EFFICACY OF COMMUNITY EDUCATION PROGRAMMES IN INFLUENCING PUBLIC RECEPTION AND RESPONSE BEHAVIOUR FACTORS RELATED TO TORNADO WARNING SYSTEMS

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Abstract

The thesis explores the U.S. early warning system in the context of three separate but interlocking components: emergency management; special needs populations, in this case represented by the Deaf and hard of hearing community; and disaster education. Of importance is the need to bring further understanding to the relevancy of each and how the interrelationship among all three reflects a microcosm illustrative of the larger early warning paradigm and its challenges. Meeting those challenges requires implementation of innovative interventions and evidence-based approaches for adapting to the changing urban and rural demographics, climatological and technological environments. Severe weather and tornado hazard early warning is the embodiment of an integration of multiple systems requiring complex coordination of functions consisting of forecasting, detection, analysis, message development and dissemination, message reception, and action. This culminates in individual decision making for taking self-protection measures.

The thesis methodological framework consisted of a mixed method approach. Data collection utilised a survey questionnaire instrument, individual interviews and focus groups. The research questioned if current warning processes within the U.S. tornado early warning system positively integrate with emergency management practices and effectively influence protective actions of the special needs population. Results indicate the emergency management system continues to be institutionally focused and operationally centric. Emergency managers recognise the need to become more of an integrated component between the warning mechanism and the communities they represent. Data indicate the Deaf and hard of hearing population remains underserved and generally ill prepared for severe weather events. Disaster education programmes addressing their particular needs are scarce and current warning notification processes are often inadequate. Although tornado early warning detection and notification times are increasing, questions remain on how to more effectively encourage individuals to better heed warning messages.

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LIST OF ABBREVIATIONS AND ACRONYMS

AMBER	America's Missing: Broadcast Emergency Response
ARC	American Red Cross
BEOP	Basic Emergency Operations Plan
CDC	Centers for Disease Control and Prevention
CERT	Community Emergency Response Team
CMAS	Commercial Mobile Alert System
CPR	Cardiopulmonary Resuscitation
DDC	Disaster and Development Centre
DDN	Disaster and Development Network
DHS	Department of Homeland Security
DF	Degree of Freedom
DRR	Disaster Risk Reduction
EARS	Emergency Awareness and Readiness Services
EAS	Emergency Alert System
EF	Enhanced Fujita Scale for Tornado Damage
EMA	Emergency Management Australia
EM	Emergency Manager
EMWIN	Emergency Managers Weather Information Network
EPRC	Earthquake Prediction Research Center
EWS	Early Warning System
FOS	Family of Services
FEMA	Federal Emergency Management Agency
FCC	Federal Communications Commission
HOH	Hard of Hearing
HFA	Hyogo Framework for Action 2005-2015
HBM	Health Belief Model
IDNDR	International Decade for Natural Disaster Reduction
ICT	Information and Communication Technologies
IPAWS	Integrated Public Alerts and Warnings
IRB	Institutional Review Board
ISDR	International Strategy for Disaster Reduction
ITU	International Telecommunication Union
JMA	Japan Meteorological Agency

NASA	National Aeronautics and Space Administration
NDEC	National Disaster Education Coalition
NEMA	National Emergency Managers Association
NEXRAD	Next Generation Radar
NIDCD	National Institute on Deafness and Other Communication Disorders
NGO	Non-governmental Organizations
NOAA	National Oceanic and Atmospheric Administration
NSSL	National Severe Storms Laboratory
NSTC	National Science and Technology Council
NWR	NOAA Weather Radio
NWS	National Weather Service
NWWS	NOAA Weather Wire Service
OECD	Organization for Economic Co-operation and Development
PADM	Protective Action Decision Model
PPW	Partnership for Public Warning
PrE	Person-Relative-to-Event
PTM	Protection Motivation Theory
RED	Risk Reduction Education for Disasters
RRM	Risk Reduction Model
SCT	Social Cognitive Theory
SEDAC	Socioeconomic Data and Applications Center
SFDRR	Sendai Framework for Disaster Risk Reduction
TAB	Tennessee Association of Broadcasters
TEMA	Tennessee Emergency Management Agency
TEMP	Tennessee Emergency Management Plan
TCA	Tennessee Code Annotated
TTM	Transtheoretical Model
TV	Television
UN	United Nations
URL	Uniform Resource Locator
U.S.	United States
USD	United States Dollar
USGS	U.S. Geological Survey
VOAD	Voluntary Organizations Active in Disaster

