Quick Response Report

Mobile Home Resident Preparedness and Response to Tornado Warnings: The 27 April 2011 Disaster in DeKalb, County, Alabama

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Abstract

On April 27, 2011, an EF5 tornado hit DeKalb County, Alabama, as part of the Dixie Alley Tornado Outbreak of 2011. The tornado resulted in over 30 fatalities. A post-disaster survey was conducted in the county on May 6-11, 2011. A total of 124 local residents participated in the survey including 39 mobile home residents and 85 non-mobile home residents. The mobile home residents were less prepared than the non-mobile home residents in having a tornado-resistant shelter on the premises and having a plan for seeking shelter. Furthermore, 45% of mobile home residents with a plan intended to seek shelter at the mobile home. Factors associated with having a plan included previous experience in seeking shelter from a tornado and a high internal locus of control. Perception of danger upon receiving a tornado warning was equal among mobile home and non-mobile home residents; however, mobile home residents should be expected to have a greater sense of danger given their enhanced vulnerability.

Introduction:

The vulnerability of mobile home residents to tornadoes has been widely recognized (Golden and Adams 2000; Simmons and Sutter 2007; Schmidlin et al. 2009, Chaney and Weaver 2010). The limited protection provided by the housing structure is well known, but other variables such as socioeconomic characteristics have also been

cited as contributing factors. For example, low income or education might present barriers to an individual's ability to prepare for, or respond to, a tornado threat. More specifically, low income or education might limit a person's ability to receive a tornado warning, to understand the meaning of the warning, or to know how to respond to the warning in an appropriate manner. Given the limited protection provided by a mobile home structure when compared with a traditional brick or wood-frame house, it is important to understand the influence of these other types of variables on preparedness and response among mobile home residents in order to develop a comprehensive strategy for reducing vulnerability. These types of issues have also been noted in studies on mobile home vulnerability to hurricanes (Morrow 1999; Montz and Tobin 2003; Lindell et al. 2005; Chakraborty et al. 2005; and Kusenbach et al. 2010).

This study evaluates tornado preparedness and response characteristics of mobile home and non-mobile home residents, and identifies differences between the two groups. Factors such as previous experience with tornadoes, personal perception, and basic socioeconomic characteristics will be used to help gain a better understanding of mobile home resident preparedness and response, and how they differ from non-mobile home residents.

Primary research questions to be addressed in this study:

1. What were the preparedness characteristics of mobile home residents (e.g., did they have a plan for seeking shelter, where did they plan to seek shelter, did they own a NOAA weather radio)?

2. How did mobile home residents respond to the tornado warnings (e.g., perception of danger, shelter-seeking activities)?

3. How did the preparedness and response of mobile home residents compare with non-mobile home residents (e.g., are MH residents more, or less, prepared than non-MH residents)?

The study site for this research is DeKalb County, Alabama, which is a rural county in the northeastern corner of the state with a relatively sparse population of 69,380 (U.S. Census Bureau 2011a). DeKalb County was selected for the study because early reports indicated that it had suffered the highest number of tornado-related fatalities (33) in the state during the tornado disaster that is being referred to as the April 26-28, 2011 Dixie Alley Tornado Outbreak, and because it represented the best opportunity to collect data on mobile home residents. More recent estimates show that DeKalb County (35) is second in tornado-related fatalities behind Tuscaloosa County (41).

Tornadoes and Mobile Homes

Tornado-related fatalities in the U.S. occurred more often in mobile homes (44%) than in permanent homes (25%) during the period 1985-2005 (Ashley 2007). The difference in these statistics is more important when considering that mobile homes account for such a small fraction of housing stock in the U.S. (7.6% in 2000 US Census).

Furthermore, the high percentage of mobile homes in the Southeast (20% of housing stock or greater) was identified as a critical factor in understanding why tornado fatalities and killer tornado events occur more often in the Southeast than in the Great Plains, in spite of the fact that more tornadoes (and more violent tornadoes) occur in the Great Plains region (Ashley 2007). In the southern states of Arkansas, Alabama, Georgia, Mississippi, and Tennessee, mobile home fatalities accounted for 52% of all tornado fatalities.

