PUBLIC RESPONSE TO THE 10 MAY 2010 NORMAN, OKLAHOMA TORNADO

Sarah Louise Stalker[1, 2], Heather Lazrus[3], Kristin Kuhlman[4], Randy Peppler[4], and Kim Klockow[5]

[1]National Weather Center Research Experiences for Undergraduates Program
and
[2]St. Cloud State University

[3]Social Science Woven Into Meteorology
University of Oklahoma, Norman, Oklahoma

[4]Cooperative Institute for Mesoscale Meteorological Studies
University of Oklahoma, Norman, Oklahoma

[5]Oklahoma Climatological Survey
University of Oklahoma, Norman, Oklahoma

ABSTRACT

The purpose of this project is to gather initial actions and reactions from the public in response to the 10 May 2010 Norman, Oklahoma tornado. This is done in support of the National Severe Storms Laboratory's Warn-on-Forecast project for severe thunderstorm, tornado, and flash flood events. The tools and products that will be developed as part of the project are needed to improve warning for both the public and community stakeholders i.e. emergency managers, hospitals, and schools. This research study consisted of formally interviewing 6 individuals impacted by the May 10 storm and analyzing their responses. The majority of the interviewees did not feel any direct threat from the tornado during the early stages of storm development and advisories. Interestingly, with a longer lead-time promised by Warn-on-Forecast, most said they would still probably wait to obtain more information before taking any form of shelter or enact a safety plan. Most of the participants said it would be beneficial to see the expected track information Warn-on-Forecast will provide to help make their decisions on whether they felt the need to take safety measures. The results in this study will help to aid the National Severe Storms Laboratory in further development of the Warn-on-Forecast system with respect to public perspectives on longer lead times and other information needs.

1. INTRODUCTION

Less research has been done to examine public response to tornado warnings in comparison to that of other natural hazard warnings (e.g., Golden and Adams 2000). First to understand the public response, we need to have respect for what public really means. The pubic population can be examined as separate demographic factors such as race, ethnicity, age and gender. In reality each member of the public has some mixture of these demographic factors (Phillips and Morrow 2007). Demographic variables are important to consider because they may indicate different vulnerability characteristics. Next, to understand what the public knows about and does in response to tornado warnings, several research methods can be employed, including direct questioning of those who have personal experience with tornado warnings. Most often anonymous surveys are used to research warnings after a hazard event (Simmons and Sutter 2008). However, these efforts have not provided us with the complete picture as to why

[1] *Sarah L. Stalker*
407 Jordyn Lane
Hudson, WI 54016

the members of the public acted the way they did in the heat of the moment; individual interviews are a way of providing this insight.

Approximately 36 minutes, on average, of a US person's time is spent in a tornado warning over the span of one year (Erickson and Brooks 2006). Although this is a statistical average, it indicates that tornado warnings are a nontrivial component of the average American's life each year. The current average warning lead-time on a tornado is 13 minutes (Stensrud et al. 2009). This lead-time of was as low as 0-3 minutes in 1978 (Golden and Adams 2000). Thus, there have been significant improvements in our ability to warn with additional lead-time, primarily through advances in technology such as Doppler Radar. Simmons and Sutter (2008) have found the average warning lead-time increased 4.2 minutes after the WAR-88D was installed by the NWS.

Currently the National Weather Service (NWS) uses a "warn-on-detection" method to initiate warnings. This means tornado warnings are issued based on observations such as indication by radar, or rotation seen by spotters (Stensrud et al. 2009). The National Severe Storms Laboratory (NSSL) is now developing a next-generation Warn-on-Forecast (WoF) system to take this a step further. WoF seeks to increase lead-times for convective scale severe weather alerts, including severe thunderstorm, tornado, and flash flood warnings by using prediction data primarily generated by numerical forecast models (Stensrud et al. 2009). The lead-time anticipated from the WoF is estimated to be as much as 1-2 hours and is expected to be ready for deployment by the year 2020. One of the questions the NSSL is looking to answer now is if the public actually wants or needs more lead-time, and if so, what would they do with it. Ultimately, tornado warnings serve to increase the probability of public safety, so although emergency managers, public officials, and media personnel all rely on warnings, at the core of the issue is learning what the public actually hears and the actions they take according to what they are hearing. This will help tell WoF researchers whether or not longer lead times for tornado warnings will help promote the protection of life and property.

