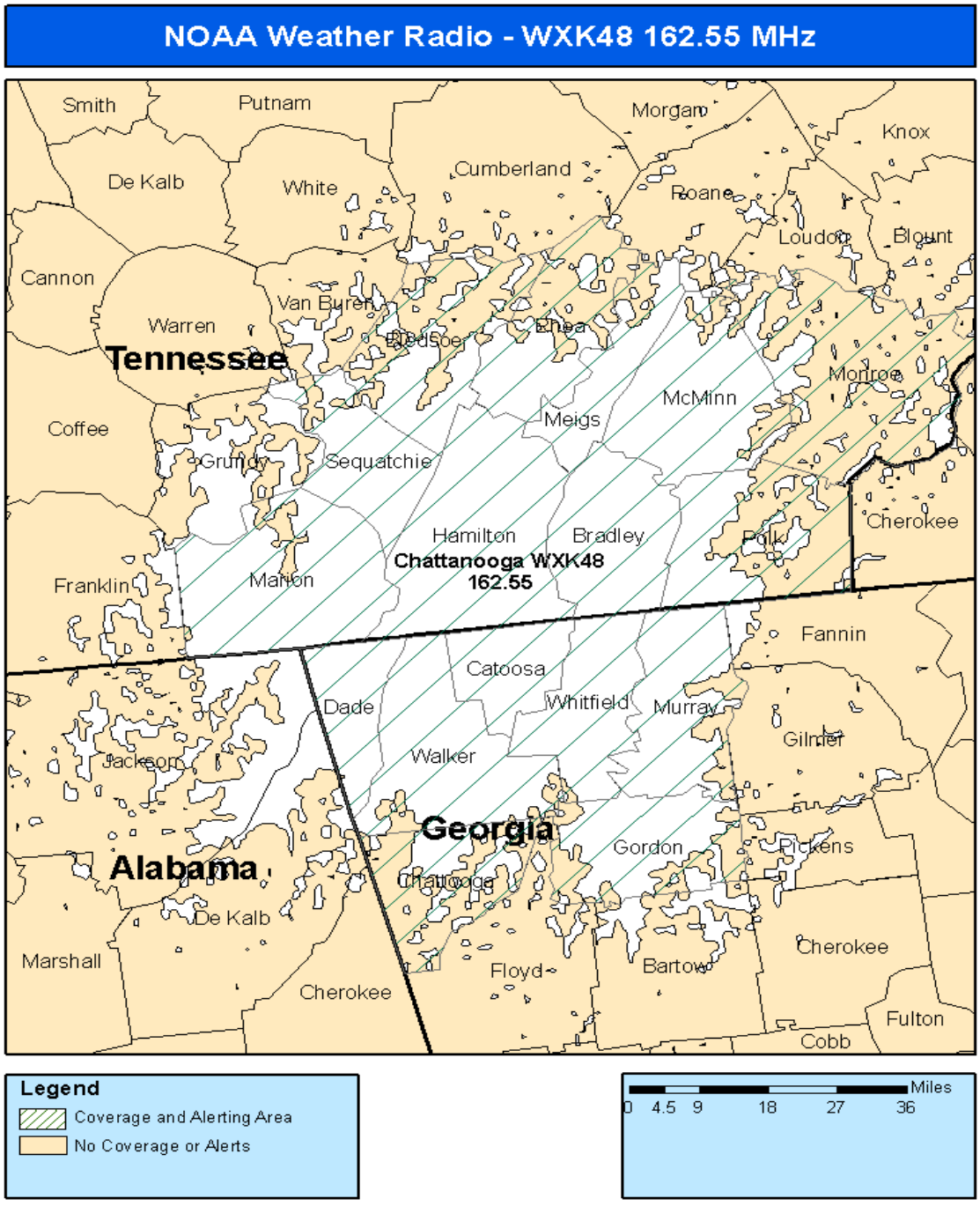
Appendix C



Retrieved September 10, 2015 from

http://www.nws.noaa.gov/nwr/coverage/site2.php?State=NC&Site=KXI75

Appendix D



Retrieved September 10, 2015 from

http://www.nws.noaa.gov/nwr/coverage/site2.php?State=TN&Site=WXK48