638   PUBLIC PERCEPTION AND RESPONSE TO SEVERE WEATHER: LESSONS FROM THE 27 APRIL 2011 TORNADO OUTBREAK ACROSS N ALABAMA

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1. INTRODUCTION

As a result of the historic tornado outbreak across the southeast US on 27 April 2011, the state of Alabama alone suffered over 230 fatalities. A push in the field to combine meteorology with social sciences (Pielke 1997, Changnon et al. 2000, Pielke and Carbone 2002, Demuth et al. 2007, etc.) to understand human decision making and behavior strives to grasp how individuals process weather information, personalize weather threats, and decide if, when, and how to take protective action. In order to supplement ongoing efforts to understand the public's decision making process in the event of tornado warnings (e.g. Klockow 2012), we seek to evaluate the dissemination of severe weather information in an attempt to aid in the prevention of future catastrophic loss of life. The goal of this work is to establish a set of recommendations for improvements to the process of dissemination and the public's receptiveness and comprehension of severe weather information and warnings.

2. METHODOLOGY

Interviews were conducted with north Alabama anonymous resident volunteers and Emergency Management Agency directors and personnel. Fig.1 shows a map of the tornadoes that affected the area on 27 April (Note: Marion County, to the south the Franklin County, AL, was also included though it is not labeled in the map). A combination of convenience and snowball sampling was used for identifying resident interviewees. In total, twenty-four interviews were conducted, the majority of which were with Emergency Managers either at their offices and Emergency Operations Centers or via telephone. Our interviews were conducted in June and July of 2011, with two follow up emergency manager meetings in October and November 2011.

In each case, interviewees were asked open-ended questions to convey their overall experience and recollections of the event. Lists of

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specific questions were used to guide the remainder of the session. Generally, participants provided answers for most of the specific inquiries, without being asked, during their initial narratives.

Questions for residents included information about their awareness of the threat for severe weather on the 27th in the days and week prior to the event; typical sources they use for obtaining weather information on a daily basis; how they became aware of tornado warnings during the event; if, when, and where they sought shelter throughout the day on the 27th; and changes to their family severe weather plan after the event. Emergency Managers were asked questions pertaining to their office protocols for severe weather events, their particular actions and challenges that arose during and immediately following the event. Copies of questionnaires used will be made available upon request.
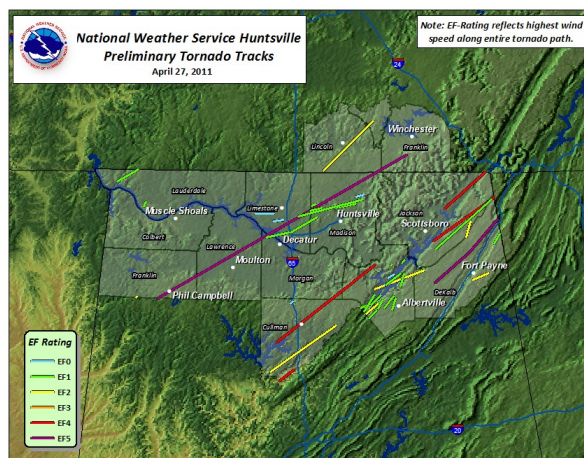

Fig. 1. Map of tornado paths across NWS Huntsville's County Warning Area. Note that this study also included Marion County, to the south of Franklin County, AL.

3. RESPONSES OVERVIEW

All residents we interviewed eventually sought shelter while under threat of a tornado. However, all of them obtained further information after first hearing about the warning for which they responded. The most prevalent immediate actions were tuning into to local TV stations for weather reports, and looking (or going) outside. Of those that monitored TV coverage, most (all but one)

noted that changes in the broadcaster(s) composure played a role in their comprehension of the severity of the event. Respondents used phrases such as "it was the *way* he said it was time to get to our safe place," that persuaded them to take protective actions.

