2. 6 PUBLIC WARNING RESPONSE FOLLOWING TORNADOES IN NEW ORLEANS, LA, AND SPRINGFIELD, MO: A SOCIOLOGICAL ANALYSIS

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ABSTRACT[1]

This study examines public response to tornado warnings through an application of the framework laid out by Mileti and colleagues (2000). A qualitative approach was adopted to supplement our knowledge of public warning response with detailed descriptions of how individuals interpret and react to risk information. Following tornado outbreaks, data were collected from individuals in regions surrounding New Orleans, LA, and Springfield, MO, using in-depth interview guides. As each region is characterized by significant diversity, researchers developed a purposive sampling strategy to ensure the collection of representative data. Interviewees (n=40) were asked about how they received, interpreted, and responded to warning information. Researchers then used content analysis to analyze these data in order to evaluate and supplement Mileti's model. Ongoing analysis confirms Mileti's model, yet reveals a high degree of complexity with regard to a) stage transition, b) interaction and communication, and c) social factors. Findings from this study will contribute to the development of quantitative models intended to establish end-user policies. These policies will guide the deployment and use of radar technology currently under development by the Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). From a forecasting perspective, findings suggest that a meteorological approach to public safety could be greatly augmented through the incorporation of social science methods and data. For instance, paying greater attention to how cultural myths about tornado threats shape risk communication could improve the effectiveness of watches and warnings.

1. INTRODUCTION

We possess few empirical records documenting how socio-cultural factors affect public response to tornado threats (Donner 2006; Mitchem 2003; Balluz et al 2000; Aguirre 1988; Legates and Biddle 1999, Schmidlin and King 1998). Partly to address this problem, qualitative data were collected using in-depth interviews with respondents in New Orleans and southwestern Mississippi following tornado touchdowns in each region. Data were organized and interpreted by using Mileti's model of warning response (1999), which incorporates research on disasters, communication, and risk perception. Findings shed much light on warning system design difficulties, diagnose future complications, and suggest ways to guide radar development in a manner consistent with end-user needs.

2. PROBLEM

When warnings are issued, research demonstrates that a considerable number of people will not respond, react too slowly, or take incorrect steps towards protecting themselves. Meteorologists, engineers, and public officials attempt to mitigate these problems through the development of new technologies. In itself a necessary but insufficient solution, this approach remains unchallenged among scientists and policymakers despite our understanding of how social factors influence risk perception, communication, and protective action. Many public officials, moreover, consider public

response a problem of individual choice (Sorenson 2000). A potential outcome of ignoring social factors is that the technologies we develop will fail to offer sufficient protection to communities. The objective of this research is to develop an understanding of non-technological (e.g., social, psychological, economic, etc.) features of warnings systems often at the root of response problems and solutions.

3. LITERATURE

From a sociological perspective, the principal problem of warning response lies at the level of interpretation, interaction, and protective action. In order to address these issues in a more systematic fashion, Mileti (1999) summarizes the work of Mileti and Sorenson (1990) and Perry and Lindell (1992) into a generalized model of warning response applicable to a wide range of disaster agents. The model is used to interpret and organize the data colleted in this research. Principal components of the warning process, according to Mileti (1999), include:

1) Receiving a warning
2) Understanding the warning
3) Believing the warning is credible
4) Confirming a threat
5) Personalizing a threat
6) Determining whether protective action is needed
7) Determining whether protective action is feasible

With the problem of reception, it is important to consider that the public is likely to hear warning messages via the mass media or television (Schmidlin and King 1997). While the mass media appears, however, to have become an important means of communicating warning information, one should still bear in mind that it is through multiple channels that a warning message is most likely to reach its intended audience (Lindell and Perry 1987).

Research also reveals a trend among some warning recipients to misunderstand the instructions or misinterpret the meaning of warnings (Blanchard-Boehm 1998). In some cases, degrees of understanding vary according to the number of channels through which a warning is conveyed, as well as the attributes and characteristics of those channels. There is some evidence, for instance, that the public experiences difficulties comprehending warnings conveyed solely by way of sirens (Tierney 1987; Lachman, Tatsuoka, and Bonk 1961). That multiple sources of warning increase chances of comprehension is consistently observed in studies (Mileti and Darlington 1995, Mileti 1975).

When it comes to belief, evidence indicates that one's proximity to a given threat also shapes warning response: a closer location to the threat for which the warning was issued elicits greater credulity (Sorenson 1982; Diggory 1956), which, admittedly, may simply result from exposure to an upsurge of environmental cues (Hammer and Schmidlin 2002; Mileti 1993; Tierney 1987; Saarinen and Sell 1985; Sorenson 1982; Quarantelli 1980, 1984; Drabek 1969). Further findings suggest that *how* information is conveyed determines whether someone will believe the warning. Specific information is preferred over general information (Carter 1980, Greene, Perry, and Lindell 1981, Fritz 1957; Perry, Lindell, and Greene 1980; Perry, Lindell, and Greene 1981; Perry 1979), and studies point out that *official* sources, such as government and media, enhance the potential for belief (Drabek 1994; Rogers 1985; Perry, Green, and Mushkatel 1983; Sorenson 1982; Perry, Lindell, and Green 1981; Flynn 1979; Drabek 1969). In spite of such observations, nevertheless, other researchers make a strong case that warning belief is enhanced within personal channels or through the actions of "significant others" (Clifford 1956; Li 1991; Perry and Greene 1983; Nigg 1987; Sorenson 1982).