WCESD	World Conference on Education for Sustainable Development
WCDR	World Conference on Disaster Reduction
WEA	Wireless Emergency Alerts
WMO	World Meteorological Organization
WSR-88D	Weather Surveillance Radar - 1988 Doppler
WTC	World Trade Center

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Importantly are two groups that allowed me to probe into their lives, personal thoughts and professional duties and responsibilities. They are individuals from the Deaf and hard of hearing community and representatives of the local emergency management agencies I interviewed, questioned and spent many hours with observing and interacting. I sincerely hope the results of this research will be beneficial in better understanding their needs and lead to building safer and more responsive communities.

Having the support of family through this process is important and in my case especially so. My children, Joe and Sarah, both educated and highly successful in their own right, were always there to listen and remain supportive. I thank you both! Moreover, of course I could never have attempted this or completed this endeavour without my wife Kathy. Your approval, encouragement and total support is the most important reason I was able to accomplish this. Your willingness to give up our time together and allow me to spend the hours, days, months and years to complete this research is appreciated more than I can ever express. Thank you!

John Walsh, Newcastle-upon-Tyne, UK, (April 2016)

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee, approved on 16 May 2011 and by the Vanderbilt University Institutional Review Board, approved on 3 October 2012.

I declare that the Word Count of this Thesis is 73,498 words

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Chapter 1. Introduction

"The tornado isn't a peculiar kind of cloud but a certain configuration of the air, a moving vortex within the storm, which in its purest form is invisible." Lee Sandlin, 2013, *Storm Kings: the Untold History of America's First Tornado Chasers*, p. 248.

1.1 Background

Severe weather and tornado hazard early warning is the embodiment of an integration of multiple systems requiring complex coordination of functions consisting of forecasting, detection, analysis, message development and dissemination, message reception, and action (Mileti & Sorensen 1990, Aguirre et al. 1991, Aguirre 2000, Balluz et al. 2000, Collins & Kapucu 2008, Brotzge & Erickson 2010). This culminates in individual decision making for taking self-protection measures. The U.S. early warning system is a public/private partnership that is reflective of an evolving process of natural science research and sociological research, policy implementation, and development of education and training programmes designed to influence protective behaviours. As with all social systems it is representative and influenced by political, sociological, economic and cultural aspects of a living organisational structure. This is evidenced by the complex set of factors that impact both the technological and sociological aspects of early warning system functionality (EWC III 2006, Hall 2007). Therefore, the ultimate goal of minimising deaths and injuries as the result of natural, human induced or technological hazards remain a considerable challenge for researchers, disaster professionals and the public. Drabek (2010) clearly outlines the interrelationships of individuals, organisational groups and governance bodies required for development of a people-centred, effective, and functional hazard early warning system. Meeting this challenge requires implementation of innovative interventions and evidence-based approaches for adapting to the changing urban/rural demographics, climatological and technological environments.

The major focus of this thesis is to explore the U.S. early warning system in the context of three separate but interlocking components: emergency management; special needs populations, in this case represented by the Deaf and hard of hearing community; and disaster education. Of importance is the need to bring further understanding to the relevancy of each and how the interrelationship among all three may reflect a microcosm illustrative of the larger early warning paradigm and its challenges. Although each separately encompasses a singular construct, how and to what degree their interaction and integration affects the preparedness and response to tornado early warning system (EWS) in the community remains unclear. Better understanding of the needs and requirements for alerting, preparing and protecting the community will further the development of improving community wellbeing, while encouraging more participatory community-based strategies from governing bodies (IFRC 2009). A premise of this approach is that designing disaster reduction education materials reflective of people-centred needs will increase community capacity, safety and motivation.

