Chapter 3

Communication and Preparedness Issues on Various Scales from Extreme Atmospheric Hazards

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Additional information is available at the end of the chapter

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Abstract

Most federally declared disasters are from atmospheric hazards. These could be from floods, tropical cyclones, tornadoes, or winter storms. Some of these hazards are events with relatively short warning times such as tornadoes or have sufficient warnings from tropical cyclones. This research examined communication of weather information and personal preparedness following the Florida landfall from Tropical Storm Debby in 2012. Another case study examined emergency management issues such as preparedness and response after the 2011 tornado in Tuscaloosa, Alabama. The concentration was on emergency management agencies at the County, University, State, and Federal levels. A sample of elderly residents of Pinellas and Pasco Counties in Florida completed a self-administered survey to examine various means of receiving weather information along with hurricane preparedness actions. In-depth interviews were conducted with representatives of various agencies on different scales in regard to preparedness and response following the Tuscaloosa tornado. The elderly used television as the primary means of receiving weather information, thus stressing the importance of utilizing both traditional and newer forms of communications to reach all citizens. One of the major issues on all levels following the Tuscaloosa tornado is related to communications such as resource allocations and response actions.

Keywords: disaster communications, tornado and hurricane preparedness, personal and community emergency management preparedness, methods of receiving weather information, emergency management response

1. Introduction

Most of the federally major declared disasters are due to atmospheric hazards. Of the 3477 total declarations, from 1953 to 2015, 2449 or 71% are weather related [1]. There were 293 major disaster declarations from 2011 to 2015. Only 18 of these major declarations were non-weather related such as earthquakes [2]. Meteorological disasters could be from events such as but not limited to floods, tropical cyclones, tornadoes, or winter storms. Some of these hazards are quick fuse events with relatively short warning times such as tornadoes or have sufficient warning such as a tropical cyclone. This research examined two different atmospheric hazards that were declared major disasters. The first studied means of communicating weather information and personal preparedness of elderly citizens following Tropical Storm Debby in 2012 that made a landfall in Florida. An additional case study examined emergency management issues such as preparedness, response, recovery, and mitigation after the tornado in Tuscaloosa, Alabama, in 2011. The research covered emergency management organizations at the county, university, state, and federal levels.

2. Background

2.1. Tropical cyclones

Some of the most destructive storms are tropical cyclones. Based on the geographic location, tropical cyclones are known as typhoons over the western Pacific Ocean, cyclones over the Indian Ocean, and hurricanes over the Atlantic and eastern Pacific Oceans. Hurricane season in the North Atlantic basin (which impacts the United States) starts 1 June and ends 30 November, with the peak being around mid-September. The North Atlantic basin includes the Gulf of Mexico, Caribbean Sea, and Atlantic Ocean [3,4].

Tropical cyclones are classified by organization of thunderstorm clusters, circulation patterns, and wind speeds. First there is a tropical wave which is an unorganized cluster of thunderstorms with a weak surface circulation. An organized cluster of thunderstorms is generally 150–350 miles (250–600 km) in diameter with no closed circulation and maintains an identity for 24 hours is a tropical disturbance. A tropical depression has an identifiable pressure drop, closed circulation, and wind speed less than 39 mph (34 kts); the system is then assigned a number by the National Hurricane Center. If the storm continues to organize with wind speeds greater than or equal to 39 mph (34 kts) to less than 74 mph (64 kts), it is classified as a tropical storm and given a name. Continued development of the system becomes a hurricane with wind speeds exceeding or equal to 74 mph (64 kts) [3,4].

There are five major environmental factors which determine successful tropical cyclone development. These are sea surface temperature, surface layer of warm water, weak vertical wind shear, sufficient moisture in the middle troposphere, and a location at least 5° north or south of the equator. Sea surface temperature must be greater than 80°F (26.5°C) as this supplies the heat and moisture released into the atmosphere. The layer of warm water is usually around

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200 ft (60 m) to ensure there are enough warm water and energy as the ocean gets mixed in a process known as upwelling. This depth keeps the warmer water rising and cooler water in deeper regions that will not impede the energy source. Wind shear (winds from opposite directions or too high a speed) needs to be relatively weak to form the vortex. If speeds are too high, the vortex will be torn apart and moves downstream. Dry air in the middle troposphere can weaken the storm by reducing latent heat and increasing downdrafts through evaporative cooling; hence, a tropical cyclone requires enough moisture to ensure formation. Rotation is another important aspect of tropical cyclones and thunderstorm clusters. These clusters need to be 5° north or south of the equator so the Coriolis force is strong enough to help develop rotation; the Coriolis force is zero at the equator [4].

The Saffir-Simpson Scale classifies hurricanes based on wind speed on a scale of 1–5 with 5 the strongest. Before 2010, the scale predicted storm surge height and barometric pressure along with wind speeds. The wind scale was revised again in 2012 (**Table 1**) due to the rounding and conversions from mph to km/h; only category 4 and 5 storms were impacted with this update. Previous storms will not have their categories changed with the new scale. Expected damage generally increases with higher category levels. Category 3 and higher hurricanes are known as major hurricanes [4,5].

Category	Wind speed	Damage type
1	74-95 mph	Some
2	96-110 mph	Extensive
3	111-129 mph	Devastating
4	130-156 mph	Catastrophic
5	157 mph or higher	Catastrophic

Table 1. Saffir-Simpson scale [5].

Tropical cyclones are some of the most destructive storms. Some of the impacts are due to storm surge, heavy rain, inland flooding, high winds, and potential tornadoes. Storm surge refers to the rise sea level as the hurricane makes landfall. Onshore winds and the barometric effect (rise in sea level due to low pressure) cause storm surge. Other factors are the wave height, tides, and shoreline shape. Storm surge can cause extensive damage to the landscape and structures. If the tropical cyclone is slow moving or stalled, heavy rains can hit an area. Heavy rain can produce inland flooding and causes the most fatalities along with property destruction. High winds can cause damage, especially to structures not built to withstand higher tropical force winds. There can also be hurricane spawned tornadoes which are often highly concentrated in the right, front quadrant (when looking at the perspective of the hurricane approaching the shore). These tornadoes are usually in the EF0–EF2 range and can also cause property damage [4].

2.2. Tropical Storm Debby

During the 2012 hurricane season, Tropical Storm Debby originated in the south-central Gulf of Mexico after a surface low developed near the Yucatan peninsula and propagated eastward toward an area where the prevailing subtropical ridge had weakened. There was a northern edge of a tropical wave in the Caribbean Sea that merged with the disturbance near the Yucatan peninsula that eventually became Tropical Storm Debby on 22 June [6]. Hurricane Hunter aircraft determined circulation was well defined and the winds were tropical storm strength on 23 June (**Figure 1**). Over the next 24 hours, Tropical Storm Debby moved slowly north to northeastward without a well-defined trajectory forming a rain shield over the northeastern Gulf of Mexico on 24 June. On 25 June, Debby approached the Big Bend area of Florida (area where the Panhandle and Florida peninsula curve on the Gulf of Mexico) and made landfall near Steinhatchee, Florida, on 26 June. Peak winds were estimated at 63 mph (55 kts) and minimum surface pressure was 990 mb [6].