The few studies that have examined how much lead-time the public wants have revealed mixed results. In one study (Ewald and Guyer 2002), school administrators said on average the ideal lead-time was approximately 18 minutes, with a minimum of 3 minutes maximum of 60 minutes. Hospitals and assisted living facilities indicated that on average the ideal lead-time was approximately 34 minutes, stating daytimes might only need 10-15 minutes where as at night 20-30 would be needed because of staffing. However, this work does not provide information about responses from member of the public outside of the very particular responsibilities of a few user groups. The empirical study done by Simmons and Sutter (2008) indicated a lead-time of about 15 minutes resulted in fewer fatalities than did a lead-time of longer than 15 minutes; however, this work does not take into account the rating of the tornado on the Fujita scale. Latter research, by Simmons and Sutter (2009), state that after a certain point, longer lead times do not seem to be effective. Doswell (1999) states, " It's possible that longer lead times would be less effective because they might not convey a strong enough sense of urgency." Alternatively, longer lead times could allow for the evolution of new warning response paradigms that do not currently exist.

The purpose of this project is to gather initial actions and reactions from the public, with regards to the 10 May 2010 tornado that began in Norman, OK and dissipated just south of Pink, OK. Individual interviews were used as a way to elicit in-depth responses to questions of decision-making in response to tornado warnings. Responses that suggest such actions include finding shelter; calling family and friends to relay information, or even altering their day to pay more attention to weather.

2. BACKGROUND

Studies have found that the public may believe it understands more than it really does about weather-related risks (Wong and Yang 2002). It is important for researchers to understand what the public knows about and does with tornado warnings for the WoF concept to be most beneficial. Risk perception, as described above is a key factor in the decision making of the public. Human beings have invented 'risks' to help them

cope and understand dangers and uncertainties in their lives (Slovic and Weber 2002). Knowing what people think their risks are will be beneficial to those providing and distributing the warnings by being able to address them in advance. Although most of these studies are not tornado focused, the processes described inform hypothecs regarding tornado events as well.

One key to understanding the decision-making process of a person responding to a warning is noting the entire chain of communication involved in the warning process (Sorensen and Mileti 1987). Three categories for classifying evacuation actions for hurricanes and reactions of the public were established by Riad et al. (1999); these include: 1) risk perception, 2) social influence, and 3) access to resources. These three categories follow into the research of Sorensen and Mileti (1987), who indicated that the ability to interpret the impending event, communication with others directly and indirectly, perceived impacts of the warning, and exogenous parameters all influence individual decision-making. Risk perception fits in the category of ability to interpret the impending event. Certain cloud formations may mean a tornado to some and rain to others, for example. The variation in the ability to interpret the event may cause people to over-or underestimate the seriousness of the event (Sorensen and Mileti 1987). This variation in perception and interpretation can influence a person's ability or preferences regarding protecting themselves, their property, and family (e.g., Riad et al. 1999).

Sorensen and Mileti (1987) take a deeper look at the communication between officials and the public, and the uncertainties that are inherent in that communication as well as other communication uncertainties. Social influence is a process by which an individual's notions of events, people or ideas are shaped by the opinions of those around them, carrying implications for their perception of risk through communication with those around them. An example is if someone calls his or her mother down the street and finds out the she is calm about the storm. This person may then feel less anxious or worried in response.

Perceptions about tornadoes can vary depending on stories they have heard about tornadoes, past experiences, preparations they make for tornado season, and even if they thought there was a chance of being impacted by a tornado (e.g., Danielson 1990). The Social Amplification of Risk Framework (SARF) details one way that risk perception, particularly, can be affected through social influence. This framework shows us that the communication of these risks can be initiated or passed from sender to receiver by "passing through" the other person's perceptions of the risk, amplifying or dampening it. This characterization of the personal experience of risk may include either direct or indirect experience through information received about that specific risk (Kasperson et al. 1988).