One instance of sheltering occurred as residents in a small town west of Moulton (see Fig. 1) fled to a friend and neighbor's home, seeking protection in a storm shelter on his property. A dozen people survived there, most of whom lost their homes to the EF-5 that also destroyed the communities of Hackelburg and Phil Campbell. A similar fleeing behavior, in part to seek more protective shelter, was well documented for the 3 May 1999 Oklahoma City tornado by Hammer and Schmidlin (2002). Despite surviving in the single-entrance shelter, at least one of the residents expressed concern over using a similar shelter alone in the event of a future tornado threat. In this case, a telephone pole had fallen across the entrance (see Fig. 2), requiring two "big men" to push the door open so the occupants could get out once the storm passed.

Fig. 2. A downed telephone pole blocked the only entrance/exit of a storm shelter where a dozen friends and neighbors survived in Lawrence County. They were trapped until two men inside we able to shove the door open enough to knock the pole forward.

Power outages as a result of the multiple rounds of severe weather crippled the region even before the worst of the outbreak occurred. This led to compounded problems as residents were both without power and faced limited communications as the day progressed and the late afternoon supercells presented a continued, dangerous threat.

One example of this was in the case of interviewees from the Rainsville community in DeKalb County, where the NWS based its EF-5 rating for one of the late afternoon tornadoes. An interviewed resident noted that while he knew the weather was "going to be bad," information was difficult to access because of the power outage. He had driven toward the town in an attempt to get more information about when the weather threat might be over. While in the vehicle, he spotted the tornado and decided to quickly head home, where he had an in ground shelter (Fig. 3), to escape. After speeding home and getting underground, he waited for the storm to pass and emerged to find his two story, brick home completely destroyed (Fig. 4). This resident's home was located near a warning siren, which he regularly "did not ignore," but due to the prolonged power outage it was unable to sound the alarm.

Fig. 3. In ground shelter where a family in Rainsville survived as an EF-5 destroyed their home (also note scouring to grass that had covered the top portion of the shelter). Visual observation of the tornado prompted sheltering action, as the widespread power outage made obtaining updated weather information difficult.

In terms of emergency management procedures, DeKalb County sets a good example. The vast majority of Alabama counties have some type of outdoor warning siren system, but how it is configured varies greatly. In DeKalb, sirens are

Fig. 4. View of Rainsville resident's home location at the time of our interview (July 2011). In ground shelter where he and his family survived is located to left of the visible frame of the photo.

quartered-off, so that they can alert sections of the county without sounding county-wide. This is by far the exception, and sirens in other counties have not been upgraded to this capability. Of the residents that we interviewed, only those in DeKalb County responded somewhat positively when speaking or asked about tornado warning sirens. Residents of other counties expressed frustration when hearing a siren and seeing "not even a drop of rain," in addition to an attitude of general nonchalance toward the idea of sheltering when hearing a siren go off. County-based siren systems essentially negate the progress made by SBWs and contribute to public confusion, complacency, and perception of an artificially high FAR.

DeKalb County also provides citizens the option of signing up for a mass notification system that is set up to give them a phone call or SMS text message in the event that a tornado warning is issued. This allows the public to be directly contacted via a personal land line or cell phone, and DeKalb's emergency management office reports encouraging feedback from the residents that participate. It's a relatively small county, with a population of only about 70,000, yet they have invested in the system, something most counties ignore because of high costs.

A more personal information avenue in use in nearly all north Alabama counties is social media. Continuing our good examples, DeKalb County uses these well. Their EMA Twitter and Facebook pages serve a dual purpose: providing weather and other emergency information to the public and allowing residents to report conditions and request specific information, cutting down on phone calls to the office. Direct involvement with residents though the use of social media outlets proved to be very helpful in the aftermath of the 27 April event, as updates on infrastructure, supply locations, and closures to local schools and businesses were posted in one easily accessible, and continuously updated, place.