Research addressing disaster risk education from both a scientific and sociological perspective is a relatively new area of interest among researchers. It is becoming recognized as significant for establishing resilient, well-prepared and knowledgeable communities (McEntire and Myers 2004, Kapucu 2008, WCESD 2009). This evolution and collaboration between disaster science and disaster risk education provides the framework for studying the educational and scholarly value of the instructional learning materials being developed and their measurement against community response outcomes. The academic community is challenged to address the effectiveness of disaster risk education programmes and begin developing practical models of design and development based on scientific and scholarly measured outcomes.

1.2 Historical Approach to Disaster Risk Education

Disaster risk education from a community perspective often encompasses a generalized, broad based, pedagogy directed at general populations affected by specific hazards (Dynes & Quarantelli 1976, Drabek 1999, Duval & Mulilis 1999, Kapucu 2008). This broad approach is most certainly reflective of the diversity of populations within communities, limited funding sources for community disaster risk education programmes, and the relatively new emphasis placed on establishing resilient, people-centred approaches to early warning response and behaviours (King 2000, Lindell & Perry 2004). This multiplicity of audiences demands care in identifying appropriate citizen responsive actions, better designed instructional materials, and development of educational outcomes measurable from a scholarly perspective (Mileti et al. 2004, Petal 2007, Lorenz 2013).

The scope of current disaster risk education and training programs in the U.S. covers the majority of hazards affecting most regions of the country: hurricanes, floods, tornadoes, wildfires and earthquakes. Most instructional materials are developed by government agencies or non-profit organizations with a disaster response or relief mission. Pedagogy is directed toward children or is designed with a general population focus. Delivery approaches range from hands-on materials to interactive internet activities while content continues to be somewhat descriptive and informational. Although the overall quality of the instructional materials appears to be improving over time, serious questions still remain whether they positively impact their intended audience. Preliminary research of the literature indicate little, if any, documentation exists addressing validity or reliability issues associated with the design and development of disaster risk education materials. For example, the *Public Readiness Index: A Survey-Based Tool to Measure the Preparedness of Individuals, Families and Communities* used in various U.S. metropolitan cities as an indicator of community preparedness, lacks verifiable validity or reliability measurement.

As a form of instructional design, disaster risk education has little historical development. Approaches vary significantly from developed countries to underdeveloped countries. However, even with an increase in the amount of disaster risk education materials being developed and distributed for use in schools, community programmes and for general informational proposes, validation gaps in disaster risk education remain. This is particularly true of tornado warning education.

1.2.1 *Emergency Management Development*

Emergency management is a relatively new phenomenon within the U.S. disaster response system. Disasters have occurred with varying frequency and magnitude since inception and communities have been involved in response and recovery to those disasters. The early 1900s began any real involvement of government participation in disaster response, although certainly some involvement before that time existed at the local and community level. The Federal Disaster Relief Act of 1950 initiated a history of federal funding and policy development that has evolved to the present (Rubin 2007). This emergence of disaster policy led to the establishment of the Federal Emergency Management Agency (FEMA) in 1979. Since that time, the role and responsibility of State and local emergency management has seen substantial growth, revision and reassessment of its focus and direction.

This process of change for emergency management is redefining it as an integrator of policy, operational management and purveyor of community resilience building. The result has meant that the emergency manager is now at the fulcrum of community preparedness activities and is called upon as the dispenser of disaster related information and guidance. Emergency management is no longer only an operational oversight, but has evolved and is evolving into a multi-faceted component responsible for local community planning and response requiring skills of leadership, analysis, critical thinking and decision making. These professional characteristics are a fundamental demonstration of change presently occurring and required of present day emergency management.

1.2.2 *Special Needs Inclusion into the Early Warning System*

In reality, every individual in society is a special need (Handmer 2003). A community is defined as individuals, groups of individuals and larger populations. Each one is different and requires different sets of needs. Disasters have a tendency to exploit those needs in unique ways. Most individuals have the basic physiological and psychological capabilities to function adequately to meet the challenges. Those populations that require special considerations, such as those who are Deaf or having hearing loss, can be at considerable disadvantage and risk during a hazard event. The current severe weather and tornado warning system uses both an auditory and visual alerting and warning process. Those with hearing loss are especially vulnerable and experience great difficulty at times receiving, interpreting and comprehending those transmitted alerts and warnings.

