Knowledge, experience and preparedness: factors influencing citizen decision-making in severe weather situations

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Abstract: During 1997–2007 the entire state of Tennessee experienced in total 300 tornados, causing 87 deaths and $617.1 million in damaged property. Therefore the ability to alert/warn all segments of a community regarding the potential of severe weather is essential for the safety and well-being of those potentially affected. To ascertain the best way that this could be achieved questionnaire surveys were conducted on the current practice and limitations to inform future need for change from the public, disaster management and the broadcast media. Prior experience gave the public a greater understanding of the threats associated with severe weather and actions to be taken. This study identifies a clear need for new and innovative ways to educate both the general public as well as the broadcast media and emergency management in disaster awareness and preparedness.

Keywords: emergency management; disaster awareness; disaster preparedness.

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1 Introduction

While modern society has been able to harness technological and social improvement, adverse weather continues to cause loss of life, damage to the fabric of society and other preventable social costs. Although scientific research related to climatological and geological phenomena has taken place for centuries the ability to observe and forecast severe weather events has improved markedly over the past few decades. Forecasts of snow and ice storms, hurricanes and storm surges, extreme heat, and other severe weather events are made with greater accuracy, geographic specificity, and lead time to allow people and communities to take appropriate protective measures (NASEM, 2018).

Research into disaster response behaviour to such adverse weather events has been conducted since the early 20th century (Prince, 1920), and the focus has often been hazard specific. For example Baker (1991, 2000) and Huang et al. (2016) provide comprehensive reviews of response behaviours during hurricane evacuation; Lindell et al. (2016) during earthquakes; Lindell et al. (2013), Hammer and Schmidlin (2002) and Jon et al. (2018) have provide reviews of tornado warning responses; Lindell et al. (2019) give a summary of flood warning research; and Corwin et al. (2017) and Wei and Lindell (2017) report on disaster responses to volcanoes.

Improving public safety during these periods of adverse weather requires more than creating up to date and accurate weather forecasts and there is a growing trend on helping individuals and communities to proactively reduce vulnerability and risk. The National

Academies of Sciences, Engineering, and Medicine (NASEM, 2018) highlight five key elements of the 'Weather Enterprise' namely

- preparedness and mitigation
- monitoring, assessment and forecasting
- dissemination of warnings and recommended actions
- emergency management and response actions
- activities to promote recovery.

Before an adverse weather event occurs a greater emphasis is being targeted on supporting the efforts of emergency managers, transportation officials, and others who help protect public safety when such events happen. This includes investing in leadership to build awareness; building capacity throughout the weather enterprise; and focusing on critical knowledge gaps

Mileti and Sorensen (1990a) established a scientific and social process involved in the systematic detection, warning and behavioural response aspects of disaster warning research addressing: the structure of emergency weather warnings; individual and collective cognitive processes; the social context of decision making; the protective response patterns associated with warning systems. This provided a social science approach to the effectiveness of warning system functionality and a basis for understanding the design and technological aspects that comprise an effective warning system.

The organisational aspects of warning systems were initially explored (Anderson. 1969), and the theoretical basis of organisational structure relating to warning processes has been advanced (Perry et al., 1981; Drabek, 1999; Balluz et al., 2000; Perry and Godchaux, 2005). A number of areas related to severe weather information enhancements and improvements have been the focus of researchers including warning system design (Drabek, 1985), identifying specific design parameters for coverage areas, protective response (Lindell and Perry, 1987), delineating proper response actions affecting safety for receivers, alert and notification factors, warning technologies (Sorensen, 2000), identifying advances in warning target areas, increased communications inter-operability and overall technology improvement and reliability.

For the most part, design specifics are based on a relatively consistent model using three basic subsystem components:

- hazard detection
- emergency response
- public response (Sorensen and Mileti, 1989).

1.1 Hazard detection

The technological breakthroughs in the detection of certain hazards have significantly advanced over the past years. The increase in warning times for both hurricanes and tornadoes has given substantially more notice to the public, allowing additional time for taking protective actions (Golden and Adams, 2000; Carter, 2008). The annual tornado cycle is well understood in relation to season variation and geographical area, however

spatial uncertainty in tornado prediction still poses a formidable forecast and warning challenge (Carbin et al., 2013) unlike that seen in hurricane prediction.