In 1976, the U.S. Department of Housing and Urban Development established regulations on building design and construction techniques that have since helped to reduce tornado-related fatalities in mobile homes (Hart et al. 2002; Simmons and Sutter 2008). The National Weather Service, however, still considers them unsafe during a tornado and advises mobile home residents to seek shelter elsewhere (NOAA 2009).

Although tornado preparedness is especially important for mobile home residents, recent case studies have shown that it is often inadequate. Schmidlin et al. (2009) found that a mere 2% of mobile home residents at study sites in Georgia, Mississippi, Illinois, and Oklahoma had access to a basement or underground shelter on the property. They also found that many mobile home residents had not investigated potential shelter sites near their home, which suggests that they either did not have a plan for seeking shelter or the plan was poorly prepared. Chaney and Weaver (2010) investigated the 2008 Super Tuesday tornado disaster at Macon County, TN. and found that mobile home residents were less prepared than brick and wood-frame house residents in all six categories evaluated. They also found that having participated in a tornado drill, understanding the

definition of a tornado warning, and having a plan for seeking shelter promoted higher evacuation rates among mobile home residents.

Studies such as those conducted by Schmidlin et al. (2009) and Chaney and Weaver (2010) have helped us to understand that human vulnerability also plays a role in mobile home fatalities, as opposed to this problem being entirely related to the structural integrity of the mobile home. However, additional studies are necessary to determine if these findings are consistent and transferable to other locations.

Dixie Tornado Outbreak of April 26-28, 2011

Preliminary reports suggest that the tornado outbreak of April 26-28, 2011, was possibly the largest tornado outbreak in U.S. history with approximately 300 tornado touchdowns from Texas to New York (Stormtrack 2011). The majority of these tornadoes occurred on April 27 with an estimated 250 tornadoes occurring mostly in Alabama, Mississippi, Georgia, Tennessee, and North Carolina (Figure 1).

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Figure 1. Tornado activity on April 27, 2011 based on NWS Storm Prediction Center Reports.

In Alabama, over 60 tornadoes occurred with approximately 30% of these having an intensity of EF3 or higher (NWS 2011a). Recent estimates by American Red Cross workers indicate at least 230 fatalities and 7800 homes destroyed, with over 1200 of these being mobile homes (Katie Garfinkel, Personal Communication). DeKalb County was hit by 6 tornadoes according to preliminary reports, but 4 of these were low-intensity storms with short tracks and 1 was a high intensity storm that crossed the edge of the county for a very short distance (NWS 2011b). The tornado that caused most fatalities and damage was an EF5 with a track length of 33 miles and a path width of 0.75 miles.

Post-Disaster Survey in DeKalb County, AL

A post-disaster survey was conducted in DeKalb County on May 6-11, 2011. The primary location for conducting surveys was the Federal Emergency Management Agency (FEMA) Disaster Center field office facility that was established in the city of Rainsville (population 5,041; U.S. Census Bureau 2011b) for processing disaster aid applications. The FEMA Disaster Center field office was a community center building with a large covered area at the main entrance, so tornado victims were approached as they exited the building after completing their applications. Although the intent was to survey every available tornado victim observed at the community center, five people declined to participate due to tornado-related fatalities/injuries in the family, some were not approached because they were visibly distressed, some declined because they were in

a hurry to attend to other business, and some exited before we were able to ask them to participate.

The survey form consisted of approximately 50 structured (multiple-choice) and open-ended questions on response to tornado warnings, preparedness, previous experience, perception, and demographics characteristics (Appendix 1). The survey process consisted of informing the potential participant of the purpose of the study and then, for those who agreed to participate, asking them the questions. Each survey lasted approximately 5-10 minutes, and 109 people were surveyed at the FEMA Disaster Center during the study period. In addition, 15 surveys were conducted in the field while evaluating damage to homes and other facilities in the county. Therefore, the total study group consisted of 124 local residents who were present during the tornado. Thirty-nine of the survey participants lived in a mobile home (32%), 82 (66%) lived in a site-built permanent home (i.e., traditional brick or wood-frame), and 3 (2%) lived in an apartment or non-traditional home.