All segments of society exhibit various forms of expression, communicative discourse, customs and social etiquettes that make up communal values and beliefs consistent with culture (Samovar, Porter and McDaniel 2010). This is particularly relevant to the Deaf community and their culture. It should be noted that for this study, Deaf individuals and hard of hearing individuals were studied as one social group. The distinctions among Deaf (with a capital D) referring to individuals associated with the Deaf community and culture, deaf individuals (with a small d) who have significant hearing loss but are not identified as members of the Deaf community, and those that are hard of hearing with mild to severe hearing loss, make up the commonly referred to Deaf and hard of hearing community. Within each one of those separate categories several degrees of both clinical and self-identified distinctions of hearing loss and social acceptance exist. Of importance to emergency managers, policy makers and responders is the formalisation of warning and alerting protocols and processes cognisant of those special need cultural distinctions.

As a growing population associated with age related development, the Deaf and hard of hearing community is only one group challenged by the limitations of the early warning system. Severe weather and the quick on-set of conditions prevalent with characteristics of tornadic development pose a succinct danger requiring dissemination of accurate, directed information and the ability to quickly assess the options for undertaking protective actions. This study explores the contextual and practical difficulties of the Deaf and hard of hearing under severe weather and tornado hazards. The interplay of the early warning system, emergency management, and disaster education is critical to the preparedness and response for those needing special support and considerations from the current system. It is accepted here that all marginalised populations would become included as routine participants in planning and preparation of hazard related activities and that emergency management has an important role in that process.

1.3 Thesis Approach

Understanding the complexity of the issues affecting disaster risk education programmes may give some insight as to reasons why programmes or instructional approaches lack clear scientific context. Exploring factors which reflect the integration of system components may begin to give some indication. The thesis approach segments three elements of the system, the tornado EWS, emergency management, and the Deaf and hard of hearing community. These are all viewed within the context of educational programmes currently being utilized. Brief historical perspective of each is addressed to establish the conceptual and theoretical framework for the operational significance each plays within the overall system. Focus concentrates on identifying and defining how each segment functions differentially relative to its conceptual role, and how that role is perceived from an individual viewpoint. The two components where this is most evident are emergency management and the special needs community. Both require a highly people centric analysis to understand their constituent role in the system. The expectations of both groups singularly and with respect to the other system components, provide common indicators as to what tornado preparedness really means and to whom.

1.3.1 *Analytical Process Utilised*

The thesis process undertaken in this research involves 1) establishing the background for the existing framework which makes up the U.S. early warning system (EWS). The early chapters map the extensive literature defining the growth and development of disaster research and the evolution of scientific hazard study and the inclusion and impact of social science to this process. 2) The methodological framework consisted of a survey based approach for both emergency managers and individuals who are Deaf and hard of hearing. Although interlinked in the analysis presented by this thesis, each required different survey designs in order to collect the data diversity requirements; however, the process utilised in developing both surveys was similar. 3) Both emergency managers and the Deaf and hard of hearing community command distinct cultural aspects that are reflective of strong trust characteristics. Gaining that trust is an important responsibility for open discussion and free flow of information. Following the collection and analysis of the survey data a decision was made to change from using mainly focus groups to performing individualised interviews for follow up and clarification of pertinent issues and relevant questions associated with the data.

1.4 Thesis Objectives

Few studies exist which provide a directed analysis of the effectiveness of the early warning system and disaster education programmes currently in place. However, the literature gives evidence of several decades of research conducted determining if the warnings sent have any impact on individual response or behaviour (Wilkerson and Ross 1970, Drabek 1986, Mileti and Sorensen 1990, Drabek 1999, Golden and Adams 2000). In central Tennessee, warnings issued by local media at times appear to be over reactionary in some cases and cause more panic and public anxiety than providing instructional information designed to elicit positive protective response. This approach and "unintended" results are substantially different to those generally experienced in states where tornadoes are a relatively common occurrence and where news media appear to have a higher degree of expertise in technology analysis and warning message development and dissemination.

The thesis research therefore centres around three objectives related to the major aim of exploring the U.S. tornado early warning system on community preparedness and response affecting the role of emergency management and the impact on the Deaf and hard of hearing specials needs population. Objectives address three specific components of the system and attempt to assess the relational influences each contributes to EWS efficiency within the community.