As the detection science for other hazards, such as earthquakes, volcanoes, avalanches and floods, becomes more precise, detection of those hazards will have a positive impact on the ability of the other two warning components to function more effectively and efficiently (Paul et al., 2003). The detection of an impending hazard triggers a set of decision making considerations, stimulating the implementation of the second subsystem related to the emergency management or response function.

1.2 Emergency management

Once the hazard identification (detection) occurs, the emergency management component assesses the level of threat posed by the hazard. Depending on the analysis, a notification or alert is disseminated to the public through an alert message. The construction, transmission and reception of the message comprise a complex warning system context, a complex interaction and integration of hierarchical and lateral communication and decision making usually involving an intertwined network of multijurisdictional and multiagency functions.

Broadcast media outlets have improved their capability to deliver a more accurate forecast to the general public, using both advanced technology (e.g., radar, GIS, forecasting consultants) and their relationship with the national weather service (NWS). During severe weather outbreaks, the NWS provides updates as needed to the broadcast meteorologists; therefore, the meteorologists are able to provide more accurate and timely severe weather information to their viewing/listening audience. Broadcast meteorologists use graphic information systems (GIS) and computer software programs to improve the way information about severe weather is communicated to the general public on television. With improvements in technology, broadcast meteorologists are able to report severe weather phenomena in a manner that most of their viewing/listening audience can understand, enabling them to take the appropriate protective actions.

1.3 Public response

The public response component incorporates an array of sociological factors and characteristics that affect individual behaviour regarding the adoption of preparedness and mitigation activities, resulting in proactive, reactive, or non-active responses to a hazard notification. The reception, legitimatisation, or disregarding of the warning message has a direct impact on the life safety outcomes of those facing the hazard. Confirmation of the warning is a critical element in taking a course of action consistent with positive results regarding public safety (Drabek, 1999). However while historically emphasis has been placed on those at risk of being affected by adverse weather to actively seek information increases preparedness and mitigation it has been suggest that it is the passive receipt of information is equally important or even more important (Bourque, 2013). While activity measures tend to be unsustained one-off events, given the information abundance of the modern era, the constant availability of up to date information may be more valuable.

1.4 Community based warning systems

Prior research and anecdotal information has underscored the need for the delivery of accurate information in a timely manner. This information should not only specify pertinent details of the imminent threat, but also provide instruction on the appropriate responsive action that should be taken by the receiver (Quarantelli, 1980; Lindell and Perry, 1987; Sorensen, 2000).

Many factors, including social structure, psychological effects, timing and cognitive reaction play a significant role in determining the effectiveness of a warning system and the protective responses taken (Mileti and Sorensen, 1987b).

Although, in general, warning integration has not shown significant increases over the past 20 years, the ability to issue warnings more quickly and efficiently has improved, much to the credit of advances in warning technology (Sorenson, 2000). The multiplicity of external and internal factors identified reflects the complex environment faced when actuating warning system processes (Drabek, 1985; Sorenson and Mileti, 1989; Lindell and Perry, 2004).

A primary component of a well-functioning community warning system is the conveyance of a clear, unified message. It is imperative that the public understand potential risk conveyed by the alert/warning and react accordingly. The severe weather alert/warning must be sufficiently clear and distinct that there is no question as to the appropriate level of protective action that should be taken.

Much is known about the important, integral components, and other related factors that may impact the efficacy of community warning systems. How these variable factors and system components interact with hazard occurrence fluctuations, socioeconomic changes and warning dissemination, in addition to contextual factors of the locale, with response to outcomes, remains unclear. However, knowledge and awareness gained from studies related to factor influences' effect on decision outcomes, with regard to protective action, can assist emergency planners and managers in better preparing warning messages (Sorenson, 1991).

There is growing recognition that a host of social and behavioural factors affect how society prepares for, observes, predicts, responds to, and is impacted by weather hazards (NASEM, 2018). While the further development and refinements of community warning systems is an understandable priority for all local and national government and emergency services this must be informed by the experiences of those within it.

In order to inform the ongoing development of such systems, this paper explores within members of general public, the broadcast media and emergency management both the understanding and diversity of adverse weather situations experienced and the current structure in places. It then suggests a series of future recommendations to enhance the system from perspectives of each of these three groups.

2 Methods

2.1 Study design and analysis

The Nashville Metropolitan Statistical Area (MSA) was the target audience for the general public surveys (approx. population of 1.9 million), with the broadcast media and emergency management agencies surveyed throughout the state of Tennessee.