The comprehensive design of the survey questionnaire resulted in the collection of a large amount of data that will take considerable time to analyze. For the purposes of this report, the permanent home residents and the apartment/non-traditional home residents were combined together to form a single group referred to as non-mobile home residents. The following sections provide the results of a preliminary assessment of the how well mobile home and non-mobile home residents were prepared for the threat of a tornado, and how they responded to the tornado warnings.

Preparedness for a Tornado Hazard

Mobile home residents were less likely to have some type of tornado-resistant shelter on the premises (e.g., basement) and were much less likely to have a plan for seeking shelter from a tornado (Table 1). Mobile home residents were more likely to have participated in a tornado drill than non-mobile home residents, but there was essentially no difference between mobile home and non-mobile home residents in the remaining three preparedness categories evaluated in this study: previous information on how to prepare for a tornado, understanding the definition of a tornado warning, and owning an emergency weather radio (Table 1). These results were also consistent with previous studies that found that most people are able to identify the definition of a tornado warning (Balluz et al. 2000), but that most people do not own an emergency weather radios for receiving tornado warnings (Balluz et al. 2000; Brown et al. 2002; Hammer and Schmidlin 2002; Comstock and Malone 2005). The low percentage of houses with a tornado-resistant shelter on the premises was also consistent with results found in Arkansas (12%) by Balluz et al. (2000) and in Oklahoma City (14%) by Brown et al. (2002).

When contrasted with non-mobile home residents, the mobile home residents in this study were slightly better prepared than those evaluated in Macon County, Tennessee, after the 2008 Super Tuesday tornado disaster (Chaney and Weaver 2010) However, as in Macon County, the mobile home residents were still more vulnerable in the two most important areas: 1) access to a tornado-resistant shelter and 2) having a plan for seeking shelter. Many studies have noted that tornado warnings are less effective if access to shelter is limited (Liu et al. 1996; Balluz et al. 2000; Hammer and Schmidlin 2002; Comstock and Malone 2005; and Schmidlin et al. 2009), so disaster management

and public health agencies should consider strategies to increase opportunities for mobile home residents to install some-type of tornado-resistant shelter.

Table 1. Preparedness characteristics of mobile home (MH) residents (n=39), and non-mobile home (NMH) residents (n=85).

	MH	NMH
Preparedness characteristics	% (n)	% (n)
Previous info	80 (31)	81 (69)
Tornado drill	64 (25)	54 (46)
Tornado warning definition	74 (29)	71 (60)
Emergency weather radio	36 (14)	32 (27)
Tornado-resistant shelter on premises	8 (3)	19 (16)
Emergency response plan	51 (20)	85 (72)

Balluz et al. (2000) found that having a plan of action was a positive indicator of shelter seeking behavior, so the large difference between the mobile home and non-mobile home residents in having a plan for seeking shelter is a critical problem that disaster management and public health agencies need to address. Furthermore, 45% of the mobile home residents with a plan intended to seek shelter at their house, which suggests that many of these plans were inappropriate. In contrast, 80% of non-mobile home residents with a plan intended to stay at their house, which is a much safer option given the increased protection provided by the structure. It is not clear whether the

mobile home residents who planned to take shelter at their mobile home were unaware of the risk or simply unconcerned, but this issue needs to be addressed through some form of public education program.

In order to better understand what factors might have motivated the mobile home residents with a plan for seeking shelter to develop their plan, we investigated the following areas: previous experience, personal perception, and basic socioeconomic characteristics. A few of the mobile home residents with a plan had previous experience with tornadoes (35%), but more importantly, most of those with previous experience had sought shelter from the tornado (86%). Most of the mobile home residents with a plan agreed or strongly agreed (65%) with the statement "except in extreme circumstances, my safety is under my control when a tornado threatens." This finding suggests that these people tend to have a high internal locus of control (see Tobin and Montz 1997 for further discussion). Slightly over half of the households had children living at home (55%), but only a few included members with disabilities (15%). Many had a high school education (30%) and some had additional trade school or college training (25%), but many had less than a high school education (30%). The majority of mobile home residents with a plan had an average annual household income of less than $40,000 (60%), but many people selected No Response for this question (30%).