While the power outages rendered some avenues difficult or in some cases useless (e.g.: warning sirens) for getting information to the public, it is still instructive to assess the various procedures in place by emergency managers across north Alabama. DeKalb's unique siren capability and implementation of a mass notification system for residents, while not perfect, are examples of ways to improve information dissemination across other parts of the state. Most counties do have a social media presence, something that should be continued and treated as

a powerful communications tool, especially for post-event situational awareness.

The North Alabama Mutual Aid Association (NAMAA) links all north Alabama counties in part for sharing resources, both of equipment and personnel, to respond as quickly and efficiently as possible to disasters in the region. One example of this at play was after early morning storms severely damaged part of Cullman County in the morning on the 27th, fire and medical responders from Madison County arrived to assist with rescue and infrastructure problems. However, because Madison itself also was soon under threat, the personnel sent to Cullman had to return to manage the problems that arose later in the day in their own county. Joint allocation of resources among counties allows for better response after an event, but when threats persist over a large area this must be done with timeliness and an awareness of changing needs and threat locations.

Not mentioned yet, but significant, are pre-event communications. Each county EMA office receives regular updates from the Huntsville (or Birmingham) NWS office. When a potential for severe weather exists, briefings are held with all EMA directors to notify them of the possible threats. To notify the public, both broadcasters and EMA personnel will explain the presence of a severe weather possibility on TV and radio broadcasts, as well as in newspapers and internet news services (such as al.com). For the 27 April event, this was done multiple days in advance, and each of the residents we spoke with noted that they were aware at least one day before that tornadoes might occur. Continuing to alert the public for specific events as their potential becomes clear to forecasters is an important step to ensuring heightened awareness.

4. RECOMMENDATIONS FOR IMPROVED DISSEMINATION OF WEATHER WARNING INFORMATION

The following list of recommendations was composed based on responses collected during the interview process. We include suggestions for both Emergency Management and Broadcasters, as the latter were identified as residents' most widely used source for timely local weather information.

For Emergency Managers:
- County-based siren systems need to be updated to issue information consistent with the SBWs provided by NWS. Lack of such an improvement will continue to

promote skepticism in warning validity and perception of an artificially high FAR. The same issue applies to the current NOAA Weather Radio system.

- There is a clear need for a standard of protocols and/or guidelines for how sirens should be used. Variations in EMA siren procedures by county can be confusing (e.g.: a citizen that lives in one county and works in a another).
- Social media outlets are important: This can provide advanced notice for a significant threat (day/days before) and are a heavily monitored source for residents' post-event infrastructure, services, and situational awareness.
- Challenge of resource allocation: sharing of equipment and response personnel among counties is practical, however must be done with an understanding of context and how the progression of an event can result in new threats that change resource needs.
- Mass notification systems can be helpful and may provide some reprieve to the challenge of notifying residents in SBW polygons, especially if this is done with the inclusion of GPS capabilities.
- Redundancy in communications and power systems for emergency services institutions is critical. All offices we interviewed have such systems in place, but their importance cannot be overstated.

For Broadcasters:

- Your nonverbal and social cues, such as tone of voice, posture, and composure, are sometimes the single type of information that leads to sheltering action.
- Keep in mind the need to convey the most important and relevant information as efficiently and succinctly as possible.
- Maintain a map in view at all times to show where threats are spatially, even when showing visual confirmation such as live photos or video.
- Remember there is a radio audience (espically when power is lost) and provide specific threat location and scale information based on things local populations understand (e.g.: landmarks, schools, churches, etc).
- Provide reminders for reviewing weather safety plans at regular times of year (e.g.: at "spring forward" or "fall back", as many do for replacing smoke alarm batteries).

These recommendations are made to improve the dissemination process for weather threat and warning information in hopes of preventing future loss of life. It also bears noting that a key aspect of severe weather safety is personal responsibility and preparedness, which highlights the need for continued public education (at all ages) and reminders throughout the year for assessing family weather safety plans.

5. ACKNOWLEDGMENTS

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