To ensure confidentiality of respondents, demographic data collected did not divulge identification of individual respondents.

A cross-sectional survey design was used to gain the views of;

- General Public (GP)
- Broadcast Media (BM)
- Emergency Managers (EM).

The GP survey was conducted in 2007 (July 26 – August 29), 2008 (July 1 – August 15) and 2010 (September 21 – December 20). The 2009 GP survey data was unavailable due to equipment failure during the data collection period. The BM and EM surveys were both conducted on one occasion in 2010.

All three survey questionnaires were made available online but hard copies were also available on request. The Nashville Office of Emergency Management sent out reminders utilising mailing lists to the general public. The Tennessee Association of Broadcasters sent out reminders to the broadcast media to its members. The Tennessee Emergency Management Agency sent out reminders to all county emergency managers.

Study approval was obtained through the Internal Ethics Review Board at the University of Glamorgan (now known as the University of South Wales).

2.2 Survey design

The three survey questionnaires used in this study were derived from the Public Readiness Index (PRI). PRI is a widely used and validated (PRI, 2012) and was initially created by a partnership between the American Red Cross, the Council for Excellence in Government, the George Washington University Homeland Security Policy Institute and the U.S. Department of Homeland Security. It consists of simple questions on the Readiness Quotient (RQ) test that are predictive of an individual's preparedness for a weather emergency, natural disaster or terrorist attack.

2.3 General public survey

The General Public (GP) survey questionnaire was developed in conjunction with the Nashville Office of Emergency Management by modifying the existing PRI survey divided into the following areas: emergency situations, evacuation, knowledge of government actions, personal preparedness, employment, schools and demographics. Subject matter experts from the Nashville Office of Emergency Management along with others reviewed and validated the questionnaire before it was distributed.

2.4 Broadcast media survey

Since 1948, the Tennessee Association of Broadcasters (TAB) has been a 501c (6) corporation and the voice of the federally licensed, free-over-the-air radio and television stations and associated industries in Tennessee. The TAB represents approximately 250 members annually (25 television stations, 200 radio stations and 25 affiliates).

The BM survey questionnaire was divided into the following categories: station demographics, station operational protocols, severe weather emergencies, knowledge of the NWS, knowledge of the Emergency Alert System (EAS) and level of preparedness. In addition questions from the GP survey questionnaire were included: demographics, severe weather emergencies and level of preparedness. Representatives from the TAB along with representatives of broadcast organisations assisted with the question validation process using face validity.

2.5 Emergency management (EM) survey

There are 95 counties within the state of Tennessee and each of these counties has an emergency manager that assists in coordinating prevention, preparedness, response, recovery and mitigation activities. The Tennessee Emergency Management Agency (TEMA) agency acts as the coordination point for response agencies for additional resources that may be needed in planning for or responding to a community in need.

Colleagues from TEMA assisted with the development, validation and distribution of the emergency management survey questionnaire. It featured some of the same questions as the PRI public survey questionnaire (demographics, severe weather emergencies and level of preparedness) and the broadcast media survey questionnaire, along with specific topics related to severe weather and emergency management (operational protocols, knowledge of the NWS and knowledge of the Emergency Alert System (EAS).

3 Results

The Nashville-Davidson–Murfreesboro–Franklin Metropolitan area consists of 14 counties and is centred on Nashville, Tennessee, USA. It is the 36th largest Metropolitan Statistical Area (MSA) with an estimated population as of July 1, 2017, was 1,903,045. Within the communities of the Metro Davidson-Nashville, Tennessee area, 14 tornadoes, resulting in one death, 68 injuries and an estimated $111.8M in damage (NOAA, 2012d) were experienced between the years 1997 and 2007. During that same period, the entire state of Tennessee experienced 300 tornados, causing 87 deaths and $617.1M in damaged property in total.

3.1 GP survey

The number of respondents to the GP survey was 2254 in 2007, 2161 in 2008 and 1379 in 2010, totalling 5794 responses. The demographic information from respondents showed participation from diverse segments of the community, largely with characteristics representative of the state of Tennessee. A higher number of females (59.6%) responded to the GP survey than males (40.4%), with the majority of the respondents being Caucasian, college educated females earning $50,000 or greater on an annual basis. A higher proportion of people aged 45 to 50 (30.1%) responded to the GP survey and there was a significant increase in the number of respondents between the ages of 55 to 64 over the study period, from 20.9% in 2007 to 27.0% in 2010.