Knowing what social influences people have and how these affect their decisions will also give the warning providers insight on how to communicate a warning that will elicit the best response. These providers of weather information such as television and radio stations, and Internet sites, may be able to use such information to help target a certain segment of the population that may not be getting addressed properly. For example, evacuations, or responding to a warning, can vary depending on the networking size of a particular person (Riad et al. 1999). They also could understand what ends up getting passed down the chain as risk perception amplifying, in situations where such strong response is desired.

The entire warning process involves more aspects than just the forecasting step. The warning process also is influenced by developers who construct the models used, emergency managers who distribute the warnings and turn on sirens, media, other officials who distribute the warnings, and the people who use the warnings. This study focuses on the end-users of the warning process. Based on the literature in risk communication and social amplification of risk in hazards, it is hypothesized that with extra lead-time, the public will take the time to prepare for the oncoming storm. Further, a secondary hypothesis arises through the recent work connected to the field of meteorology that there might be an optimal threshold of lead-time, after which the public will no longer react.

3. DATA AND METHODOLOGY

Interviews were conducted to collect the data for this research. Descriptions of the selection of the population sample, topics covered, and coding used to analyze the data follow.

3.1 Survey Population

The population of this study consists of residents of the Norman, OK area affected by the 10 May 2010 tornado. Subjects under the age of 18 were not permitted to participate in the interviews. Each interview lasted approximately 35 minutes, with the shortest being 20 minutes and longest being 45 minutes. Different types of professional backgrounds as well as a 50-50 female to male ratio are included in the sample. Six people ultimately participated in this interview process. The American Red Cross and the Facebook Group: 'I Survived the May 10, 2010 Oklahoma tornado Outbreak!' served as the initial sources of the sampling. From there, snowball sampling served as a means for gathering more samples for the study. Snowball sampling, or chain referral sampling, takes place when potential participants are identified by current participants (Mack et al. 2005). An initial e-mail or letter was sent to potential participants with contact information to set up an interview.

3.2 Interviews

Interviews were conducted at times convenient to the participant. They were held at one of two places: the National Weather Center, Norman, OK, and the Tecumseh Public Library, Tecumseh, OK. There are pros and cons with face-to-face interviews (e.g., Bernard 2006). Face-to-face interviews have the potential to elicit rich information not necessarily available via more impersonal data collection methods. Also, the person conducting the interview is able to clarify questions the participant might have that otherwise might not have been answered in a survey. The main reason we used face-to-face interviews here is that they allowed us to probe for more in-depth answers and the reasons why the participants took the actions they did. Cons are that face-to-face interviews are intrusive and reactive. They require a time commitment from the participant. Allowing the participants to choose the time and location that would work best for them help address this. Another time cost is how many participants the researcher has time to interview. Questionnaires can be sent out thousands at a time, while interviews can only be done one by one.

3.3 Interview Topics

The interviewees were asked questions in the following categories: setting before the storm, perceptions about tornadoes, communication about the storm before it hit, interpretation of the information they received about the warning, actions taken once becoming aware of the warning, and lastly a reflection question. Included were specific questions about their day, what they were feeling before and after the tornado as well as where they received information about the storm, if at all. At the end, they were asked to explain what they might have done if they had a longer lead-time. A full list of the questions can be seen in Appendix 1. The responses were then analyzed using thematic analysis to find common perceptions and actions taken. We also asked them what alerts they heard -advisory, watch or warning- and their resulting actions and reactions to them. This is crucial to understanding why they may have acted the way they did.

3.4 Thematic Analysis

Thematic analysis involves identifying themes in the interview transcripts, doing it reliably, developing codes, and interpreting the information and themes in the context of a theory or conceptual framework. Boyatzis (1998) states, "A theme is a pattern found in the information that at the minimum describes and organizes possible observations or at the maximum interprets aspects of phenomenon." Using thematic analysis worked well with this study since the interview protocol was already split into topical (thematic) categories.

Sorensen and Mileti's (1987) categories of decision-making are used as the main themes and the interview categories are used as subthemes for analyzing the data. The coding used for this project is deductive coding; it is an analysis of the text that uses a hypothesis before the coding begins (Bernard 2006). This methodology allows testing the validation of the initial actions and

reactions from the public, with regards to the 10 May 2010 tornado event. This method also allows the participants to speak for themselves and really tell us the story.