Researchers observe a common tendency to confirm questionable or uncertain information. What conditions present the need to verify warning messages? Interestingly enough, the more times one receives warning information, the more likely one is to confirm it (Nigg 1982). Additionally, those in possession of information confirming the threat are more likely to believe and/or personalize a warning message (Perry and Greene 1982). Indeed, it is often through personal channels that warning information is confirmed: Kirschenbaum's (1992) study of public response following a major gas explosion in Israel found that a majority of those who attempted to confirm official information did so not through formal channels (e.g., police), but through immediate neighbors.

Acknowledging the presence of a risk, however, is not tantamount to believing that one personally is at risk. In many cases, warning

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messages fall short of eliciting response simply because the risk they convey is too uncertain and abstract. Before action is taken, one must define oneself as "at risk"—one must "personalize" a risk. It is such personalization that so often takes the form of social behavior. Repeated studies of earthquake response, for instance, demonstrate that one's likelihood of preparing for a disaster increases when others are seen as doing so (Mileti and Darlington 1997; Mileti and Fitzpatrick 1992). Mileti and Darlington (1998) write, "Our most robust conclusion is to underscore the value of an interactionist perspective in explaining how actors convert new information into action." Confirmation of a message also makes people more likely to personalize it (Nigg 1987). If one does not find the source credible, one will not personalize the message (Perry 1979). Cues also play an important role in this process (Perry and Greene 1982).

An often overlooked feature of warning response is culture. Whereas some societies have been shown to develop strong "cultures of resilience" (Aguirre 2004), cultural acclimation to disaster is maladaptive in such cases where "threatening situations can be incorporated into the familiar schemes of 'normal' cultural problems [whereby] [t]he nature and degree of accommodating the schemes then becomes critical in analyzing the cultural adaptation to threatening situations and the consequences for structured behavior in crises" (Anderson 1968: 303). One can thus clearly believe that one is at risk, but, because one lives in a culture in which risk has become "normalized" or part of day-to-day activities, one makes no attempt to reduce the risk. Fritz's (1961) seminal article on society and disaster includes a brief description of how mining communities come to accept the common tragedy of mine collapses. Within these communities, little is done about mine collapses as they are viewed as inevitable.

Culture may also give rise to differing "styles" of response among groups. In their examination of the structural and cultural differences between volcano victims in the United States and Japan, Perry and Hirose (1991: 112) find that the Japanese were more likely to seek public shelter. Most notably, the researchers hypothesize that this may have been due to the difficulty of housing large families in Japanese households (which are traditionally small) and the existence in Japan of a "collectivist culture in which citizens have higher expectations that authorities will provide

care in the event of disasters or other disruptions in social life." Thus, the decision to access public shelter may be contingent on a number of factors, ranging from the physical characteristics of certain social groups, as well as dominant cultural patterns with respect to housing styles and cooperation. Some cultures may actively avoid engaging in protective behavior because of hegemonic control exerted through culture (Webb, Wachtendorf, and Eyre 2000).

The objective of the study is to describe the data using Mileti's model of warning response. Data are organized and interpreted according to each stage of the model. Findings will be used to propose new policy directions with respect to specific areas of the response process and offer suggestions on how to integrate this knowledge with radar technology currently under development by the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA).

4. DATA

Data were collected from communities located in regions surrounding New Orleans, LA, and Springfield, MO, immediately following tornado outbreaks. Both regions were selected due to the simultaneous a) occurrence of tornadic activity and b) activation of tornado watches and warnings. Researchers used in-depth interviewing techniques to collect data from residents in theses regions (n=40). Interviews were conducted as quickly as possible following an event in order to reduce the potential of interviewees forgetting important details of what occurred during the tornado. Participation was voluntary and verbal consent was obtained at the time of the interview to ensure that interviewees were aware of their rights as participants in the study.[2] The interview guide

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[2] Protection of human subjects is a key concern among social scientists and, as such, remains a principal goal for research conducted in nearly all university settings. The Office of the Vice Provost for Research (OVPR) at the University of Delaware requires proposed research to be approved by a Human Subjects Review Board (HSRB) or, alternatively, exempted from review by the Vice Provost for Research. The Office initiates full- or expedited-board reviews on the basis of the level of risk participants will face during the course of the study. As the level of risk was judged minimal for both the emergency manager and

was pre-tested and—due to a range of difficulties—modified following research on Hurricane Katrina conducted in early 2005. The interview guide consists of questions aimed at producing data relevant to the concepts outlined earlier in Mileti's model, including understanding warnings, belief, personalization, protective action, social networks, and resources.