> **Objective #1**: To assess emergency managers' opinions regarding severe weather/tornado early warning system processes, individual protective actions, and disaster education influences.
>
> **Objective #2**: To determine how the severe weather/tornado early warning system affects protective response behaviours among Deaf and hard of hearing individuals.
>
> **Objective #3**: To determine how disaster education is integrated within the severe weather/tornado early warning system and its impact on individual protective actions.

The question becomes one for determining if current warning processes positively integrate with emergency management practices and effectively influence protective actions of the special needs population? This further leads to a subcategory of inquiries to determine the effective implementation of appropriate warning strategies. Are existing tornado/severe weather communication mechanisms effectively utilized? Are current preparedness and response strategies designed for tornado/severe weather events adequately utilized under the present system? Do disaster education and training programs impact the public preparedness and response behaviours? The fluidity and interaction of societal elements and warning system components continues to create challenges needing constant adjustment and refinement. The thesis will contribute to addressing the theoretical, methodological and policy aspects of the early warning and response conundrum in society.

1.5 Methodological Considerations

The methodology for the research used a combination of approaches to develop a data collection mechanism. Investigation into current severe weather alert and tornado warning system and related education programmes includes data obtained from emergency management sources, weather media sources, and inquiries into a sampling of local non-governmental organizations (NGOs). These include use of survey questionnaires of both emergency managers and representatives of the Deaf and hard of hearing community, individual interviews of persons from both groups and conducting focus groups of persons representing both groups. Secondary data such as county emergency preparedness plans and operational protocols were also analysed. Although emphasis on collection focused on tornado hazard, the current U.S. preparedness and response philosophy focuses on an all-hazard approach. Therefore, some overlap into broader environmentally centred hazards was considered at times.

The complexity of emergency management operations and community factors required a different methodological approach. Determining the emergency management perspective involved the analysis of process, assessment of risk and the evaluation of policy specific to the tornado warning system. The Deaf and hard of hearing community data incorporates population demographics, accessibility to disaster education programmes, equipment needs, and availability and participation in preparedness programmes. Follow-up interviews were used in the methodological process for subsequent measurement and analysis.

Determining the existence and context of significant proactive community/public tornado disaster programmes underscores the need for research and expanded scholarly approach to the effectiveness of the early warning system progression. The design of research studies for improved warning message content directed toward public reception and positive responsive behaviour is therefore also a basic objective. The thesis proposes that identifying key variables for determining effectiveness criteria of the current warning system in use and providing a framework for scholarly design of a tornado disaster risk education programme producing measurable outcomes is a step toward a safer, people-centred and resilient community approach to this topic. The determination of effectiveness by many researchers is often avoided, and generally for good reasons. Effectiveness is difficult to measure. Furthermore emergence of disaster risk education as a significant factor in the disaster science-disaster risk reduction education paradigm underscores the critical need to bring further clarity to this dilemma. This thesis adds to the knowledge of early warning paradigm, developing better understanding of people-centred needs, and hopefully, furthers the continuation of scholarly work that makes communities bettered prepared, safer and resilient.

1.6 Thesis Outline

Chapter 2 represents the extensive body of literature relevant to early warning system design, development and evolutionary growth over the history of severe weather and tornado hazard research. The chapter highlights the research dedicated to technology advancements of hazard prediction, forecasting and detection, message development and human response behaviours. Literature devoted to the development of risk reduction awareness and disaster education is also included. The chapter addresses the various methodological approaches utilised in disaster research studies and illustrates the systemic construct of academic contribution to the formulation of applied early warning system development and implementation.

Chapter 3 describes the methodology used in this study as well as considerations, strengths, weaknesses, and designs comprising the methodological approach. As part of the overall analytical framework, the specific analytical approach accentuated the unique requirements of the populations studied and provided the flexibility needed to capture relevant data with consideration to the ethical and cultural constraints. The chapter describes the data retrieval methods that were adapted and required for the two diverse groups and the processes for development of the surveys. The chapter also provides a discussion of complexities associated with collecting data for each population as well as the ethical challenges the Deaf and hard of hearing population posed. In order to provide a foundation for understanding some of the inter-relational aspects of the U.S. early warning system and tornado hazard phenomenon, Chapter 4 looks at various elements that affect how and why the system operates in its present capacity. Specific factors that influence system interaction such as population demographics, communication and dissemination components, warning message impacts, individual decision making and behavioural characteristics affecting protective response, and the concept of public complacency to alerts and warnings illustrate the current system integration challenges. This background material is included to establish a basis for the findings of the thesis study.