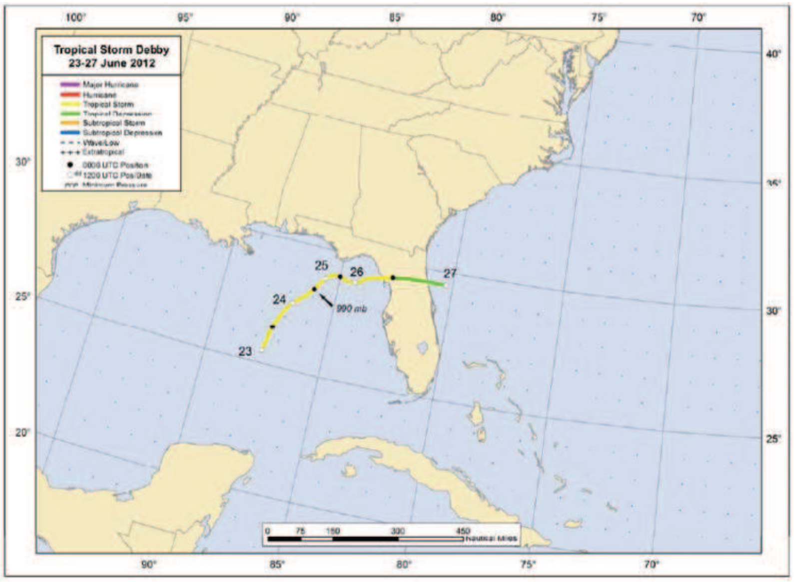

Figure 1. Track positions of Tropical Storm Debby [6].

Winds were not the major impact from Debby but the torrential rains caused major impacts along with inland flooding in various parts of the Florida peninsula. A local observer in Wakulla County measured 29 in. (731 mm) during the event and there were other reports greater than 20 in. (508 mm) in the same region (**Figure 2**). Wakulla County is northwest of the track line near the Great Bend with the light blue shading. There were several totals greater than 10 in. (254 mm) over western and northeastern Florida (see **Figure 2**, south of the purple-shaded track line) [6].

Besides inland flooding, storm surges from 2 to 4.5 ft (0.6–1.4 m) occurred from the Florida Panhandle to the southwestern coast of Florida. This resulted in inundation 1–3 ft (0.3–0.9 m) aboveground level with the highest surge reported between Apalachicola and Cedar Key [6] (see **Figure 2**) on and northwest of the purple-shaded track line) [6]. In addition to the heavy rain and flooding, the rain bands east of the center produced a number of tornadoes. NOAA's Storm Prediction Center (SPC) recorded 24 tornadoes primarily rated at EF0 in central Florida on 23 June. On 24 June, tornadoes hit over the southern and central Florida with several rated at EF1 and EF2 (**Figure 3**) [6].

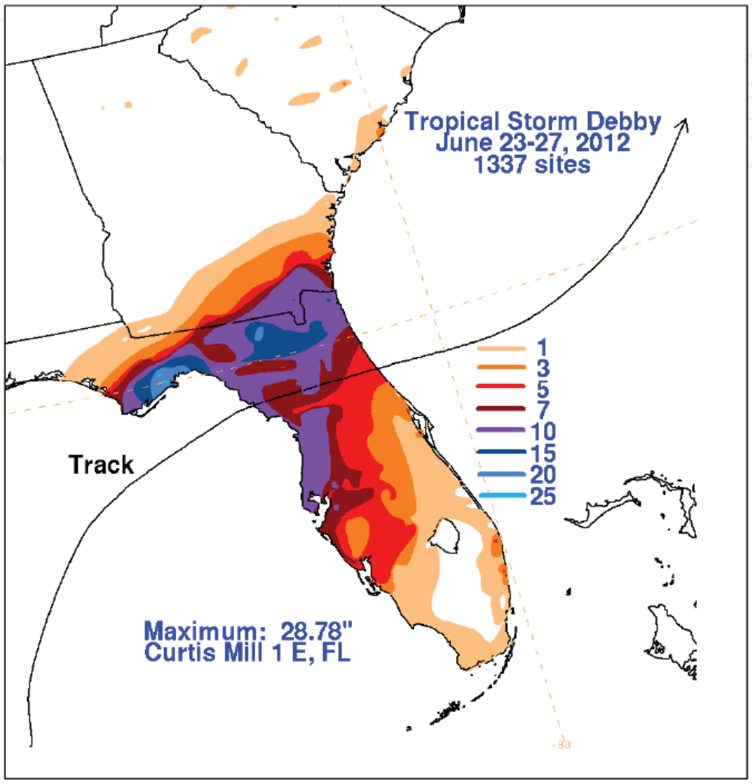

Figure 2. Rainfall totals associated with Tropical Storm Debby [6].

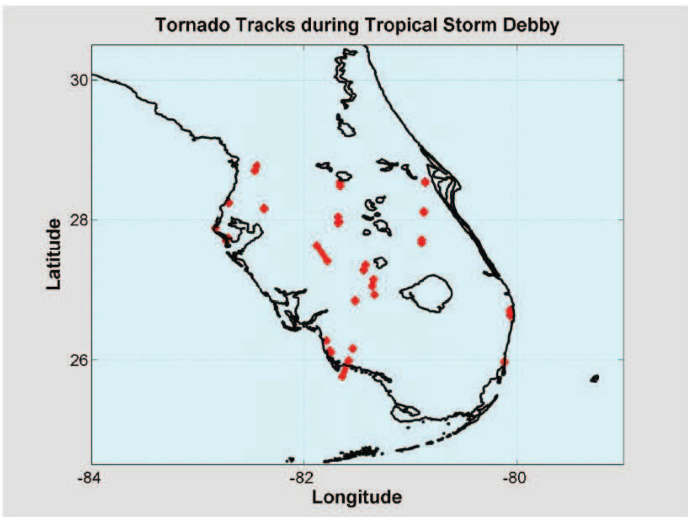

Figure 3. Tornado tracks during Tropical Storm Debby [6].

Five direct fatalities and three indirect deaths were recorded with Debby. A mother was killed in Venus, Florida (west of Lake Okeechobee, the largest lake in Florida), after a tornado hit a mobile home. One drowned in heavy surf in Pinellas County, Florida (west-central Florida on the Gulf of Mexico), and another in Orange Beach, Alabama. A canoe capsized near Lake Dorr, Florida (central Florida north of Orlando), and the person drowned and another man presumed to drown from the storm was found near Anclote Key, Florida (west-central Florida). The indirect fatalities were a man wading in floodwaters in Pinellas County, Florida, and two others were in automobile crashes on wet roads from Debby [6].