3.2 Knowledge and experience

There was a range of experiences reported (Table 1) with tornado's the most reported severe weather phenomenon by respondents in each year surveyed. Hurricanes flood and fire were similarly reported. However there was a consistent proportion of survey respondents over the three years who had no prior disaster experience.

Table 1 Respondents' experience of emergency situations

	2007 n = 2254	*2008 n = 2161* (%)	*2010 n = 1379* (%)
Tornado	52.6%	49.7%	45.2%
Flood	13.0%	10.6%	49.2%
Hurricane	17.3%	14.9%	15.0%
Fire	15.7%	14.8%	16.0%
Earthquake	4.7%	5.7%	4.2%
Disease	1.9%	2.5%	2.8%
Terrorist	2.3%	2.2%	2.5%
None	28.4%	32.2%	26.4%
Other	12.4%	11.4%	Not specified

Respondents were asked about the depth of impact of emergencies that they had experienced and how these had affected them. The biggest impact experienced by respondents was loss of power with approximately half of the respondents in each year had lost electricity for three days or longer (Table 2).

Table 2 Impact from emergencies experienced by public survey respondents

	2007 n = 2254	*2008 n = 2161*	*2010 n = 1379*
Lost electricity for three days?	46.8%	43.2%	50.2%
Saw others injured or killed?	32.6%	30.0%	29.1%
Had to leave work	28.4%	27.0%	32.1%
Had to leave home for at least a night?	27.7%	26.2%	32.3%
Could not get in touch with other family members?	27.2%	27.0%	29.5%
Provided first aid?	24.4%	23.9%	23.4%
Could not get to a store for three days?	13.6%	12.5%	20.7%
Got injured?	13.8%	12.2%	12.1%
Evacuate their community or neighbourhood?	7.5%	7.2%	12.0%
None of these	18.9%	504 (23.3)	259 (18.8)

The most common way in all three years in which public survey respondents had prepared for emergency situations was to take a first aid class (Table 3) While disaster supply kits for home and car were also relatively popular methods, still fewer than half the respondents had such kits in 2010.

Table 3 Emergency preparedness activities undertaken by public survey respondents

	2007 n = 2254	*2008 n = 2161*	*2010 n = 1025*
Taken a first aid class	38.8%	44.2%	61.3%
Disaster supply kit for home	34.0%	33.2%	46.9%
Disaster supply kit for car	23.0%	23.3%	31.6%
Identified meeting location for family	20.7%	21.8%	31.5%
Communication plan for family	19.3%	21.8%	28.0%
Volunteered for emergencies	11.4%	10.3%	15.0%
Practiced drills at home	5.7%	7.0%	11.4%
Taken a CERT class	NA	11.9%	13.5%
Disaster supply kit for the office	6.3%	6.6%	8.6%
Nothing	31.2%	29.4%	NA
Other	8.2%	7.6%	3.5%

Respondents set out a range of reasons for a lack of preparedness (Table 4) with simply not thinking about it being the consistently major reason for approximately 60% of respondents even though many must have experienced some form of emergency situation. More than a third (36.7% – 1620) of the respondents either had seen or heard a message associated with emergency preparedness warning message within the previous 30 days. However, there was little change during the three years of the study.

Table 4 Major reasons for not being prepared for an emergency situation

	2007 n = 2254 (%)	*2008 n = 2161* (%)	*2010 n = 1025* (%)
Have not thought about it enough	60.3%	60.4%	65.9%
Do not think an emergency will happen here	13.7%	12.5%	14.0%
Do not want to think about it	9.3%	9.2	9.7%
Cost too much money	7.0%	7.7%	12.7%
Do not know how to prepare	8.4%	8.1%	8.5%
Takes too much time	3.9%	5.1%	7.5%
Nothing would be effective	4.0%	3.7%	3.6%
Do not have room for an emergency kit	2.9%	2.6%	4.5%

The proportions of public respondents who expressed reliability on television/news for emergency messaging fluctuated over time. However broadcast television/news was the most reliable emergency messaging system identified by respondent with mass telephone messaging and radio also prominent. With more detailed questioning in the 2010 survey a major difference was the emphasis on text messaging as its availability and use became more widespread (Table 5).