4. RESULTS

4.1 Storm Background

10 May 2010 was an active day in Oklahoma in terms of severe weather and tornadoes. A total of 43 separate tornado reports have been submitted to the National Weather Service in Norman, Oklahoma (D. Speheger, 2010, personal communication). This was the second largest outbreak in Oklahoma in recorded history, the largest occurring on 3 May 1999.

The first tornado warning for Cleveland County was issued at 4:47pm. An extended warning was then issued at 5:26 pm, which included Norman. Prior to this warning, 16 other tornadoes had been reported in Oklahoma. The Norman tornado was first spotted at 5:32pm and ended about 23 miles to the northeast at 5:57pm (Figure 1). This indicates the storm was moving at approximately 55 mph, a relatively high rate of speed.

Figure 1: Tornado tracks near Norman on 10 May 2010. Graphic Courtesy of the National Weather Service

During the preceding week, the Norman NWS Forecast Office already had an idea about the possibility of severe weather (Fig 2). As days progressed, the target, location, and timing of severe weather narrowed to a specific day of the week (Fig 3). As Monday morning (10 May) approached the NWS had high confidence regarding storm potential across the state that day (Fig 4).

Figure 2: Graphicast issued Tuesday May 4 2010 2:50 am by the National Weather Service, Norman, OK Office.

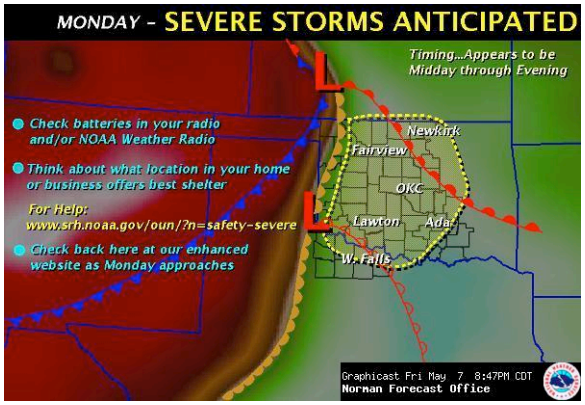

Figure 3: Graphicast issued Friday, May 7, 2010 8:47 pm by the National Weather Service Norman, OK office.

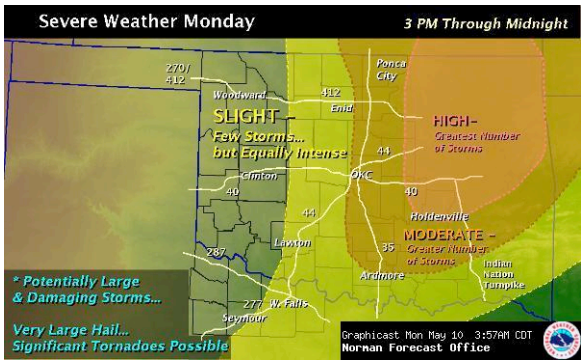

Figure 4: Graphicast issued Monday, May 10, 2010 3:57 am by the National Weather Service Norman, OK office.

The following describes the results from interviews regarding experiences the public had before and after the F4 tornado passed their location.

4.2 Perceptions and Preparedness For Tornadoes

The sample provided five people who have never been in a tornado and one that has.

Those never in one still had been around them at some time in their life. No interviewee indicated they were scared of tornadoes.

Some of the interviewees described folklore to explain why tornadoes do not happen in their area. Some of those stories seemed to hold true for the subject until the 10 May 2010 tornado. One person described what he had heard. “Chief Tecumseh put a good curse on the town and said there would never be a tornado inside the city limits.” If it wasn’t folklore that eased their minds, it was the perception of where tornadoes tend to move. Most participants stated tornadoes tend to move north, or northeast. Also as the interviewees described the direction that tornadoes tend to move, they suggested that geographic regions and landmarks, such as rivers and lakes, prohibited them from moving through certain regions. “When it gets around Lake Thunderbird, they usually turn further north and it goes more towards Shawnee area, it just kind of takes that track.”

Each person interviewed had a ‘plan’ for tornado season. These plans included paying attention to the weather more often, talking with other members of their household about the designated shelter spot in the house and having supplies ready in case a storm hit. However, none of the individuals interviewed in this study had a storm cellar.