Most of the damage was from inland flooding from the heavy rains in parts of northern and central Florida. The Sopchoppy River in Wakulla County (northwest of track line in **Figure 2**) crested at 36.8 ft (11.21 m) and affected 400 structures. There was flooding in Pasco County (south of track line near the Gulf of Mexico in **Figure 2**) along the Anclote and Pithlachascotee Rivers damaging 106 homes. The Suwanee River had observations highest since Hurricane Dora in 1964. Roads such as US Highway 90 and Interstate 10 (north of track line in **Figure 2**) were closed due to floodwaters. US 90 was closed for almost two weeks and Interstate 10 for two days [6]. In addition, there were several roads closed in many counties and sinkhole problems in Marion County (south of track line in **Figure 2**) due to the heavy rains [7].

Coastal areas were affected from storm surge in the Panhandle, Big Bend, and along US Highway 19 in Hudson, Florida, on the west-central coast of Florida. Some roads were submerged for days and others were washed out. There was extensive beach erosion form Pinellas County southward to Charlotte County with the worse erosion in Treasure and Anna Maria Islands [6].

Preliminary insured losses in Florida were $105 million according to the Property Claims Services with $40 million in flood damage covered by the National Flood Insurance Program. Total damage could be $250 million since insured values are doubled along with flood losses [6]. The Federal Emergency Management Agency (FEMA) approved 6758 Individual Assistance applications in the amount of $27,800,267.48 and Public Assistance for communities for $52,197,352.72. These figures do not include flood insurance claims [8].

2.3. US tornado background, activity, and measurement

2.3.1. Tornado background

Tornadoes are rapidly rotating columns of air extending from the cloud to the ground [4]. According to the American Meteorological Society [9], a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." By definition, tornadoes are invisible but visible once debris is in the funnel cloud [4].

All tornadoes come from thunderstorms but all thunderstorms do not form tornadoes [10]. Most tornadoes are formed in supercell thunderstorms but can develop from hurricane thunderstorms, squall lines, and regular thunderstorms. Some of these are non-supercell tornadoes, landspouts, waterspouts, mesovortices, and gustnadoes [4]. Supercells are rotating

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thunderstorms and consist of a mesocyclone (circulation that is detected on radar) and can spawn a tornado along with hail, high winds, lightning, and heavy rain [10].

The typical life cycle or tornadogenesis begins in the dust whirl stage, followed by the organizing stage that reaches full damage at the mature stage, the weakening stage, and finally the rope stage. Environmental factors necessary for formation include vertical wind shear and horizontal rotation [4]. Uplift is also necessary with temperature and pressure differentials.

Tornado widths are commonly 150 ft to 0.5 miles (50–800 m) with wind speeds ranging from 65 mph to greater than 200 mph (57 kts to over 174 kts) [4]; however, greater tornado diameters can occur. Most tornadoes are only on the ground for a short time such as less than 10 minutes [10] but can remain over an hour with damage paths over 30 miles (50 km) [4].

A tornado can occur at any time of the year in the United States. The United States averages around 1000 tornadoes a year. Peak season depends on the location. On the Gulf of Mexico coast, it is the early spring, while May and early June generally have more tornadoes in the southern plains, while the northern plains and upper Midwest have more in June and July [10].

Other countries also get tornadoes but most are reported in the United States. Some of the regions associated with tornado activity are also main agricultural areas that do not include the tropics [4]. Countries with reported tornadoes are Canada, United Kingdom, Bangladesh, Mexico, Argentina, Brazil, and Russia [10].

2.3.2. Tornado measurement and activity

Tornadoes are classified by the Enhanced Fujita Scale (EF). Prior to 2007, the Fujita Scale was used based on damage. The original Fujita Scale was developed by Dr. Theodore Fujita in 1971 as a forensic examination of structural damage. Since 2007, the EF takes into account the type of building materials and construction, damage level, and estimated sustained wind speeds. EF categories range from EF0 to EF5 [4,10,11].

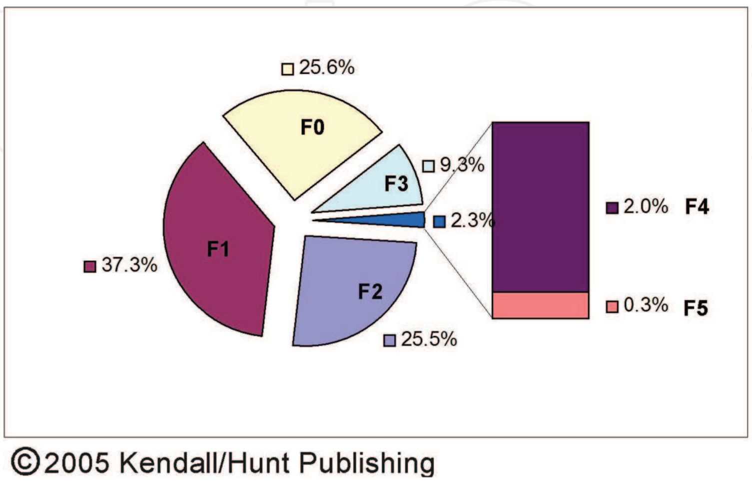

Figure 4. Percentage of all US tornadoes that occurred in each EF-scale category [4].

The majority of tornadoes in the United States are EF0 (25.6%) and EF1 (37.3%). EF4 and EF5 tornadoes are the rarest at 2.0% and 0.3% of all tornadoes, respectively (**Figure 4**) [4]. Wind speeds with EF0 range from 65 to 85 mph (105–137 km/h), EF1 86 to 110 mph (138–177 km/h), EF2 111 to 135 mph (178–217 km/h), EF3 136 to 165 mph (218–266 km/h), EF4 166 to 200 mph (267–321 km/h), and EF5 >200 mph (322 km/h) (**Table 2**). Damage associated with tornadoes is from property damage to structures from high wind speeds and heavy rain from the thunderstorms which can lead to flash flooding and hail [4].

EF number	3-second gust (mph)	3-second gust (kph)
0	65–85	104.58–136.77
1	86–110	138.38–176.99
2	111–135	178.60–217.22
3	136–165	218.83–265.49
4	166–200	267.101–321.81
5	Over 200	Over 321.81

Table 2. Enhanced Fujita Scale [11].

2.4. Tuscaloosa Alabama tornado

A tornado outbreak consisting of 353 tornadoes in 21 states occurred between 25 April and 28 April 2011 [4]. This outbreak had more tornadoes than the 1974 Super Tornado Outbreak (148 tornadoes) and more fatalities than the outbreak that occurred on Palm Sunday in 1965. There were also 2400 injuries and over $4.2 billion in damages associated with this outbreak. In the southeast United States, there were 122 tornadoes that resulted in 313 fatalities in the afternoon and evening of 27 April. Tornadoes that had hit before dawn on the 27th added three more deaths for a total of 316. States affected on the 27th include central and northern Mississippi, central and northern Alabama, eastern Tennessee, northern Georgia, and southwestern Virginia. There were 15 violent tornadoes (EF4 or EF5) and eight had paths longer than 50 miles (or about 80 km) (**Figure 5**). Two of these tornadoes in Alabama, one in the northern part of the state and the other that struck Birmingham and Tuscaloosa, each had more than 60 deaths [12].