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Table 5 Reliable emergency messaging for public survey respondents

	2007 n = 2223	*2008 n = 2161* (%)	*2010 n = 1371* (%)
Television/news	51.9%	52.2%	37.6%
Mass telephone calls	12.5%	13.1%	10.9%
Radio stations	14.8%	11.1%	8.8%
Email	9.4%	10.6%	5.3%
NOAA weather radio	3.2%	5.1%	5.6%
Highway message boards	1.9%	1.8%	1.5%
Internet	1.9%	1.4%	1.8%
Television/government access	1.2%	0.8%	0.8%
Other	3.1%	3.8%	NA
Text messages	NA	NA	24.9%
Community alert siren	NA	NA	0.3%
Emergency alert system	NA	NA	0.1%
No electricity, alternate notification	NA	NA	0.1%
Mail	NA	NA	0.0%
Pager	NA	NA	0.0%
In person	NA	NA	0.1%
PA speaker	NA	NA	0.1%
All of the above	NA	NA	1.4%

NA = Not Asked, 0.7% missing.

3.3 BM survey

There were responses to the BM Survey from 21 out of 35 broadcast television stations and 45 out of 250 broadcast radio stations within the state of Tennessee. Respondents from the broadcast radio stations survey were representative of larger corporations which own multiple stations but did not complete individual questionnaires for each station. A majority of television stations were staffed 24 hours a day, seven days a week, whilst most of the radio stations were only staffed during daytime hours (6 am – 7 pm).

Both television stations and radio stations had confidence in the NWS to supply them with severe weather information for emergency alerts. Responses indicated that 91.1% (41) of the radio stations receive emergency alert information from the NWS compared to 85.7% (18) of the television stations (Table 6). The study also shows that 44.4% (20) of the radio stations received emergency alert information from the local EMA/public safety agencies compared to 76.2% (16) of the television stations ($p = 0.016$). The 'Other' category consists of; use of the emergency alert system (EAS); use of the Local Primary – 1 (LP-1) and Local Primary – 2 (LP-2); and use of talk radio network (TRN).

Television stations and radio stations relied on emergency generators to keep stations operational during power outages. 100.0% (19) of the broadcast television stations had access to emergency generators for a back-up power supply compared to only 65.9% (29) of the radio stations. When dependent on emergency generators, respondents had procedures in place to monitor their fuel consumption to determine when to contact fuel suppliers.

Table 6 Origin of emergency alert information for broadcast media

Knowledge/experience	*Radio n = 45*	*Television n = 21*
National weather service	91.1%	85.7%
Local EMA/public safety agencies	44.4%	76.2%
Local television station	22.2%	42.9%
Other broadcast stations in the area	40.0%	38.1%
Web/internet	28.9%	14.3%
Weather spotter	4.4%	19.0%
Contract service	2.2%	19.0%
HAM radio operators	6.7%	0.0%
Other	4.4%	4.8%

The majority of respondents had policies in place to address non-weather alerts. 81.8% (36) of the radio stations and 89.5% (17) of the television stations had policies and/or procedures in place for non-weather alerts, such as an Amber Alert (child abduction), and road conditions (traffic accidents).

The survey revealed that 28.2% (11) of the radio stations met with local authorities about emergency alerting capabilities and plans within the last year compared to 18.8% (3) of the television stations. Whereas 30.8% (12) of the radio stations did not know the date of the latest meeting with emergency management compared to 56.3% (9) of the television stations (Table 7).

Table 7 Time interval between broadcast media and county emergency management preparedness meetings

Level of preparedness	*Radio n = 39*	*Television n = 16*
Do not know	30.8%	56.3%
Within the last 30 days	12.8%	6.2%
Within the last six months	10.3%	6.2%
Within the last year	28.2%	18.8%
Other	17.9%	12.5%

11.1% of radio stations and 23.8% of television stations were missing.

Disaster exercises allowing those involved to test response capabilities were not undertaken by 59.1% (26) of the radio stations who had not participated in any form of severe weather exercises compared to 57.1% (12) of the television stations, 11.4% (5) of the radio stations had participated in table top exercises compared to 9.5% (2) of the television stations.

It appears that most television and radio stations throughout the state of Tennessee did not have sufficient capability to broadcast in any language other than English. Respondents stated that 87.8% (36) of the radio stations did not have the ability to provide information in various native languages to non-English speaking populations within the viewing or listening area compared to 88.2% (15) of the television stations. A limited number of stations did have the ability to provide multi-language broadcast and samples of the non-English communication capabilities were identified such as a

newscaster fluent in three languages, others who were bilingual although these were the exception rather than the rule.