Due to the demographic complexity of the region, a triangulated system of data collection was employed consisting of snowball, purposive, and convenience techniques. Convenience sampling involves gathering data from available interviewees, whereas snowball sampling selects participants through contacts identified by previous interviewees. During the data collection process, the researchers intended to generate a diverse sample of participants representative of the regions from which they were drawn. Attempts were made to target minority groups (African-Americans, Hispanics, low-income populations, the elderly, and so on) shown to face different, and, in many cases, more acute challenges when responding to warnings (see Mileti 1999 and Tierney, Lindell, and Perry 2001). Convenience and snow-ball sampling, however, cannot ensure adequate representation of these important groups and were accordingly supplemented by other approaches. Researchers used purposive sampling techniques, which allowed them to successfully gather data from a number of different racial, gender, and class groups. Two levels of analysis were used in the study. Some interviews were conducted with individuals. In other cases, interviews were conducted with all or a few members of a household.

Before proceeding, it is important to mention two difficulties researchers faced during the data collection process. First, sampling in the New Orleans area presented difficulties in obtaining interviewees. The interviews were conducted in late February, just months after Hurricane Katrina struck the gulf coast region. As it were, many potential interviewees were simply too busy repairing homes and businesses to participate. Additionally, during the interviews, it was often necessary to guide interviewees away from discussions of recovery

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public interviews, CASA has until now received expedited reviews from the Office. A prerequisite, however, regardless of level of risk, is informed consent: an ethical approach to research requires subjects to know the goals of a study, the risks they face, and their overall role as project participants.

and response to Katrina. Another problem observed in the Gulf Coast region, where there were many African-American communities, was obtaining interviews from African-Americans. Difficulties in interviewing minorities have been discussed elsewhere (Dunbar, Jr., Rodriguez, and Parker 2003). Adding to the mistrust may have been the poor treatment minority communities received prior to during the aftermath of Hurricane Katrina.

4.1 *New Orleans*

As with most major cities, New Orleans rarely sees tornadoes. On Februrary 14, 2006, however, the city, as well as its surrounding suburbs and towns, was to see the touchdown of three tornadoes. The majority of the damage occurred in Kenner, where the Louis Armstrong International Airport experienced significant damage. Other touchdowns occurred in Lakeview, a then nearly uninhabited area hard hit by Katrina, as well as a small suburb South near the river. No deaths or injuries were officially reported, but a number of those with whom we spoke revealed minor injuries such as cuts from glass. It should be noted that research in New Orleans was conducted just months after Katrina hit the gulf coast. As such, some of the towns and areas (Lakeview, for instance) investigated as part of the study were found largely uninhabited or occupied by residents unable to participate because they were involved in the cleaning-up and recovery process. Three communities were visited during our fieldwork: New Orleans, Kenner, Hahnville. Kenner is a small suburb of New Orleans. Hahnville, on the other hand, is a small suburban community approximately 30 to 40 minutes from the city.

4.2 *Missouri*

From March 9 through March 12th, a major tornado outbreak occurred in the Central United States. As a result of the storms, authorities reported 12 deaths and estimated $200,000 in damage to residential housing and businesses. Fieldwork took place in Springfield and the surrounding area wherein we visited the communities of Nixa, Marionville, and Battlefield, and Republic. In comparison to New Orleans, tornado warnings and watches are not uncommon in southwestern Missouri. This reflects a greater level of tornado activity in the region, but, as one interviewee put it, caused a

"numbness" among many residents to the warnings and watches regularly issued by emergency management, National Weather Service (NWS), and the Storm Prediction Center (SPC). During the outbreak, a total of 84 tornadoes were spawned from a supercell causing extensive damage across the region. In Nixa, a small town near Springfield, three injuries were reported along with 40 damaged homes. Near Battlefield, a smaller community, there were four injuries along with downed power lines, downed trees, debris damage, and homes destroyed near the major highway. Republic experienced the lightest damage of the five communities visited. Marionville by far experienced the most extensive damage: there were three injuries, one fatality and numerous houses destroyed. In Verona, there was one fatality and one injury with a one-mile track extending northeastward. Geographically, the areas researchers visited lie within or close to the Ozark Mountains, (in reality a misnomer as a majority of the Ozark region consists of highlands or plateaus), which is composed of the Springfield Plateau, the Salem Plateau, and the Boston Mountains. As will be seen, the importance of Southwestern Missouri's geography would emerge within the interviews.

5. FINDINGS

5.1 *Reception*

How did interviewees learn of the tornado threat? Official sources most commonly reached respondents first, albeit, in a considerable number of cases, indirectly through social networks. Social networks served as a principal means of receiving warnings, confirming warnings, and protective action in many communities. In fact, several interviewees in regions where the tornadoes struck may have remained unaware of the tornado hazard if not for communication with friends, family, and neighbors. Watching a pre-recorded television show at the time, for instance, one resident of Missouri only received notification of the storm when a neighbor, "*who tends to get nervous at storms*," called to inform him that warnings had been issued [QR-MO-5]. Another interviewee, living in a different community near Springfield, MO, recalled similarly receiving information by means of the community's social network [QR-MO-6]. In this case, had the interviewee not been told about the storm by a neighbor, he may have simply gone to bed. For those who rarely watch television, moreover, the importance of social networks cannot be overstated.