The outbreak was forecast by the SPC five days before the event. Weather forecast offices (WFOs) in the area were also preparing for the threat of severe convective weather and tornadoes five days in advance. Some of the activities from the WFO to emergency managers included discussions and tools such as "Hazardous Weather Outlooks, Web images, prerecorded multimedia briefings, and webinars that discussed the potential impacts [12]."

All of the tornadoes occurred in tornado watch box and warning areas. Lead time from watches to warning averaged 2.4 hours while watch time to the first significant tornado ranged from 3 to 6 hours in each area. Warning lead time for tornadoes was 22.1 minutes. The fatalities were all in watch and warning boxes [12].

Even with the forecasts from the SPC and WFOs, there were a high number of fatalities and injuries for several reasons. The tornadoes hit urban, suburban, and rural areas and were long-track violent tornadoes. The storms damaged warning sources, such as NOAA Weather Radio Transmitters. Human behavior was also a major factor as many individuals did not respond to warnings without additional confirmation or waited for visual confirmation before taking action. Furthermore, the storms moved 45–70 mph (or about 72–112 km/h) which gave less time for those who waited to seek shelter, and for some, adequate shelter was not readily available [12].

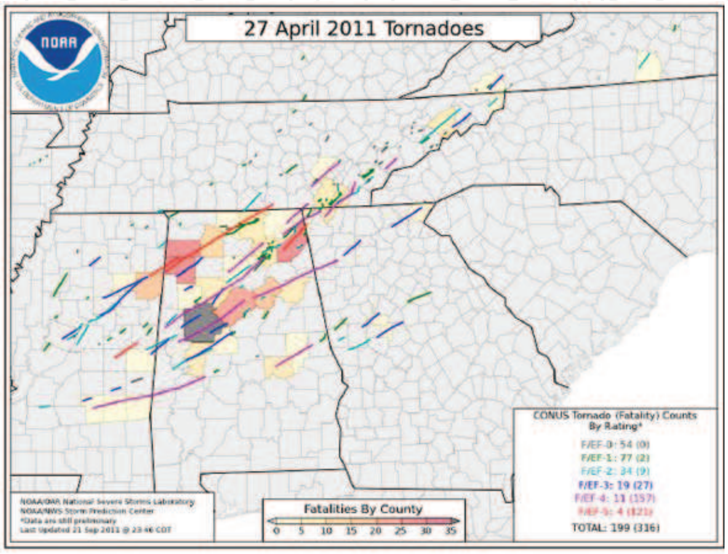

Figure 5. Tornado tracks from 27 April 2011 outbreak [12].

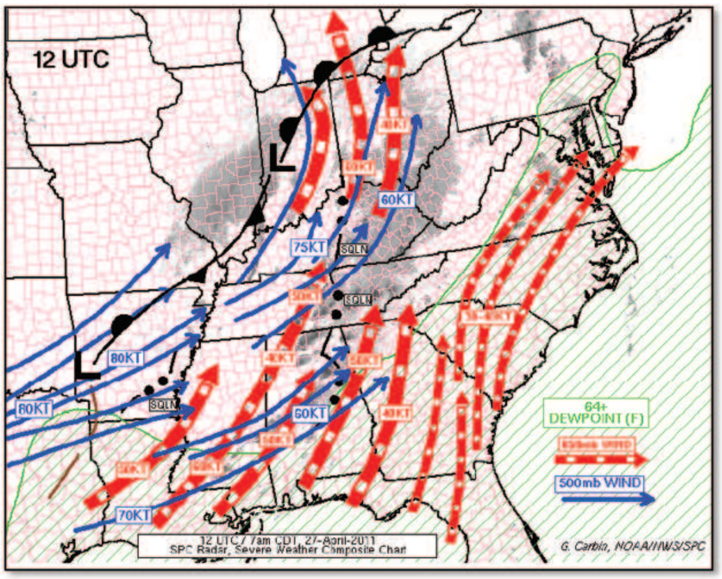

Figure 6. Composite weather analysis 1200 UTC 27 April [12].

The active April severe weather event in the Southern Plains and southeastern United States peaked on 27 April. Conditions were ripe for atmospheric instability due to colder air (compared to previous systems) with an upper-level storm moving east out of the southern Rocky Mountains. The upper-level storm continued east while a strong low-pressure system formed in western Arkansas (**Figure 6**). “As this low formed in the morning, southerly winds increased dramatically in the lower portion of the atmosphere, from around 15 mph at the surface to 45 mph approximately 3000 ft aboveground level. The change of wind direction and speed with height, known as vertical wind shear, helped create highly organized storms that could develop strong rotation in the lower and mid-levels. The approaching upper-level storm brought strong westerly winds at high altitudes, helping ensure that long-lived thunderstorms would occur [12].”

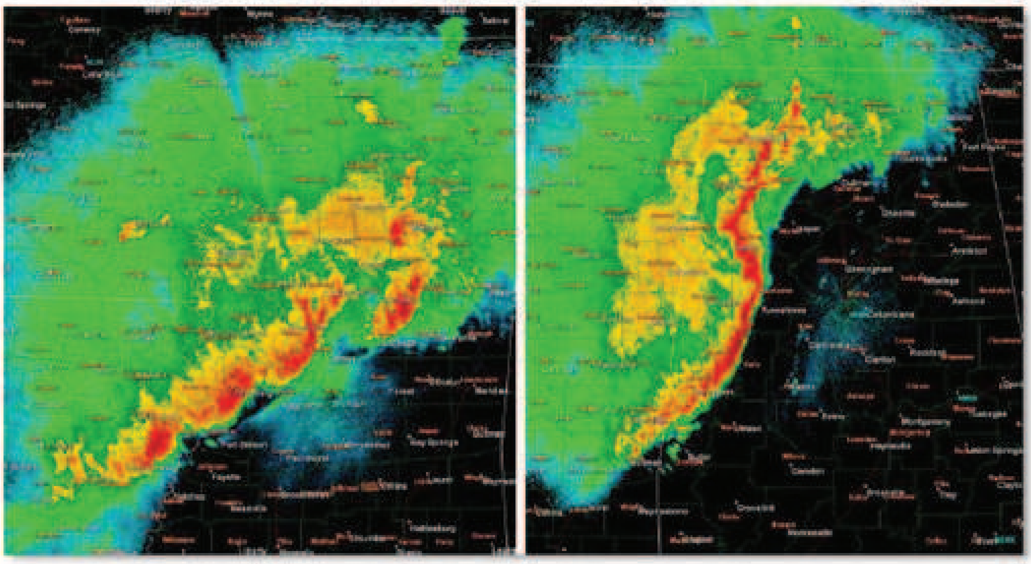

Figure 7. Radar images of early morning storms 27 April 2011 from Jackson Mississippi (left) and Birmingham Alabama (right) WFOs [12].

A line of severe thunderstorms hit central and northern Mississippi, central and northern Alabama (including Tuscaloosa County), and southern middle Tennessee before dawn and produced over 24 tornadoes and caused three fatalities and over 40 injuries (**Figure 7**). Besides causing widespread power outages, several NOAA Weather Radio All-Hazards Transmitters were out of service; this would be a factor later in the day regarding warnings in some of these areas [12].