Establishing triggers to disseminate information to the public was felt to be one way to improve the timeliness and accuracy of severe weather alerts/warnings. There were differences in the number of responses from 71.4% (15) of the television stations who used severe weather watches issued by the Storm Prediction Centre as triggers compared to 31.1% (14) of the radio stations. Broadcasters were triggered to alert the public about severe weather warnings issued by the NWS; and 'when a tornado had been spotted in the viewing/listening area'. Other severe weather triggers included: Storm Prediction Centre's outlook; direct contact from EMA office live; the discretion of the in-house meteorologists; use of NOAA weather radio; use of Weather Central; local police calls about severe weather in the area; local television partners switching to full-time live coverage for severe weather in the area; and determination by broadcast media to simulcast the broadcast over the air until the situation had improved.

The majority of the television and radio stations sent out alerts during severe weather watches as frequently as needed. 86.0% (37) of the radio stations and 88.9% (16) of the television stations reported that alerts were broadcast to the general public as needed during a severe weather watch, as opposed to being on a timed schedule. Television stations mainly used news/weather reports and crawlers, continuous subtitles on the bottom of the television screen to display severe weather warning information to the public. Radio stations, however, used general staff announcements from on-air personalities, alongside used news/weather reports to inform the public of severe weather information. Other options included: running a direct feed of the live weather coverage from a partner television station; interruption of programming with news/WX alerts as needed; internet streams during severe weather events; live cut-ins and/or simulcast of local television station partners; and severe weather event updates provided by the station on its website.

3.4 EM survey

The EM survey was completed by 96.8% of the county emergency managers in the state of Tennessee.79 (91.9%) of the emergency management agencies had Emergency Operation Centres (EOCs) and a majority of these (84.9% (73)) had emergency generator back-up.

Table 8 Level of preparedness

	n = 80
Identified shelter facilities with appropriate support services	67.5%
Identified necessary resources needed for transportation and evacuation	57.5%
Status checks on elderly and disabled persons living alone that may be at risk (pre- and post-incident	43.8%
Understand the resource and cultural needs of the given population	41.3%
Establish communication networks with caregivers for delivering disaster/severe weather notifications and alerts	37.0%
Provide essential conduits for distribution of disaster preparedness/severe weather information	35.0%
Establish 'Registry' for the special needs/vulnerable populations	31.3%

There were variations in the aspects that were encompassed by the planning of the emergency management agencies, the most common of which were identification of shelter facilities with the appropriate support services (67.5%) and identification of necessary resources for transportation and evacuation (57.5%) (Table 8).

4 Discussion

4.1 Experience and response

Historically, severe weather events have caused significant damage and loss of life across the USA, resulting in large economic loss to the impacted communities. However there is little doubt that improvements in prediction, forecast, and warnings have dramatically reduced deaths and injuries in the USA (Sorenson, 2017). Despite such improvements this study confirmed that natural disasters still have considerable impact causing appreciable property damage and fatalities: during the study period (2007, 2008 and 2010), a total of 105 tornadoes were reported within the state of Tennessee, causing $284,688,700.00 in damage and 32 lives lost (NOAA, 2012d).

Several disasters of immense proportion have had an impact on the USA in recent years, notably, Hurricane Katrina in 2005 (Burby, 2006) and Hurricane Sandy in 2012. Experiences of the general public in the New Orleans area as a result of Hurricane Katrina included electricity outages for a period of approximately two weeks, with flood waters inundating the New Orleans area and impacting transmission stations. New Orleans lost thousands of households after Hurricane Katrina and had only returned to 300,000 (66% of its pre-impact population) four years after the disaster (Lindell, 2013).

Hurricane Sandy impacted on the New York/New Jersey shores area of the country and, again, the general public lost power in many areas for an extended period of time-up to several weeks in some locations. These instances reflect an important finding from this study: the frequency of the loss of electricity because of severe weather conditions. This suggests a clear need to focus on more resilient electrical grid systems to withstand such area-specific threats. Such threats are well catered for by the television organisations who responded to this survey with 100% of broad cast television media organisations.