Chapter 5 characterises the data derived from survey instruments related to both study populations. These results explore the perspectives and influences of emergency managers regarding the severe weather and tornado alerting and warning under the protocols and applications currently used within the early warning system. Both methods and sources for alerting were evaluated. Effectiveness of system components, public non-responsiveness and educational responsibilities were evaluated from the emergency manager viewpoint. The chapter also explores data for identifying and developing a general profile of the hearing loss community in Tennessee regarding tornado preparedness experiences and needs. The data describe population demographics, reliance on warning system components, preparedness, disaster education and training levels, and other influencing factors.

Chapters 6, 7, and 8 contain the findings based on the data collected for the thesis. The Findings chapters are approached in the context of the three major emphases of the study. Chapter 6 addresses those data relative to emergency management and its relationship and integration within the broader severe weather and tornado early warning system. Chapter 7 focuses on the various findings associated with the Deaf and hard of hearing population within affected communication parameters and preparedness and response actions. Chapter 8 looks at data addressing disaster education issues and their relationship to both emergency management and special needs population of the Deaf and hard of hearing. Communication, preparedness and education each provide distinct input for determining effectiveness of EWS components and for development of strategies responsive to diverse community populations.

Chapter 9 discusses the overall thesis data and its focus identifying those factors which influence and impact protective behaviours requiring the knowledge and understanding of the contextual parameters existing within the warning paradigm. The thesis conclusion, Chapter 10, summarises the key findings of the thesis as a whole. It addresses the pathway for integrating emergency management within the process of policy development and community implementation and encourages the promotion of applied evidence-based evaluation and outcomes associated with disaster education programmes. The chapter concludes with thoughts on future research, briefly addresses potential policy recommendations, and comments on pertinent thesis strengths and limitations.

Chapter 2. Literature Review

"Among these findings [*Human Reactions in Disaster Situations Report,* 1954], most significantly, people tend not to panic or become hysterical in a disaster, disasters bring out prosocial and innovative behaviors in communities, people do not wait for help and routinely do not understand instructions from outside disaster experts or readily conform to command and control regimes. …behaviour in disaster scenarios was socially constructed, contextual, and variable from community to community, while still conforming to discernible and predictable patterns."
Scott Gabriel Knowles, 2013, *The Disaster Experts*, p. 212-213.

2.1 Introduction

The concepts of disaster early warning, risk awareness and disaster education are the summative result of considerable research carried out over the past 70 years investigating natural disasters and the cumulative effects they have on our lives, communities and societal framework. The study of natural and physical sciences, which encompass the enquiry of cause and effect through earth's evolutionary process, has a much longer history. The relatively young study of the interaction between nature and people is both complex and often times little understood. What knowledge that does exist offers a snapshot into human attempts to calculate the forces of nature and establish a capacity and behaviours for living safely in a hazardous world. These clashes between nature's geophysical/meteorological events and the human behavioural response to those events produce a substantial gap on how best to bridge the phenomenological challenges faced. In order to mitigate the effects of disaster events the development of early warning systems evolved as one approach to alerting susceptible individuals to those dangers.

This thesis focuses on components of the U.S. early warning system in the context of tornado hazard, and the impact disaster education has on life safety issues as individuals and communities prepare and respond to tornadic activity. In the U.S., annual fatalities resulting from tornadoes contribute significantly to deaths resulting from severe storms and natural hazards (Summary of Natural Hazard Statistics 2012). Preparing individuals, families, and communities to understand and heed warnings, and to respond appropriately to take protective actions when tornadic activity is present, will ultimately minimize deaths and injuries. The research in this thesis is designed as a further contribution to the process of understanding why people respond or do not respond properly during tornado alerts and warnings and what can be done to increase their knowledge, skills and protective actions to reduce mortality and morbidity. As a relatively new focus of disaster research, disaster education is becoming more emphasised as a strategy concept within the disaster risk reduction field (Paton and Johnston 2001, HFA 2005, Burstein 2006, EMA 2006, OECD 2008). Most of the studies addressing disaster education are recent, found mainly in the late 90s with the majority of this research taking place in the 2000s.