The early morning storms left a strong low-level jet along with a lot of moisture to assist in more atmospheric instability. An outflow boundary in northern Mississippi and northern Alabama brought more severe storms later in the morning. Further south heating occurred from the sun resulting in more heated low-level air resulting in more destabilization. Vertical wind shear increased, from 20 mph (32 km/h) at the surface to 70 mph (112 km/h) at 3000 ft (0.9 km) to over 100 mph (160 km/h) near the tropopause (34,000 ft or 10 km). These conditions gave “an extraordinary high potential for strong low-level rotation in the storms.” In addition,

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the upper-level wind speeds helped to produce long-lived storms, an environment suggesting severe, long-lived supercells capable of producing violent tornadoes (**Figure 8**) [12]. There were 62 confirmed tornadoes in Alabama and 29 in central Alabama 27 April [13].

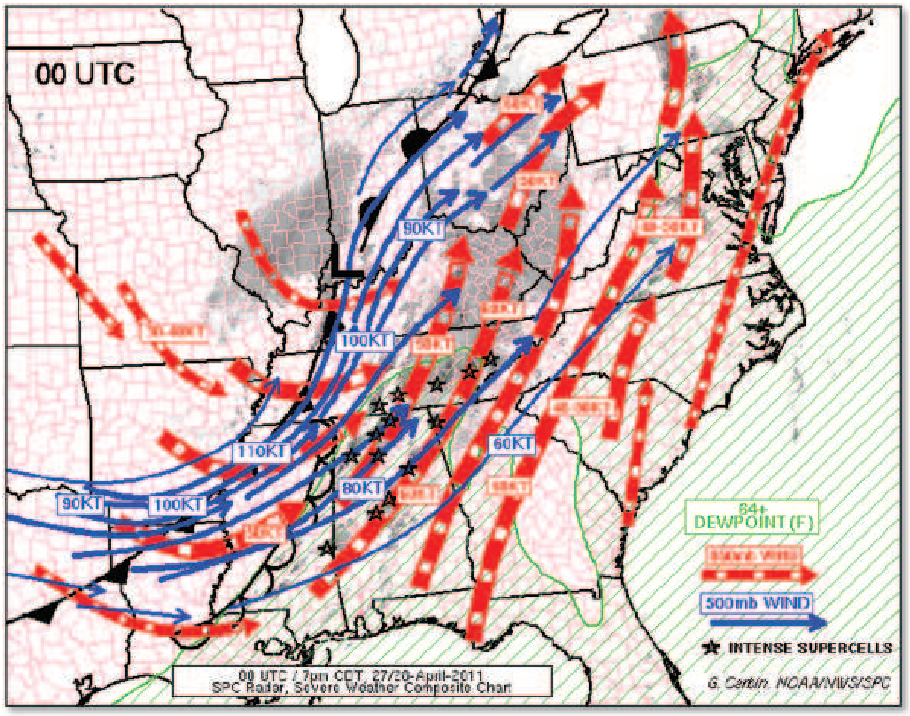

Figure 8. Composite weather analysis 0000 UTC 28 April [12].

Storm Data [14] named the Tuscaloosa-Birmingham EF4 Tornado the "outstanding storm of the month." This tornado was not the strongest (there were EF5s) or the longest track of the outbreak, but it had significant impacts due to the population affected and social impacts. There are 194,656 people in Tuscaloosa County and 90,468 in the city of Tuscaloosa according to the US 2010 Census [15]. The 27 April 2011 outbreak was well forecast by the SPC and local WFOs with most severe weather parameters such as instability and shear on the higher ends of the scale.

The first afternoon tornado touched down at 3:05 pm CDT (2005Z), in Marion County, Alabama, was an EF5. Another supercell would produce the Tuscaloosa-Birmingham tornado started around 3:00 pm in Newton County, Mississippi (110 miles or 176.99 km southwest of Tuscaloosa), and took about an hour and 45 minutes to develop a tornado. This tornado dropped in Greene County, Alabama, and then to Tuscaloosa County into the populated city of Tuscaloosa. As the tornado continued to move east-northeast, it moved into Jefferson County, Alabama, and finally weakened around north of downtown Birmingham, Alabama, and lifted around 4 miles northeast when the parent supercell and another supercell merged. This supercell would produce other tornadoes and was tracked into western North Carolina. The National Weather Service (NWS) damage survey said the tornado caused 64 direct fatalities and over 1000 injuries along with impacting more than 36,000 people [14].

3. Methods and case studies

These two atmospheric hazards had two separate case studies and different research questions and methods. Both of these studies examined preparedness along with communications on different levels and scales.

3.1. Tropical Storm Debby case study

3.1.1. Research objectives

The research objectives of this study examined various means of communicating weather information among the elderly. One of the major themes was comparing traditional media (i.e., television and newspapers) to newer forms of social media such as Facebook or Twitter. In addition, questions were asked in regard to preparedness actions for a tropical storm or hurricane.

3.1.2. Methods

Self-administered questionnaires were given on voluntary basis to elderly citizens. Since American Association Retired Persons (AARP) considers membership from age 50 and older, this was the threshold for elderly. Surveys consisted of both close-ended and open-ended questions. Questions dealt with methods of weather communications prior and following Tropical Storm Debby. Additionally, questions dealt with other potential disaster situations, evacuations, and any changes in actions following this event. A few respondents were interested in elaborating in interviews but the majority only completed the surveys. Subjects resided in Pinellas and Pasco Counties, part of the Tampa Bay area in Central West Florida. There were 30 participants in the 40 question survey. All of the responses were kept confidential with no identifying characteristics of the respondents.

3.1.3. Results

The first question asked on the primary method of receiving weather information. Some of the choices were local television, newspaper, radio, cable television news (i.e., CNN, MSNBC, and Fox), specialized cable news (Weather Channel), local cable news, the Internet, National Weather Service, cell phone, or personal communication with friend or relative. Local television was the overwhelming choice with 60.2% selecting this option. The second choice was local cable news at 13.3% (there is a 24-hour local news channel with weather updates every 10 minutes). Third was the National Weather Service at 10.0%. All of the other choices totaled 16.5%.

Question two asked if respondents utilized a second method of receiving weather information. Of those responding, 83.3% were affirmative and 16.7% did not go to a secondary source. For those who went to another source, 23.3% used the Internet, 13.3% the National Weather Service, 13.3% Weather Channel, local television and cable news each 10%, newspaper and local cable news each 6.7%, and cell phones and personal communication 3.3% each.

In regard to technology owned, 90% owned a computer, 6.7% did not own a computer, and 3.3% did not respond. Almost as many respondents owned a cell phone at 86.7% while 10% did not own a cell phone, and 3.3% did not respond to the question. For those who owned a cell phone, 23.3% indicated it was a smartphone while 66.7% did not have a smartphone and 10% did not respond.