Interviews revealed the importance of understanding how social networks function during periods of heightened risk and uncertainty. Bound by what is known as *social time*, few make use of social networks to communicate warning information during periods judged culturally inappropriate. In the case of reception, this, in one case, led to the withholding of warning information: "*It was like the middle of the night. So, I didn't wanna wake anybody up…had I heard the train whistle, well maybe I would have called, but I didn't hear anything* [QR-NO-18]. Shared definitions of appropriate behavior regulate when and under what conditions communications can take place, and, therefore, it is within reason to conclude that the diffusion of warnings is not immediate.

5.2 *Belief*

Normalcy Bias

In some regions, tornado warnings—and particularly watches—are simply part of everyday life. This may be part of the reason why initial warnings elicited mixed responses from residents of New Orleans and Springfield. Interviewees admitted that warning information, in many cases, triggered almost immediate disbelief that storms would generate tornadoes. This has been elsewhere called a "normalcy bias" (Okabe and Makami 1981), a common reaction to risk information. It remains a common reaction among those exposed to frequent false alarms and is often a response to uncommon threats. Far from "human nature," the normalcy bias is a result of numerous psychological, social, and political variables.

Its repeated presence in situations of risk should lead us to ask why the normalcy so often emerges. Past experience, shown in studies to influence warning response, determined whether one believed a warning message to be valid. A married couple, at home when the tornado struck their subdivision, took no steps towards protecting themselves despite having a place in which to shelter. Why? They agreed that much of the previous weather—mostly rain and wind—had been harmless and so too would be the current threat. In a statement representative of the general problem, they recall, "*we watched and listened...because we've never had anything like this and so we had had never became all that*

concerned" [MO-NO-2]. In other cases, discussions with significant others about environmental cues themselves led to imputations of normalcy. Another couple interviewed was aware of the potential for tornadoes, but opted to go about their normal activities because of calm weather conditions that did not prompt them to seek further information about the storm, or, for that matter, tornadoes [QR-MO-5].

In some cases, a simple lack of attention to the tornado caused many to impute normalcy. The most obvious barrier is a denial by public official sources. Apart from outright denial, indecisiveness among media and official leads also to frame warning information as false: "*Well you know you hear so many "could be," "maybe."* [QR-MO-2]. One woman expressed similar opinions about the level of conviction with which warnings are conveyed, citing what she perceived to be a general lack of seriousness and unconvincing attitudes among T.V. forecasters [QR-NO-2].

Lack of experience with tornadoes, in certain cases, also led interviewees to disbelieve warning information. One interviewee, though he could accurately describe a watch, claimed he didn't expect a tornado simply because he had never experienced one [QR-NO-13]. Another interviewee shared similar sentiments and puts the problem quite cogently: "*Something [would] have to really happen to make people get up and leave*" [QR-NO-17].

Social interaction at the time of the warning was found to either reinforce these imputations or, in other instances, transform a sense of normalcy into an awareness of threat. Collective judgments regarding the legitimacy of warning information sometimes reflected the sentiments of group members holding the most power and authority—heads of households, for instance. These definitions—whether thought true by less-powerful members of the household—nevertheless formed a basis for collective action. In other cases, decisions were made in a more democratic fashion, yet remained no less contingent upon social relationships and the problematic definition of the situation.

For tornados, as with all quick-onset hazards, the crucial issue of how to go about eliminating a normalcy bias even within regions regularly experiencing false alarms should be a chief planning concern. The problem with short-time-onset events like tornadoes is that by the time the tendency to impute normalcy ceases, the level of threat increases considerably.

Specificity

Specificity is generally thought to influence one's understanding of the warning message: if the warning message contains precise information about where and when a tornado is likely to strike, one is more likely to obtain a better understanding of the threat, and, in turn, make better safety decisions. This may indeed be true, but, in addition to offering awareness, specificity also shapes whether one accepts warning information as true. One interviewee, for instance, "*took a chance*" because she claimed that the news failed to indicate specific areas the tornadoes were going to hit [QR-NO-2]. Other problems with specificity were apparent when analyzing the interviews. Specificity also seems problematic when it comes to watch information: in some cases, the geographic region covered by the watch was too broad to elicit a strong belief in interviewees: "*It was just typical watch broad area map showing pretty much hundreds of counties, doesn't really, a lot of times doesn't really get effected, you know it doesn't really get a rise out of anyone because I think it's just so wide spread most of the time*" [QR-MO-6].