4.2 Preparation

Although all television stations did have emergency generators, this was not the case for radio stations (which are not required to do so by the Federal government). Contingency planning and preparation for the impact of severe weather events could enhance broadcast media's capability to provide news and information to the public before, during and post event (Rudman, 2007).Improved communication could be strengthened by the development of relationships between stations and fuel suppliers for the provision of emergency fuel supplies in order to improve the functionality of the stations' information, even when critical infrastructures (cable and electricity) have failed.

Contingency plans on the part of emergency management are required to be properly in place in order to address, adequately, infrastructure failure as the result of a disaster or other event (Lindell and Perry, 2007, Chapter 12). The presence of emergency generators and back-up fuel supplies among the majority of emergency management agency's

allows emergency managers to maintain an adequate, functional EOC during a power outage

Risk perception is shaped by experience, optimism and demographic factors including gender, majority/minority group status and age ref. proper preparedness information provided to the general public in a timely and proactive manner is well recognised to increase the ability of the public to respond effectively to an impending threat (Tierney et al., 2001). However even over time only small number of respondents had access to disaster kits despite FEMA recommending that all members of the public should have such kits available? at home or in the car

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4.3 Relationship of knowledge/experience to levels of preparedness

Many of the study respondents reported prior experience and knowledge of severe weather emergencies and that these had an impact on their preparedness and decision-making process. While it has been reported that such experiences correlate with increasing awareness and risk perception (Paton and Johnson, 2001) more recent studies indicate that this relationship is more complex. The majority of people at risk from earthquakes do little or nothing to reduce their vulnerability making little or no 'Seismic Adjustment' (Solberg et al., 2010) while those in areas prone to flooding actively adjust down their perception of risk (Bradford et al., 2012). As such those taking measures to improve their resilience must at first be aware that they are indeed at risk, Lindell and Hwang (2008) have shown hazard proximity affects hazard adjustment through hazard experience and risk perception.

4.4 Approaches to communication

Previously it has been shown that community outreach programmes heightened public awareness of severe weather hazards and the associated need for appropriate protective actions (Hoekstra et al., 2011). It is evident that emergency management and broadcast media have worked together to develop more comprehensive public outreach severe weather programmes. The need is urgent, however, to increase levels at which emergency preparedness information is provided so that communication capabilities for diverse populations are enhanced during severe weather events. Those whose first language is not English or may have other speech and language issues are in particular at greater risk. Use of sign language which was eventually used in warnings in New York. Greater engagement with radio stations for the Hispanic communities

4.5 Social media

The rise of social media and individualised communications have both enriched and complicated the public–private partnerships that have delivered weather messages for decades (NASEM, 2018) and have driven the abundance of information that is instantly available. However it has also created new opportunities for collaborative advances in decision support with weather forecasting, and new challenges with respect to accuracy, reliability, and quality control. Given the ubiquitous of access to social media platforms, organisations are relying more on such approaches. For example, people with smart phones can download FEMA's mobile app to receive weather alerts, safety reminders and preparedness tips, disaster resources including open shelters and to submit disaster photos

to help first responders (FEMA 2018). This democratisation of information both as user generated content and immediate access to disseminated information holds a great potential to impact on disaster relief activity.

5 Conclusions

Combining the views of the public with key stakeholders in the broadcast media and emergency management provides a comprehensive picture of how to pragmatically address the warning and preparation for communities at risk of severe weather events. The study also showed in the low levels of preparedness activities reported that there are opportunities to educate the general public, as well as the broadcast media and emergency management sectors of the population, regarding disaster awareness and preparedness which proved to be an important topic that is needed to be addressed.

6 Recommendations

General public

1 Broader community outreach, education and training related to severe weather events, including appropriate preparation and protective actions to be taken (i.e., identification/designation of emergency shelters for the community).

2 Increase in capabilities of all agencies to alert and communicate with non-English speaking segments of the community.

Broadcast media

3 Participation of broadcast media with county emergency management agencies in local emergency planning, including coordination of alerting capabilities.

4 Emergency back-up generators as standard radio station equipment.

Emergency management

5 The development of severe weather exercise programmes to involve the general public, broadcast media and emergency management agencies, in order that existing plans and capabilities can be tested adequately.

6 Standardisation of initial severe weather message content to be utilised by broadcast meteorologists.

7 Develop and utilise of the social media platforms to aid both preparation and responses to adverse weather situations. Engagement with other organisations especially the electricity companies.

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