Besides owning technology, the survey inquired how it was used by the respondents. A large majority of 90% use e-mail, while 6.7% do not and 3.3% did not respond to the question. The majority of respondents who use e-mail only on a computer were 66.7%, none used a phone only, 23.3% used both the computer and phone, and 10% did not respond. A minority utilized texting at 36.7% but 60% did not text, and 3.3% did not respond. Similar to texting, only 26.7% of the respondents engaged in social media with an overwhelming majority of 70% not using services such as Facebook or Twitter. The nonresponse rate was 3.3%.

Those who used social media primarily were for personal reasons, such as communicating with family. Only 4.6% used social media to get information. Some of the reasons stated for not using social media from the respondents include “don’t like it, security issues, not interested in public exposure, privacy concerns, do not need it, don’t feel comfortable with it, no time, and prefer to use the telephone.”

Only five respondents indicated they had any damage from Tropical Storm Debby and all five noted it was minor damage. No insurance claims were filed or requests for disaster assistance.

The majority of respondents (36.7%) did not think it was applicable to prepare for Tropical Storm Debby. However, 33.3% did and 26.7% did nothing while 3.3% did not respond. Preparedness actions included close hurricane shutters if threatened, have an evacuation plan, follow instructions from local authorities (such as emergency management officials), have equipment and supplies on hand, secure property if threatened, have no special actions, minimize mulch around back of house to avoid a dam and cause flooding, alert the Citizens Emergency Response Team (CERT), and have more water (for drinking and other purposes).

Another question asked if respondents owned a NOAA All-Hazards or Weather Radio. A large majority of 63.3% owned a radio with 36.7% not owning a weather radio. A question was asked regarding the perception of FEMA with 6.7% answering excellent, 3.3% good, and 90% stating not applicable.

Besides questions on weather communications and preparedness, demographic information was requested from the respondents. The gender breakdown was almost equal with 46.7% female, 50% male, and 3.3% not responding. A question inquiring to primary employment status indicated the majority (76.7%) were retired, 13.3% employed full-time, 3.3% employed part time, and 3.3% not responding. There was a range of incomes with categories of $20,000–34,999 (16.7%), $35,000–49,999 (13.3%), $50,000–74,999 (16.7%), $75,000 or above at 20%, and 33.3% preferred not to answer the question.

Ages were in categories with 50–54 (6.7%), 55–60 (13.3%), 60–64 (3.3%), 65–70 (16.7%), 71–74 (20%), 75–80 (16.7%), 81–85 (10%), and 86 or above (10%). Only 3.3% did not respond to the question.

3.2. Tuscaloosa, Alabama, tornado case study

3.2.1. Research objectives

Research objectives of this study examined fundamental emergency management issues on four different levels. These levels are Tuscaloosa County, the University of Alabama at Tuscaloosa, the Alabama Emergency Management Agency, and FEMA. Besides the emergency management issues, lessons learned were noted for each level.

3.2.2. Methods

In-depth interviews were conducted with various emergency management officials at each level. An open-ended survey/interview was utilized with the respondents. Interviews were with personnel from the Tuscaloosa County Department of Emergency Management, University of Alabama Department of Public Safety, Alabama Emergency Management Agency, and FEMA. Field observations were also completed by the author. Topics included existing and revised preparedness plans, major components of planning, lessons learned from plans, mutual aid, recovery progress, and lessons learned. Other issues included citizen and survivor experiences, mitigation, and interactions among the various agencies at the four levels.

3.2.3. Results: county level

Tuscaloosa County utilized various preparedness actions. Preplanning for events was more common in the post-Katrina era (since 2005). Emergency management personnel had plans for events such as tornadoes, hurricanes, flooding, and winter storms. Besides having planning, exercises were practiced with various community stakeholders. One of the plans and exercises was for mass casualties. Procedures were established for damage assessment such as the type of tags to be issued based on damages and having architects and engineers ready to inspect structures to determine safety or be habitable. Price gouging laws were enacted to keep those from profiteering, especially for necessary items such as gasoline and hotel rooms. The city of Tuscaloosa and Tuscaloosa County had budgeted for financial reserves in case of disaster. Local media was also a partner with the city and county to help disseminate severe storm and tornado awareness to the citizens.

Response was challenging as the tornado made a direct hit and damaged the Emergency Operations Center (EOC) for Tuscaloosa County. The EOC was relocated to the University of Alabama campus. Prior to the tornado, emergency management personnel were aware of the severe weather and tornado potential and responded to the early morning tornadoes. There was a weather briefing with the Birmingham WFO at 2:00 pm and emergency management officials used tools such as Weather Messenger and Emergency Management Weather Information Network (EMWIN) Injects to stay apprised of current and future weather. Various responders (i.e., firefighters, law enforcement, and medical personnel) were also prepared and ready to respond if necessary. The tornado cut through the city and there was a lot of structure damage in addition to the high number of fatalities and injuries. A lock down and curfew was imposed in the city of Tuscaloosa. Some looting occurred but the offenders were not from Tuscaloosa County.

Recovery included tasks such as cleaning debris, power restoration, and working to bring the community back to normal conditions. Citizen needs such as food, water, clothing, housing, and recharging cell phones were attended to by various groups. Some were private or faith-based and others were governmental organizations such as FEMA. Four Disaster Resource Centers (DRCs) were opened by FEMA in Tuscaloosa to assist survivors with their needs. In addition, one Small Business Administration (SBA) Center was available to assist with low-interest loans; SBA works with both individuals and businesses after disasters.

Tuscaloosa County worked with a few mitigation methods. One mitigation method was establishing an active group of Skywarn volunteers, a group of citizens that spot storms and report observations to the National Weather Service. Skywarn training is an annual event with many citizens either taking new or refresher training. Community shelters were established as many do not have storm shelters in their homes or apartments. Some of the structures to serve as shelters are schools and recreation centers. There have been discussions on stricter building codes and recommendations to tie down objects such as air conditioning compressors and water heaters so they are not projectiles in a tornado.

The loss of the EOC in Tuscaloosa County brought up some issues that serve as lessons learned from the incident. First, when the building was damaged, the fire suppression systems went off since the water was on. The backup generator was damaged and needed protection from the elements and water. When a generator is hooked up to the building, circuits on the generator need to be well marked to save time trying to find the live outlets. Spare COAX cable (used in communications) and antennae are necessary for setting up networks and communications. The internet was backed up with a virtual private network (VPN) that went to the University of Alabama that allowed workers to be on the county computer network. A lot of handheld radios were used and issues were found getting a signal in substantial buildings due to the interference from construction materials; hence, multiple methods for communications are needed. Besides the issues at the EOC, there was a lot of interaction within the community that involved both the private and nonprofit sectors. Some events could have gone smoother such as the Governor's Summit (meeting with emergency management and political officials) that was held too soon after the event to cover response and recovery strategies. The FEMA housing event (for citizens impacted by the tornado on rebuilding options) was not well marketed to the community and had low attendance.