4.3 Communication About the Storm Before it Hit

There was only one person out of the six that had heard any information on storm potential prior to Monday, 10 May 2010. This person heard about the possibility of severe weather from the television but did not seek additional information at the time. By Monday, 10 May 2010 three of the participants had heard about the possibility of the storm before the tornado siren. Of those, all sought out more information from television, Internet, or talked to family and friends to seek more information about the potential of their own risk. “I was told from people at the office that after 5-oclock you don’t want to be away from your house.” When asked their feelings about when they hear the phrase tornado warning, the consensus was none of them felt really anxious, and they all tried to gather more information about the storm. Specifically they would try to find the information of where the tornado was and what track it was taking to determine if they were in immediate danger or in the path of the storm.

4.4 Interpretation of Warning Information

“I am not aware that we really appreciated that there was a tornado warning for our area…” None of the respondents had heard any watch or warning alerts while watching the television. For three, the first thing that alerted them was the sirens while for the other three it was destruction from the tornado seen on television, or the howling freight train noise that spiked all of their interests. One said, “I didn’t realize it was that bad until I heard tornado sirens.” While another stated, “You could hear the freight train sound before anything.” All of the participants seemed to understand that severe weather is prominent in Oklahoma, but they all said the chances of it hitting them directly was slim, so they do not worry about it generally. However, this changed. Each participant had their own time of threat and gathered more information about the storm now feeling they could be affected directly.

Everyone was affected directly or indirectly by the actions and reactions of others. “Seeing people outside kind of comforted me. I felt better off knowing they were outside and that I was better off then them I think.” When asked, a woman responded about her child, “I couldn’t reassure her because I didn’t know what was going to happen. So I think she got the sense of fear about tornadoes from the experience.” Owing to communication through family, friends, or media everyone developed perceptions about the storm risk and the threat they felt they were in. Another participant said “As a result of it [storm information on Monday, May 10] my wife was at home and she was unhappy so I hurried home.”

4.5 Actions Taken Once Aware of Storm

Three participants took some type of shelter, such as, inside room closet, hallway, or basement. Everyone said they had a lead-time that was approximately 15 minutes. However, not everyone acted as soon as they first heard of the threat. “What strikes me is how fast that thing came from there [Norman, OK] to Little Axe…”

This was another common response in all of the interviews. “It passed pretty quickly I mean a matter of seconds.” When the question of longer lead-time was asked, all said they would now take action sooner, given what happened on May 10. If they had the longer lead-time of 1-2 hours from WoF, they indicated they would have tried to find out more about the track the tornado was going to take before taking safety actions.

4.6 After the Tornado

Interviews were conducted within three months after the May 10 tornadoes, allowing me to capture participants’ reflections on their experience. The question was posed, would they do anything differently if another event like this were to happen? Five said yes there was something they would do differently. These include: build a storm shelter, act sooner for safety, take safety precautions more quickly, or just make sure they had proper clothing attire and identification. “I might actually introduce myself to the first floor neighbors just to have some place to go, just in case.” One said, “I probably wouldn’t do anything different. I would probably be watching more outside. Another said in reference to proper clothing, “I was in the closet, with shorts and no shoes….I wish I had more protection there even a pair of slacks and shoes.” Of those saying they will be building storm cellars, they have indicated it is in the family plan to be done soon.

In asking about the one to two hour lead-times, it was found it is not necessarily the amount of lead-time that is needed but rather it is the amount of information that is given to the public. These participants said it would be more beneficial to see the predicted path of the storm more than a lengthier warning period. One stated “I am not pointing fingers, but if we would have seen a directional track…If I had seen our area in the arc at the point that the truck spun out we would have left.”

5. DISCUMSSION AND SUMMARY

This study was conducted to gauge initial actions and reactions to the 10 May 2010 Norman, OK tornado. The major research questions addressed are: what do people seek in terms of information when severe weather is in their area, what are their actions and reactions to it, and what would they do if they had a one or two hour lead time. It was found that there is not one dominant source people use for information about severe weather but as other research has suggested multiple sources are sought by those affected.