Previous experience and high internal locus of control appear to play some role in motivating people to develop a plan for seeking shelter. It is not clear that any of the socioeconomic characteristics provided here were contributing factors. It should be noted that these results are based on a preliminary analysis of the data, and that a more

extensive evaluation in future will provide a more complete understanding of these relationships.

Response to Tornado Warnings

There was essentially no difference in the success rate of communicating the tornado warning to mobile home and non-mobile home residents (Table 2). Although the perception of danger was also the same for mobile home and non-mobile home residents, this finding is problematic given the established vulnerability of mobile home structures. These patterns were similar to the near-equal rates of communication success and perception of danger among mobile home and non-mobile home residents found at Macon County, TN. in 2008 (Chaney and Weaver 2010). On a positive note, the relatively high percentage of survey participants who perceived danger is encouraging given Schmidlin et al.'s (2009) research showing that perception of danger is a positive indicator of shelter-seeking behavior. The analysis of the sources of the warnings (e.g., TV, radio, phone call from friend or family member) has not been completed at this time, but one issue we are interested in investigating is whether the warning was received by a direct (e.g., TV broadcast) or indirect (phone call from friend/family member) source and how that influenced perception of danger and response.

For mobile home residents who were at home when they received the warning, 39% evacuated to some other location while 61% chose to stay at their home (Table 3). This evacuation rate was 14% lower than the 53% rate documented at Macon County (Chaney and Weaver 2010). Further analysis of the data will focus on attempting to explain this difference. The evacuation rate for non-mobile home residents was much lower at 17% than the rate for mobile home residents, which is to be expected.

Table 2. Tornado warning communication success rate, and perception of danger upon receiving the warning, for mobile home (MH) residents and non-mobile home (NMH) residents.

	MH % (n)	NMH % (n)
Received tornado warning:		
Yes	74 (29)	76 (65)
Perceived personal danger upon receiving warning:		
Yes	72 (21)	74 (48)

Table 3. Places where survey participants who were at home when they received the tornado warning took shelter for mobile home (MH) residents (n=23) and non-mobile home (NMH) residents (n=53).

	MH % (n)	NMH % (n)
Stayed where I was	61 (14)	83 (44)
Someone else's house (brick or wood-frame)	26 (6)	13 (7)
Public place or building	4 (1)	0 (0)
Public shelter	4 (1)	4 (2)

Automobile	4 (1)	0 (0)

Mobile home residents were only slightly less likely to follow their plan for seeking shelter (81%) than non-mobile home residents (86%). These rates were similar to those documented at Macon County at 76% and 94%, respectively (Chaney and Weaver 2010). It is encouraging to find that the rate for both groups was very high, which should provide additional support for disaster management and public health agencies in justifying efforts to develop public education programs.

Conclusions:

Mobile home residents were better prepared for a tornado than non-mobile home residents in 3 of the 6 categories evaluated. However, mobile home residents were less prepared in possibly the two most important categories: having a tornado-resistant shelter on the premises and having a plan for seeking shelter. Furthermore, 45% of mobile home residents with a plan intended to seek shelter at their mobile home, which is contrary to NWS recommendations. Factors that were associated with developing a plan included previous experience in seeking shelter from a tornado, and possessing a high internal locus of control.

A relatively high percentage of both mobile home and non-mobile home residents perceived danger upon receiving a tornado warning. However, mobile home residents should be expected to have a greater sense of danger given the limited protection provide by the mobile home structure. Less than one-half of mobile home residents evacuated the mobile home and sought shelter elsewhere. However, time-constraints or other factors

most likely influenced this response. Although these findings are based on a preliminary assessment of the survey data, they clearly identify several areas that disaster management and public health agencies should focus on in developing educational or other programs to reduce vulnerability among mobile home residents.

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Literature Cited:

Ashley, W.S. 2007. Spatial and temporal analysis of tornado fatalities in the United States: 1880-2005. *Weather and Forecasting* 22: 1214-1228.

Balluz, L., L. Schieve, T. Holmes, S. Kiezak, and J. Malilay 2000. Predictors for people's response to a tornado warning: Arkansas, 1 March 1997. *Disasters* 24 (1), 71-77.

Brown, S., P. Archer, K. Kruger, and S. Mallone 2002. Tornado-related deaths and injuries in Oklahoma due to the 3 May 1999 tornadoes. *Weather and Forecasting* 17, 343-353.