3.2.4. Results: university level

Preparedness at the University of Alabama was evident with their established Emergency Operations Plan (EOP) (Tuscaloosa County had one too), marked tornado shelters, an Emergency Call Center Plan (to get out information), preestablished mutual aid agreements, and following the Incident Command System (ICS). The university also had an Emergency Notification/Crisis Communication Plan. These systems utilized texts, e-mails, phones, signage, and public address system to get out warnings and information. Additionally, the university was designated by the National Weather Service as StormReady, meaning the university meets standard communication protocols for informing their community on present and future hazardous weather conditions. Other plans were established for using resources such as the campus buses along with shelter plans with dormitories and continuity plans dealing with dining, facilities, payroll, human resources, and public safety.

The tornado path came within 1200 ft (366 m) of the campus and impacted many students and faculty. There was a lack of power in Tuscaloosa and cell phone communications were severely hampered. This was due to tower damage, lack of power, and heavy usage. The university was able to offer mutual aid to the community in a number of ways for response. First, the EOC was used by Tuscaloosa County for two days and university law enforcement officers assisted the city for a month. Many university vehicles and equipment such as trucks, vans, gators (small all-terrain vehicles for transporting people and materials), and forklifts were used in the community. The campus was used as a staging area for several groups including Urban Search and Rescue (USAR) teams. Some university personnel were used as translators for the non-English-speaking population in shelters. Classes were canceled and dorms used for responders such as utility workers, National Guard, Red Cross, and law enforcement personnel. Still, some students and employees also needed shelter along with meals for responders and key personnel. A "Seek and Find" website was established to track missing people. University resources were used for power and communications, especially with towers. With classes canceled, many students volunteered to help in the community and the university offered food assistance to citizens in need. Other university resources included medical personnel working at the hospital along with the Incident Command Center that was open for 17 days, 24/7. A Joint Information Center (JIC) was established to communicate with citizens and the media. Participants in the JIC included the City of Tuscaloosa, Tuscaloosa County, the University of Alabama, and the State of Alabama.

Since there was no damage to the campus, recovery was more financial than physical. The university was reimbursed by FEMA for expenses assisting the city and county. They also worked with the city recycling services with the large amount of debris. An "Acts of Kindness" program was established to assist students and employees who needed financial aid for recovery and helped manage donations. Another mitigation effort was a Hazard Mitigation Grant Request to FEMA for additional community shelters and generators on campus. The decision was not known at the time of research visit and it was not listed as a funded grant by FEMA. A Damage Assessment Response Plan was established to coordinate personnel to assess and restore buildings.

The University of Alabama learned several emergency management lessons through this event. For example, the university needed to evaluate the generator fuel supplier as the university was in direct competition with the City and, if conditions warranted, both could run low on fuel. Generators were found to be in short supply and increased power capacity was needed. The incident reinforced the need for redundant internet and network pathways; this could be accomplished with multiple ingress/egress core routers. Volunteers are usually forthcoming in disasters and the university needed to establish and coordinate their use in an effective manner. Once Incident Command was established, all requests for resources should go through the Incident Commander to avoid miscommunication issues along with utilizing

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volunteers. Another lesson learned was to expect traditional communications to be overwhelmed or unavailable. Good working relationships (networking, training, and exercises) and mutual aid agreements with other partners such as the city, county, and state are essential during a crisis. Finally, having large events (i.e., football games) with partners and utilizing Incident Command is important in a real disaster. Although a non-crisis situation, large numbers of citizens in a concentrated setting provide community experience in dealing with multiple agencies and stakeholders, a situation similar to a disaster.

3.2.5. Results: state level

Preparedness for the Alabama Emergency Management Agency also involved planning, exercises, and training. The state agency also has a strong relationship with Voluntary Organizations Active in Disasters (VOAD) and the various organizations that are members. Faith-based groups along with civic organizations are among the members that are prepared to respond when needed at a disaster. The State Emergency Management Agency partners with the National Weather Service in educating the public on Severe Weather Awareness Day. Alabama Emergency Management Agency was very aware and communicating with the National Weather Service before and during the tornado outbreak.

Response from the state was to ensure citizens and communities received necessary aid and resources. Mutual aid compacts worked in the majority of counties with no problems in Tuscaloosa County (there were some issues in other counties). State subject matter experts coordinated and worked well with FEMA. Personnel from the state were working in the EOC at the University of Alabama within three hours of the tornado.

One of the major recovery objectives was to give support to the local level. The process for the citizens who needed assistance can be described as "bottom-up" (citizens starting the process and working up through the various agencies), whether to rebuild or obtaining information. The state made a big effort to prevent those "from falling through the cracks" or not following through with individual and community cases. This is due to the bureaucracy and regulations for receiving aid and resources – both to individuals and communities. Another major task was assisting with debris removal and reimbursements.

The State Emergency Management Agency was involved with a few items regarding mitigation. There were grants available to individual homeowners for tornado shelters. They received hundreds of calls along with almost 4200 applications regarding these grants for a shelter or safe room. Hurricane straps and safe rooms were encouraged to be included in the rebuilding process; however, these items were not required items per the building code. Other mitigation issues were related to historic structures. The state advocated slowing down the process and be practical in regard to regulations dealing with historic preservation. Several individuals in Tuscaloosa are not fond of government regulations and wanted to proceed quickly with recovery and not spend too much time regarding older damaged structures that needed to be repaired or totally rebuilt.

A Tornado Recovery Action Council of Alabama (TRAC) was conferred by the Governor and aided in lessons learned from the outbreak. The major sections of the report were a summary of the tornadoes and prepare, warn, respond, recover, and forum reports [14]. Other variables included the importance of ICS training and that all resources and requests should go through the Incident Commander which helps with proper tracking. This is important for getting reimbursements. Like the other levels, the state found issues with communications, coordination, and managing resources.

3.2.6. Results: federal level

FEMA was following the whole community approach of collaboration in the Post Craig Fugate (Administrator since May 2009 through present time of 2016) era for the entire disaster cycle including preparedness. Personnel in the agency were aware of the severe weather potential and had strike teams ready to activate to work with partners at all levels of government along with the private and nonprofit sectors.

There was a quick response by FEMA with Community Affairs workers on the scene within 24 hours. A Joint Field Office was established in Tuscaloosa along with DRCs. In addition, a Federal Coordinating Officer was dispatched to Tuscaloosa to aid with response and recovery functions. At the peak, 3000 FEMA employees were assisting in the disaster. It was imperative for qualified personnel and a strong command and control structure to assist in getting a quick awareness of the situation and evaluate what resources would be needed to help the community.

Some of the recovery tasks involved debris removal resources and wholesale rebuilding of structures. The Army Corps of Engineers also worked with homeowners on debris removal. A program called Tuscaloosa Forward was established consisting of town hall meetings to inform residents of assistance and procedures in this phase. One of the first priorities for survivors was temporary housing assistance while public assistance was infrastructure restoration. There were around 30,000 applications submitted to FEMA for assistance. Those with private insurance used their policies for recovery first and then FEMA assistance would come into aid if they were eligible.

Mitigation measures included education of current building codes and suggestions of strengthening structures (even if not enforced by building codes). This included tie downs and safe rooms. There was also a priority of establishing community shelters, especially with the number of apartments and manufactured housing in the community.