5.3 *Understanding*

Believing a warning leads one to interpret it, which can naturally result in misunderstanding. Misunderstanding can fall into two categories. The first category is *misunderstanding the level of risk*; the second, *misunderstanding the geography*. In the case of the former, there was an observed tendency to conflate watches and warnings, and, in some cases, both were articulated with a degree of confusion. If confusion arises, a subsequent misinterpretation of the risk one faces is expected to follow. In the second case, knowledge of the region combined with accurate and reliable weather information led to better decision making many believed.

Many of the interviewees expressed uncertainty over what a warning and watch represents. In a number of cases, the two concepts were confused. Knowledge of what warnings and watches mean ranged from vague to altogether incorrect, with interviewees often struggling to define the meanings of warnings and watches, their associated level of risk, and

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the type of protective action each require. The following passage is notable because the interviewee defined a warning as a watch: "*a warning, as I understood it, was such that it was to the point that a tornado could develop at any time.*" [QR-MO-2]. What is troubling is that this confusion was not uncommon, and the expected result is that the interviewee will not simply be confusing terminology, but the level of risk they face. If one believes a warning simply indicates the potential for tornadoes (when it actually indicates their presence), then one's protective action will indeed be inappropriate for the level of risk truly present.

The second problem, *geographic misunderstanding*, relates to one's familiarity with the region. A clear trend witnessed in the interviews is that those in possession of the equipment and ability generally attempt to track the movement of tornadoes from the West. This tracking, however, implies one knows one's location relative to the storm, which, in turn, implies one holds a requisite level of geographic knowledge of the region. Further complications arise within the context of risk personalization: one cannot define oneself at risk if one does not understand, geographically, where one is relative to a storm system.

It is therefore not difficult to imagine groups who might be most vulnerable. Migrants—particularly immigrants, both legal and illegal—face significant barriers: they are unfamiliar with the region and thus impaired in their judgments of risk. One can easily imagine this problem compounded by the presence of non-English-speaking immigrants. [QR-MO-6] Another interviewee claimed that in combination with his knowledge of the area, storm spotter's reports, due to their specificity, allowed him to make better safety decisions.

5.4 Confirmation

Confirmation should be thought of as "bridge" from understanding and belief to risk personalization. Scholars identify confirmation as a critical process running throughout the course of risk perception, communication, and warning response. In one case, a resident confirmed through an official source the tornado threat: "*We had not heard a warning yet. Since I am the pastor at the church where the shelter is, I'm one of the ones on the list to open up the shelter if need be and so I called the Republic Emergency management to find out if they were*

opening shelters and they said they were in the process" [QR-MO-5].

What is interesting in many cases is that a combination of factors—both physical and social—are used to confirm the presence of a threat. One interviewee relied on confirmation of a more somatic nature. He explained that while his reaction was due to a combination of events, it was ultimately a pressure in his ears that led him to seek shelter. The official warnings were simply not enough to prompt protective action [QR-MO-7].

Even the most seemingly unequivocal warnings yielded behavior intended to confirm the threat. In Hahnville, a community in which sirens were sounded, one interviewee felt the need to corroborate the sounding of area sirens with local emergency management. A company safety director living in Hahnville said this may be a problem particularly in communities in which sirens are used to warn multiple hazards [QR-NO-20].

Much of the behavior intended to visually confirm the presence of a tornado was initiated by males, according to the interviewees. One woman reports going into a hallway while her husband entered the kitchen in an attempt to visually confirm the presence of the tornado. After doing so, she said, he rushed back into the hallway only seconds before the tornadoes hit the community [QR-MO-4]. One woman, who recalled the impact lasting only moments, told researchers that it was her husband who attempted to confirm the tornado from the back door in the basement [QR-MO-1] In other cases, the media was used to confirm the message, albeit in this case through social interaction with members of the household [QR-MO-7].

5.5 Personalization

The widespread presence of disaster myths appeared to affect the personalization of risks. One popular myth holds that mountainous regions are less likely to experience tornadoes. In the Ozark Mountains[3] of Mississippi, this was mentioned by one respondent. Scientists agree that this is a largely mistaken belief, citing the example of a tornado that struck the mountainous Yellowstone National Park (NOAA). Although one interviewee clearly knew a tornado was present, the risk of personal harm

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[3] Ozark Mountains is a bit of a misnomer, as the region by that name is really a series of plateaus.

was minimized due to her belief that mountains affect local meteorological conditions [MO-MO-2].

In urban and suburban regions, another cultural myth may increase the vulnerability of populations: the belief that tornadoes will not enter urban areas. This is simply not true. Although tornadoes tend to dissipate before reaching the center of cities, the outer sections of the city and, more importantly, the suburban housing surrounding them may be impacted by tornadic activity. An example is the tornado that killed two near Washington, D.C. (USA today 2001). While there is evidence that tornadoes are less likely to hit urban areas, they are far from a rare occurrence. Yet, many hold the belief that they are not personally at risk: *"I never heard of that [it could come through a city] you know being in urban areas"* [QR-NO-13].