Responses to the 1-2 hour lead time, question tell us it is not a matter of amount of lead-time that is wanted, it is a spatial outlook that would then give them information to make a safety decision. This way they can see the predicted trajectory of the storm relating it to their position. Figure 5 provides the conceptual model of WoF, which could be one way of providing this information to the public.

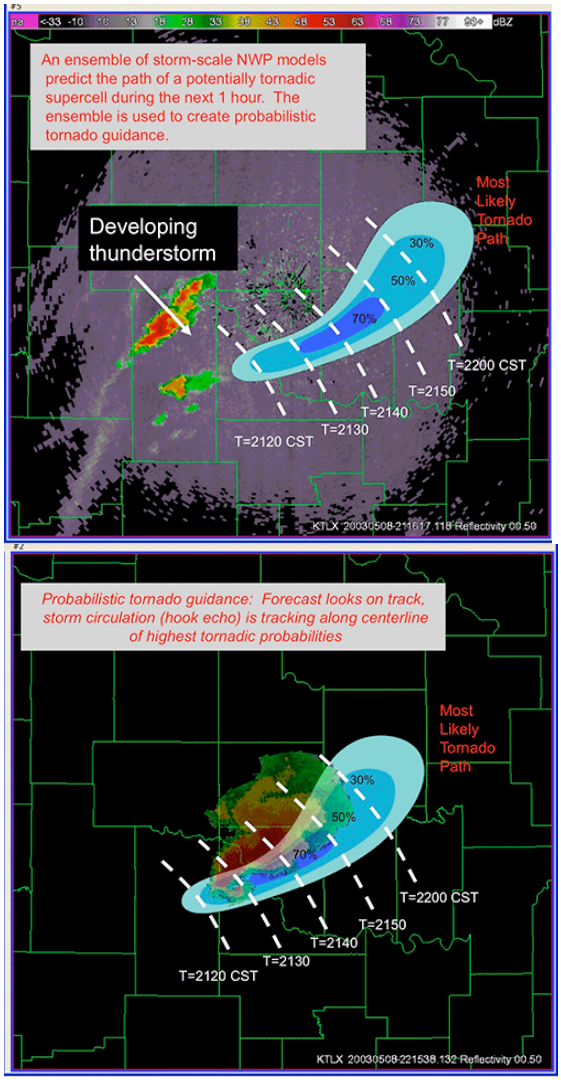

Figure 5: Warn-on-Forecast conceptual model

Actions regarding severe weather and tornado activity do follow the social amplification of risk framework. As stated above, social amplification is the experience of risk, directly or indirectly. Each person who participated in the interviews had their own perception of risk. If the person heard about the storm through co-workers, family, television, or Internet, they were either directly or indirectly communicated to. This was demonstrated by the quote "Seeing people outside kind of comforted me. I felt better off knowing they were outside and that I was better off then them I think."

Each of these means of communication validated Sorensen and Mileti's (1987) decision-making categories. The first category of interpreting the event was shown with the response about none of the interviewees feeling threatened by tornadoes. They all are used to them being in the area all the time so they may act numb to the situation. The second category, communications, played an important role in all of their decision-making. From a wife calling her husband asking him to come home, to being told not to be away from the house after 5 pm, these examples are directly related to communication uncertainties that will then affect the decision one makes about the impending event. The next category, perceived impacts of the warning, is concluded to affect warning decision-making by the response to the additional lead-time question. Each person had their thoughts of what the warning or the siren was saying and they sought more information. When asked if given more time they said they still would have waited to gather more information. The last category of exogenous influence came with time availability. Since the storm was moving so quickly this affected the way the participants were able to react to it. Decision-making is event dependent and can have more uncertainties in one category and less in others, but each of the categories that Sorensen and Mileti (1987) bring to our attention hold true for this tornado event.

Questions have arisen with whether this study has regional bias. To address this, interviews need to be done in many different regions around the country.

ACKNOWLEDGMENTS

This work was prepared by the authors with funding provided by National Science Foundation Grant No. ATM-0648566, and NOAA/Office of Oceanic and Atmospheric Research under NOAA-University of Oklahoma Cooperative Agreement #NA17RJ1227, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, NOAA, or the U.S. Department of Commerce.