Lessons learned by FEMA went along with the other levels of government, such as the success of using the ICS and the cooperation/knowledge of community leaders with the process. All levels expressed a great working relationship with the local, state, and federal government personnel. The importance of a Public Information Officer (PIO) was useful with the different agencies along with communicating information to the media and public; however, there were communication and coordination glitches. Additionally there was a housing shortage due to the tornado hitting a populated area with housing needs for residents, volunteers, and responders. Due to the number of damaged vehicles, transportation shortages existed. Finally, there were challenges with commercial sites and insurance policies in regard to debris management.

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4. Summary

4.1. Tropical Storm Debby summary

Research indicated that the elderly use local television to get their primary weather information. As with most individuals, they also want to verify their information with a secondary source. The majority used the National Weather Service and the Weather Channel for their sources of secondary information. However, results indicated the elderly use technology in their lives. A large majority own computers and cell phones which are used for personal use such as e-mail and phone calls instead of receiving weather information. Another technology used by the respondents was NOAA Weather Radios. This could be due some of them being members of CERT teams along with previous tropical storm experiences. The majority of respondents do not text or use social media. These results indicate the importance of using both traditional means of communicating weather information and newer methods such as social media in order to reach all citizens. Only a third indicated preparedness actions with Tropical Storm Debby compared to around a quarter who took no action. More than a third said it was not applicable and did not feel the need with this tropical system.

4.2. Tuscaloosa Alabama tornado summary

The research examined emergency management issues on different scales ranging from county to federal levels. All of the respondents indicated the importance of using Incident Command in the response of a disaster. Other commonalities emphasized the usefulness of planning and exercises along with networking. Mutual aid agreements for entities are also important for assistance and resources. Tornado-specific findings were having more tornado shelters, especially community shelters and tougher building codes. Common issues on all levels were with communications and obtaining and utilizing resources.

4.3. General themes

These two case studies examined communication and emergency management issues along with disaster preparedness on different levels. Elderly citizens were surveyed to their preferences for receiving weather information along with preparedness actions before Tropical Storm Debby. Seniors are often vulnerable populations in disasters. They use more traditional methods of receiving weather information and will listen to authorities such as local media and the National Weather Service. Elderly preparedness actions follow practices established and communicated by the media and local emergency management agencies. Tropical systems such as tropical storms or hurricanes are usually well forecast and receive a lot of media attention. However, most of the respondents did not have any impacts from Tropical Storm Debby but there were citizens who were flooded or had tornado damage.

Tornadoes do not usually have the lead time compared to a tropical storm or hurricane. However, the Tuscaloosa tornado had lead time but previous severe weather damaged some communication methods such as NOAA Weather Radio. This outbreak was forecast days in advance and the media communicated its progress live to listeners and viewers. Emergency management agencies were prepared and utilized existing networks for response and recovery actions. There was cooperation and mutual aid demonstrated on the various levels which ranged from the local community to the federal. While there were some issues and glitches, the objective of reducing social vulnerability was primarily successful. Most citizens were able to survive even with the large amount of property damage and high number of fatalities and injuries.

These case studies demonstrate the necessity of efficient communications, from a personal level of receiving weather information to all the levels of emergency management. In addition, preparedness actions and procedures need to be explicit and able to be understood by all, again from a personal level to working with agencies. Being prepared will not stop a tropical storm or hurricane but can help mitigate an event and if disaster strikes makes response, recovery, and resiliency better for those impacted and hopefully decreases fatalities, injuries, and property damage. Effective communications can help achieve this goal. No matter what the scale is, it is important to remember that all disasters are local.

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References

[1] Federal Emergency Management Agency. Data Visualization: Summary of Disaster Declarations and Grants. [Internet]. 2015. 44325–4304 Available from: http://www.fema.gov/data-visualization-summary-disaster-declarations-and-grants [Accessed: 2016-01-13].

[2] Federal Emergency Management Agency. Disaster Declarations by Year. [Internet]. 2016. Available from: http://www.fema.gov/disasters/grid/year [Accessed: 2016-01-13].

[3] National Hurricane Center. Tropical Cyclone Climatology. [Internet]. 2016, Available from: http://www.nhc.noaa.gov/climo/ [Accessed: 2016-01-16].

[4] Rauber R, Walsh J, Charlevoix D. Severe & Hazardous Weather: An Introduction to High Impact Meteorology. 4th ed. Dubuque: Kendall Hunt; 2012. 612 p. ISBN: 9781465250704.

[5] National Hurricane Center. Saffir–Simpson Hurricane Wind Scale. [Internet]. 2016, Available from: http://www.nhc.noaa.gov/aboutsshws.php [Accessed: 2016-01-16].

[6] Kimberlain T. Tropical Cyclone Report Tropical Storm Debby. [Internet]. 2013. Available from: http://www.nhc.noaa.gov/data/tcr/AL042012_Debby.pdf [Accessed: 2016-01-15].

[7] National Oceanic Atmospheric Administration. Storm Data and Unusual Weather Phenomena. Asheville, NC: National Climatic Data Center; 2012. 680 p. Vol. 54 Number 6 [Internet]. Available from: http://www.ncdc.noaa.gov/IPS/sd/sd.html [Accessed: 2016-01-15].

[8] Federal Emergency Management Agency. Florida Tropical Storm Debby (DR-4068). [Internet]. 2016. Available from: http://www.fema.gov/disaster/4068 [Accessed: 2016-01-18].

[9] American Meteorological Society. Glossary of Meteorology. Tornado. [Internet]. 2013. Available from: http://glossary.ametsoc.org/wiki/Tornado [Accessed: 2016-01-16].

[10] Edwards R. The Online Tornado FAQ Frequently Asked Questions about Tornadoes. [Internet]. 2015. Available from: http://www.spc.noaa.gov/faq/tornado/#The%20Basics [Accessed: 2016-01-19].

[11] Storm Prediction Center. The Enhanced Fujita Scale (EF Scale). [Internet]. 2014. Available from: http://www.spc.noaa.gov/efscale/ [Accessed: 2016-01-19].

[12] Hayes J. Service Assessment the Historical Tornadoes of April 2011. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Weather Service; 2011. 76 p. [Internet]. Available from: http://www.nws.noaa.gov/om/assessments/pdfs/historic_tornadoes.pdf [Accessed: 2016-01-16].

[13] BMX Webmaster. Historic Tornado Outbreak April 27, 2011. [Internet]. 2013. Available from: http://www.srh.noaa.gov/bmx/?n=event_04272011 [Accessed: 2016-01-16].

[14] Tornado Recovery Action Council of Alabama. Cultivating a State of Readiness, Our Response to April 27, 2001. Alabama; 2012. 117 p. [Internet]. Available from: http://ema.alabama.gov/filelibrary/TRAC_Report.pdf [Accessed: 2014-03-29].

[15] United States Census Bureau. Tuscaloosa County, Alabama. [Internet]. 2010. Available from: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml [Accessed: 2016-02-18].

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