Other myths are difficult to classify and seem to be of a more personal nature, but nevertheless give rise to significant risk. Misconceptions about the protection offered by infrastructure prompted one respondent living within a trailer to believe that he and his wife were safe, which led him to take no protective action: *"I told my wife, we're in between two buildings, what's the worst that could happen?"* [QR-NO-14]. This illustrates the point of personalization quite well: one can understand a warning and believe that tornadoes are really going to be spawned, but may still impute personal non-risk. The interviewee later contacted others with similar bad advice: *"Uh yeah I had told a couple friends of mine that live in the country about it. I told 'em I said, you know, ya'll may get hit cuz ya'll in a flat plain area"* [QR-NO-14]. Other sources of depersonalization existed in the New Orleans sample in which recent experiences with Katrina shaped perceptions of other threats.

5.6 *Determining Whether Protective Action is Feasible*

There were some interviewees who believed the absence of basements or strong shelters meant that they were completely at risk. It is indeed true that basements offer—next to storm shelters—the best possible protection against tornadoes. There are, however, other helpful—if not totally effective—ways of protecting oneself from tornadoes: bathrooms, hallways, and closets afford minimal protection against debris and other threats. One can *at least* reduce the risk one faces. In New Orleans,

one of the few people to take adequate steps toward protection was a first responder who, lacking a basement, brought his family into the living room. Residents of New Orleans living in temporary shelters faced the serious dilemma of remaining in trailers, evacuating to damaged housing, or attempting to locate to another form of shelter. A majority of those interviewees remained in their trailers because they believed nothing else could be done.

5.7 Protective Action

The actions one takes in response to warnings may either reduce the risk one faces or place one at greater risk. There is one important question, however, that that remains of the warning process: how do people decide *what* course of action to take and what influences this decision? There are several factors that influence protective action—*available infrastructure*, *inappropriate abstractions*, and *future preparedness*.

Infrastructure Available

One obvious barrier facing storm victims is the lack of a shelter—whether in the form of a basement or a tornado shelter. As was noted earlier, the lack of a shelter led some to define the threat as one against which protective action would be ineffective. In many cases, lacking a basement led many to define the prospect of protective behavior as a zero-sum game in which one was *either* fully protected *or* fully exposed to the threat. Even if one lacks a basement or storm shelter, there are certain things one can do to reduce the likelihood of harm or risk. There were indeed instances in which the interviewees, despite lack of a basement or storm shelter, did do things to reduce the risk of injury or death. In one case, an interviewee in Hahnville, LA, took shelter from the storm, but he later revealed that he did this because of knowledge drawn from his first responder/emergency-management related position. It was thus that he had the knowledge of how to *reduce risk* and the cultural capital sufficient to define the situation as one in which it was necessary and plausible to do so.

In other cases, knowledge of viable sources to facilitate protective action was obtained through social networks. One interviewee told researchers that he informed his neighbors that the shelter was opening [QR-MO-5]. In other cases, if one did have the resources

to protect oneself, these resources were offered to others in the community: "*And we also told the neighbors on the north side of us who do not have a basement that if they felt imminent danger they were more than welcome to come over and join us in our basement*" [MO-NO-2].

Inappropriate Abstractions

Past literature suggests experience with disasters improves the likelihood of response among victims. There remains a tendency among those personally affected by disasters towards response when confronted with the possibility of subsequent hazard. One should not make the mistake, however, of conflating a heightened likelihood of response with an appropriate response. No two disasters are the same—they vary, among other characteristics, in their scope, range, and intensity (Mileti 1999). It follows that different disasters call for different coping strategies. An obvious comparison would be tornadoes and hurricanes. Hurricanes are larger in scope and duration. Consequently, experts recommend evacuation in such instances. The rapid onset speed of tornadoes, on the other hand, makes evacuation impractical and dangerous. Experts therefore recommend sheltering in a place such as a basement. In areas where a tornado culture is strong, these practices are generally maintained. But in areas where tornadoes are rare, yet other disasters remain prevalent, this combination could reduce the effectiveness of protective action or, worse, place populations at greater risk.

Recent and extraordinary encounters with natural disasters strongly shape warning response. In the case of the February tornadoes in New Orleans, directly following Katrina, there were at least three interviewees who claimed they would have evacuated had they known about the tornado or would evacuate in the event of future tornadoes: "*Hurricane Katrina, [we] lost everything. If we'd had a warning, trust me, we would have got out of here. Took what we could take and we woulda roll.* [QR-NO-1]" A similar sentiment was expressed by a resident in Hahnsville who claimed if another tornado came through he would evacuate. Another victim from the New Orleans area, finding few alternatives due to the lack of a basement, entered his attic and later injured himself falling down the stairs.

We can extend these findings to the case of Caribbean immigrants in order to illustrate this debate. One might speculate that immigrants from Cuba, Puerto Rico, and Haiti, due to their experiences with hurricanes, would respond more effectively to other forms of severe weather, such as tornados. This hypothesis, however, should be viewed with skepticism, for variations in the scope, intensity, duration, and time of onset of disaster agents shape the relevance of disaster culture. The disaster culture developed within the context of a prolonged-onset event may be entirely inappropriate for dealing with quick-onset events. A recent immigrant from Puerto Rico, for instance, may attempt to evacuate from a tornado rather than seek immediate shelter, an unwise and potentially deadly course of action.