Chakraborty, J., G. A. Tobin, and B.E. Montz 2005. Population evacuation: assessing spatial variability in geophysical risk and social vulnerability to natural hazards. *Natural Hazards Review* 6 (1), 23-33.

Chaney, P.L. and G.S. Weaver 2010. The vulnerability of mobile home residents in tornado disasters: the 2008 Super Tuesday tornado in Macon County, Tennessee. *Weather, Climate, and Society* 2: 190-199.

Comstock, R. D., and S. Mallone 2005. Comparing reactions to two severe tornadoes in one Oklahoma community. *Disasters* 29 (3), 277-287.

Golden, J.H., and C.R. Adams 2000. The tornado problem: forecast warning, and response. *Natural Hazards Review* 1, 107-118.

Hammer, B., and T. W. Schmidlin 2002. Response to warnings during the 3 May 1999 Oklahoma City tornado: reasons and relative injury rates. *Weather and Forecasting*, 17, 577-581.

Hart, J.F., M.J. Rhodes, and J.T. Morgan 2002. *The unknown world of the mobile home*. The Johns Hopkins University Press, 142 pp.

Kusenbach, M., J.L. Simms, and G.A. Tobin 2010. Disaster vulnerability and evacuation readiness: coastal mobile home residents in Florida. *Natural Hazards*, 52, 79-95.

Lindell, M.K., J-C. Lu, and C.S. Prater 2005. Household decision making and evacuation in response to Hurricane Lili. *Natural Hazards Review* 6 (4), 171-179.

Liu, S., L.E. Quenemoen, J. Malilay, E. Noji, T. Sinks, and J. Mendlein 1996. Assessment of a severe-weather warning system and disaster preparedness, Calhoun County, Alabama, 1994. *American Journal of Public Health* 86 (1), 87-89.

Montz, B.E. and G.A. Tobin 2003. Hazardousness of the Tampa region: evaluating physical risk and socioeconomic vulnerability. *Papers of Applied Geography Conf*erences 26, 380-388.

Morrow, B.H. 1999. Identifying and mapping community vulnerability. Disasters 23 (1), 1-18.

NOAA 2009. Thunderstorms, tornadoes, lighning, nature's most violent storms. National Oceanic and Atmospheric Administration NOAA/PA 99050, 16 pp.

National Weather Service Forecast Office, Birmingham, AL. 2011a. Preliminary tornado track map from the April 27 tornado outbreak. Historic tornado outbreak, April 27, 2011. http://www.srh.noaa.gov/bmx/?n=event_04272011. Last accessed: August 03, 2011.

National Weather Service Forecast Office, Huntsville, AL. 2011b. Preliminary tornado track map from the April 27 tornado outbreak. http://www.srh.noaa.gov/hun/?n=stormsurveys_summary. Last accessed: August 03, 2011.

Schmidlin, T.W., B.O. Hammer, Y. Ono, and P.S. King 2009. Tornado shelter-seeking behavior and tornado shelter options among mobile home residents in the United States. *Natural Hazards* 48 (2), 191-201.

Simmons, K.M., and D. Sutter 2007. Tornado shelters and the manufactured home parks market. *Natural Hazards* 43, 365-378.

Simmons, K.M., and D. Sutter 2008. Manufactured home building regulations and the February 2, 2007 Florida tornadoes. *Natural Hazards* 46, 415-425.

Stormtrack 2011. April 26-28, 2011 Dixie Alley Tornado Outbreak…Greatest in history? http://www.stormtrack.org/forum/showthread.php?27627-April-26-28-2011-quot-Dixie-Alley-Tornado-Outbreak-quot-...Greatest-in-history. Last accessed: August 03, 2011.

Tobin, G.A. and B.E. Montz 1997. *Natural Hazards: Explanation and Integration*. The Guilford Press. New York.

U.S. Census Bureau 2011a. Population Finder: DeKalb County, Alabama. http://www.census.gov/. Last accessed: August 04, 2011.

U.S. Census Bureau 2011b. Population Finder: Rainsville, Alabama. http://www.census.gov/. Last accessed: August 04, 2011.