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APPENDIX A: Interview Guide

Introduction:

First, thank you for taking the time to talk to me today. I have never experienced a tornado event, so I am very interested to hear about your experiences with it as part of my summer research project. So for each of the questions I am about to ask, describe **every detail** to me that you feel is important to understand what it was like for you. There are no right or wrong answers, make me, if you can, feel like I was there with you.

Setting before the storm:

- To begin, I'd like to ask you a few questions about yourself so I can understand what you went through.
    - What do you do for a living?
    - Neighbors
    - Family
        - [Ages of children]
    - Hobbies
- What sources do you usually consult regarding severe weather?
    - (Television, radio, internet, friends etc…?)

Perceptions about tornadoes:

Previous research has shown that tornado stories are common place in this part of the country as contemporary oral tradition and play an important role in how people communicate about, and deal with a tornado risk:

- Have you had any previous experience with a tornado?
    - If so, can you tell me about it?
- Do you know of any folklore about the risk of tornadoes in the place you live?
    - Are there places where tornadoes do and do not hit?
    - What is this knowledge based on?
        - [Religious, Tribal, Passed-down stories, etc…]
- Do you do anything to prepare for tornado season?
    - [Make storm shelter, weather radio etc…]
- How does it make you feel when severe weather is around?
- Before this tornado event, how likely did you think it was that you might be hit by a tornado someday?

Communication about the storm before it hit:

- Had you heard anything about the possibility of severe weather before Monday?
    - When?
    - How? (Radio, television, internet, social network etc…)
    - How seriously did you heed this information – did affect your plans that day?
- Did you talk to anyone about storm potential before Monday?
    - How did you have contact with these people (phone, text, internet, etc…)?
    - How frequently did you talk to people about the threat of severe weather?
- Could you tell me about your day on Monday, May 10th, the day of the tornado, before storms were developing?
    - [How did that day begin?]
- Did you try to gather more information about the threat of severe weather?
    - What sources of information did you turn to?
    - What were you finding out?
- Have you heard the terms "watch" and "warning"?
    - What do you feel/think when you hear the word 'watch'?
    - What do you feel/think when you hear the world 'warning'?
- What were you doing, and where were you, when the storms first played a role in your day?
- What sorts of 'alerts' were you receiving before the storm hit?
    - What?
    - When?
    - How?

Interpretation of the information you received about the warning:

- When you first heard the […...]:
    - What was the first thing you thought of?
        - What else came to mind?
    - What did you think was going to happen?
        - Why did you think this?
    - What do you usually feel/think when you hear the word […...]?
- What sorts of environmental cues (direct environment) were you picking up on about your potential for risk?
- Were there any cues from [broadcast media, friends, Internet, etc.] that affected your view of your potential for risk? If yes, which?

- Did you feel directly threatened in any way?

Actions you took once you were aware of the warning:

- What did you do when you heard the […….]?
    - Why?
- Did you contact anyone to alert them about the storm?
- Did you seek and take a form of shelter? [Storm shelter, bathtub, basement etc…]
    - Why did you pick this form?
    - How long after you heard the warning did you go?
    - What made you act at this specific time
    - If you did not seek shelter, was there a specific reason why?
- What was the one thing you made sure you did?
- How much lead time did you have?
    - How do you feel about the lead time you had?
    - Realistically, would you have done anything differently if you had found out about the [.…….] earlier? What?
        - What if you had 1hour… or 2 hour lead time?
- Do you have children and/or pets?
    - How did their actions/reactions affect what you did?
    - How did they make you feel?
- Can you tell me about how other people's actions affected your actions?
    - [Did you react specifically from others actions?]
    - [Did the way others acted affect your emotional feelings?]
- What happened during the tornado?
    - What did you see or hear?
- When it was over, what went through your mind?
    - [How did you feel when it was over?]
    - Can you tell me about the others people's reactions around you when it was over?
    - How did those make you feel?
- Who was the first person you talked to when it was over?
    - How did you communicate to this person?
    - Tell me how that conversation went…what did you say to each other?
    - Did you try to communicate with others?
        - If yes, How?

Reflection since the event:

- Now that you've had time to think about the May 10th tornado, would you do anything different if something like this happened again?
    - What would you do differently?