Preparedness for Future Tornadoes

A number of residents were in the process of protecting themselves from future tornadoes. Some were putting in storm shelters. Yet a sizable number had not taken steps or had taken inadequate steps to protect themselves and their family. In some cases, researchers noted the presence of pessimism towards the notion of tornado preparedness. Such pessimism found its source, in some cases, in the belief that the rapid speed and incalculable nature of tornadoes forms impossible barriers to response.

In other cases, nominal steps were taken following tornadoes, with some reporting the purchase of food and water. Many intended to purchase weather radios or storm shelters, but due to a variety of reasons—ranging from cost to time constraints—had yet to do so. Still, there were a number of cases in which people who had experienced the tornado were in the process of setting up a shelter.

6. A BRIEF NOTE ON DIFFERENCES BETWEEN NEW ORLEANS AND SPRINGFIELD

Did response patterns vary between the two research sites? Indeed, researchers observed numerous dissimilarities in the data collected in New Orleans and Springfield. Most notable are instances wherein different perceptions, behaviors, and attitudes produced similar response patterns. A common first response to tornado warning—and, especially, watches—was observed in both regions and led in many cases to a delay in protective action. Yet knee-jerk disbelief often appeared for one reason in New Orleans and another in Missouri.

On the one hand, people in Missouri, because they regularly experience watches and warnings, were less likely to take them seriously. Their skepticism was a product of an overexposure to false alarms. On the other hand, skepticism in New Orleans was also high, which was largely due to the infrequency of tornadoes, as well as concerns over hurricanes, rather than conditions of overexposure to watches and warnings. Thus, there can be no single solution to reducing warning skepticism: we must take account of the contextual factors within each community that give rise to disbelief.

7. CONCLUSION AND POLICY RECOMMENDATIONS: APPLYING MILETI'S MODEL

7.1 *Identify Groups Unlikely to Have Strong Social Networks (Reception)*

As was seen, there were cases in which persons who received information about the tornado did so through informal—i.e., family, friends, co-workers, and so forth—channels. Beyond this, speculation is only possible as to the extent victims in general pursue information through informal channels. It is not unthinkable, however, that a considerable number of victims do receive information solely through informal channels (Admittedly, as we saw, there are mixed findings in the literature regarding whether people receive warnings primarily through formal or informal sources.) If informal information represents a primary source of warning for some people, it would be useful, from a policy perspective, to think about what kinds of people informal information is *least likely* to reach. Research demonstrates groups outside social networks to be less likely to receive warning information. Who are these groups likely to be? Recent migrants may be at greatest risk—above all, immigrants isolated from the community. For instance, immigrants may find themselves unable to receive or understand warning information in the absence of alternative social networks. Such was the case in Verona—a primarily Hispanic community—in which local churches channeled information to minorities. As far as getting the message is concerned, demographic changes in the United States might be making it more difficult. It is reasonable to hypothesize, for instance, that increasing levels of urbanization may be influencing warning reception. It has been suggested that city residents face greater risks as they lack the stable and consistent social networks through which warning information is commonly conveyed in rural communities. It may be that rural residents are more likely to receive informal warnings due to their stronger social networks.

7.2 *Spanish/Multiple Languages (Reception, Understanding)*

It goes without saying that language imposes limits on warning comprehension. In the case of reception, one may "receive" the warning in the sense that one is presented with a series of images, sounds, and stimuli intended to convey risk, but one may possesses neither the linguistic nor paralinguistic tools through which to decode the message. In such cases, meaning is totally or partially lost. Language barriers may equally impact the understanding stages: warning recipients may glean in a very superficial manner the intended meaning of the message, but, in the end, they may not possess the language and knowledge requisite for determining the level of risk, location of threat, or recommended courses of action. This was observed in one community with a large Spanish minority. It was in this area where one respondent, a priest in a local Catholic church, told researchers that the large community of Hispanics in the town made it imperative that messages be conveyed in Spanish.

7.3 *Warnings vs. Watches (Understanding)*

A recurrent trend within the data was a tendency to misinterpret the difference between watches and warnings. Public education campaigns should focus on these differences, taking special care to differentiate between the a) the sequence of watches and warnings (watches come first) b) the level of risk warnings and watches are intended to convey and c) the meteorological conditions warning and watches are intended to signify. Put another way, the difficulty may simply be a semantic one—the meanings conveyed by the two terms may not necessarily be apparent to the person outside of the operational communities in which they originated. There is, semantically speaking, a discontinuity between the institutional and everyday use of the two terms. In this case, forecasters know, but ultimately take for granted, the linguistic rules they've created for watches and warnings. That a warning means a tornado is on the ground or, in the cases of a watch, that

one is possible, is not endemic to the words "warnings" and "watches" respectively. From a nonprofessional outlook, it would seem an arbitrary assignment of meaning that a watch precedes a warning and that a warning conveys a greater level of risk than a watch. Perhaps instead of these two terms, language could be used to clearly distinguish the two terms. So, for instance, instead of watch and warning, perhaps something to the effect of "pre-warning" (in place of watch) and "warning.". In such cases, one would not necessarily need to be familiar with the technical uses of the terms "watches" and "warnings" in order to grasp the level of risk each intends to convey.

7.4 *Tracking (Belief, Understanding, Personalization)*

Some people are quite weather savvy, and it appears from many of the quotes that interviewees closely monitor the paths of storms. This allowed them to negotiate their level or risk based on past experiences. Better tracking technology should therefore be implemented. In some instances, the tracking of storms increased belief that one would be personally affected by a tornado.

There are, however, a variety of social factors that can limit the ability of tracking to be effective in communities. One clear barrier to the effectiveness is language: in Verona, for instance, a local priest from Honduras adamantly told researchers that warnings needed to be in Spanish. Another is migration patterns: a recent migrant—particularly immigrants—may not know the geographic layout of cities in the area and therefore may not be able to define the situation as risky given reports of the storm's movements and current locations. So, for instance, this interviewee's knowledge of the terrain allowed him to know his level of risk: "*when they mentioned the small town of Billings, we knew that…the next stop would be Republic.*" [QR-MO-5]

7.5 *Understand and Target Cultural Myths Through Education (Belief, Personalization)*

A narrow scope characterizes the many programs intended to improve public response to tornado warnings. Education traditionally looks to explain the meanings of watches and warnings (e.g., what they are, what they mean, the level of risk they convey, and so on), along with instructing the public concerning appropriate ways of responding to tornadoes. Few attempts have been made, however, to alter the popular knowledge communities often hold on the subject of tornado climatology, which, as has been shown, is often false. A path we might take towards improving public response (in both its incidence as well as effectiveness) would involve countering the cultural myths that cause people to either a) disbelieve tornadoes will form ("tornadoes can't form in the mountains") or b) depersonalize risk ("even if tornadoes form, we are surrounded by a river; tornadoes can't pass the river"). In order to overcome this problem, we must do more than simply identify and classify an admittedly variegated collection of popular misunderstandings. A different strategy should be developed and implemented: we must work to identify why tornado myths emerge and understand how they are reproduced in our collective conscience. Only then will it be possible to eliminate the problem.

This should be done in a two pronged manner. First, there are those tornado myths that are *general* – the myth, for instance, that the safest spot is in the southwest corner of the house. These should be common to all public service announcements. However, local emergency management planning committees must also be cognizant of local cultural myths that threaten the community – such as communities located near mountains or rivers.

8. CONCLUSION: IMPLICATIONS FOR CASA AND BEYOND

CASA will revolutionize weather forecasting with techniques intended to return more accurate meteorological observations. In doing so, they hope to enhance the quality of tornado warnings and therefore offer better protection to communities from a range of severe weather threats. Accomplishing this requires that we understand how social and cultural factors influence warning response. To that end, this research provides links between radar design, system implementation, and the socio-cultural worlds inhabited by end-users. CASA should devote greater attention to sensing technologies through which is made possible the tracking of weather events. This would have the effect of adapting system design to the needs of end-users, for some interviewees monitored severe weather and took action only when the threat appeared inevitable. The false alarm rate, another major problem,

could also be reduced with more accurate warnings.

It should nevertheless be remembered that all problems of warning and response cannot be reduced simply through technology. As mentioned, tracking would be of little use to recent immigrants with few social network connections. Moreover, false alarms remain a cultural as much as technological problem, for the operational equation, *Total Warnings – True Warnings = False Alarms*, often means little to the general public; indeed, the false alarm rate is often a cultural product. For instance, in some communities residents may evaluate the false alarm rate in terms of both warnings and watches. In other cases, if residents did not directly experience the effects of a tornado, they may nevertheless assign it "false alarm status" even if the event for which the warning was issued occurred only a few miles from town.

This research lays groundwork for further quantitative studies. Researchers are currently developing indicators capable of measuring forms of response behavior in order to build predictive models. These predictive models will reduce the uncertainty of our knowledge about human response system, thus allowing CASA to develop more reliable end-user policy. One of the weaknesses of this study—its qualitative nature—is that while it is useful in *describing* attitudes and behaviors, the predictions and causal connections it makes between these behaviors remains at a hypothetical level. In order to validate these hypotheses future tests must be undertaken using quantitative techniques (e.g., multivariate regression). Through these techniques, a more consistent knowledge of how people respond can be developed. These models will make it easier to develop rules that will distribute radar resources.

Finally, it should be noted that the changing demographic characteristics of American society necessitate more than ever a reevaluation of warning policy. In particular, the growing Hispanic population, whose only language might be Spanish, is at a major disadvantage when it comes to warnings (see Section 7.2). Increasing diversity, it follows, requires a diversity of approaches to warning populations. If the changing nature of U.S. demographics is not taken into account, we shall surely see a rise in fatalities and injuries.

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