As we shall see from the literature, early studies concentrated on the behavioural and sociological aspects of why and under what circumstances an individual may or may not respond to hazard warnings (Mileti and Sorensen, 1990, 2006). In March of 1952 a large tornado outbreak struck White County, Arkansas causing death and destruction. The aftermath investigation resulted in a 960 page report which would help define the methodological approach and research direction of tornado disaster study for decades to come, The report, *Human Reaction in Disaster Situations* (National Opinion Research Center 1954) provided findings that are still applicable in today's setting and reinforce much of the basic beliefs associated with tornado warning research and behavioural practices related to preparedness and response activities. Knowles (2013) describes the importance of this early research in this manner,

> "Among these findings, most significantly, people tend not to panic or become hysterical in a disaster, disasters bring out prosocial and innovative behaviors in communication, people do not wait for help and routinely do not understand instructions from outside disaster experts or readily conform to command and control preparedness regimes. The researchers, in sum, discovered the behavior in disaster scenarios was socially constructed, contextual, and variable from community to community, while still conforming to discernible and predictable patterns. Discovering these patterns set the research agenda for the following two generations of disaster researchers, who worked largely in academic settings and offered their results in academic journals, books, and conferences." (p. 212-213)

Warning message design and development, sender and receiver characteristics and public response processes have remained primary research areas. One reason for the specific development path of the research is that many of those who became interested in disasters were sociologists by profession and were specialists in collective behaviour research and organizational analysis (Laska 1990). Research into understanding the social effects of disaster continues to attract much interest today. As we will see however, the maturation of disaster research now includes bridging the gap between the natural and the social sciences. The result of this evolution in disaster research has opened up new emphasis and led to more disaster studies devoted to prevention, sustainability and resiliency. A people-centred approach integrated with institutional and political support can provide an environment whereby "rather than being vulnerable, people can be capable, resilient and able to protect themselves" (Collins 2009, p.39). Disaster education research will have a central importance in the next generation of research formulating disaster science.

The literature related to early warning systems has mainly focused in three general categories of study. They address 1) technology associated with detection of the natural hazard (tornado, flood, hurricane, earthquake, volcano, etc.)(Dvorak and Okamura 1987, Aguirre et al. 1991, Doswell et al. 1993, Franklin, McAdie and Lawrence 2000, Powell and Aberson 2001, Dean, et al. 2006, Jiren and Yesou 2006), 2) warning message development and dissemination (Mileti and Sorensen 1990, Mileti et al. 1990, Aguirre et al. 1991, Lindell and Perry 2004), and 3) receiver response and protective behaviours related to hazard warnings (Quarantelli 1980, Sorensen 1993, Drabek 1999, Balluz et al. 2000, Golden and Adams 2000, Sorensen 2000). The seminal research in these three areas establishes the foundational framework for the basis of what may be termed "warning science" knowledge. The resulting outcomes of this research merge the physical and meteorological sciences with the behavioural and social sciences, thus providing the backdrop for continued study in what Thomas Drabek (2010) aptly titled his book, *"The Human Side of Disaster."* The UN Global Survey of Early Warning Systems (2006) clearly recognized the importance of providing a comprehensive system worldwide while emphasizing a "people-centred" designed system that ensures natural hazards are managed and responded to appropriately.

This chapter on the literature is therefore providing an overview of the research and associated studies that have influenced early warning system development and have opened new insight and direction for the further promotion of disaster risk reduction and disaster education. The first section of this chapter explores the relational aspects found in the literature between the primary components of early warning research defining the interplay among technology, message development and response behaviours. The second section focuses on the evolving research dedicated to the further development of risk reduction awareness, risk reduction education and disaster education. This relatively recent focus in the research builds on the seminal studies and expands the research potential on a global basis to look beyond system development and inter-relational components. It is this next phase of disaster research that directs evidenced-based studies utilizing scientific evaluation for measuring how well our risk reduction and disaster educational strategies are meeting the challenges associated with promoting a culture of safety.

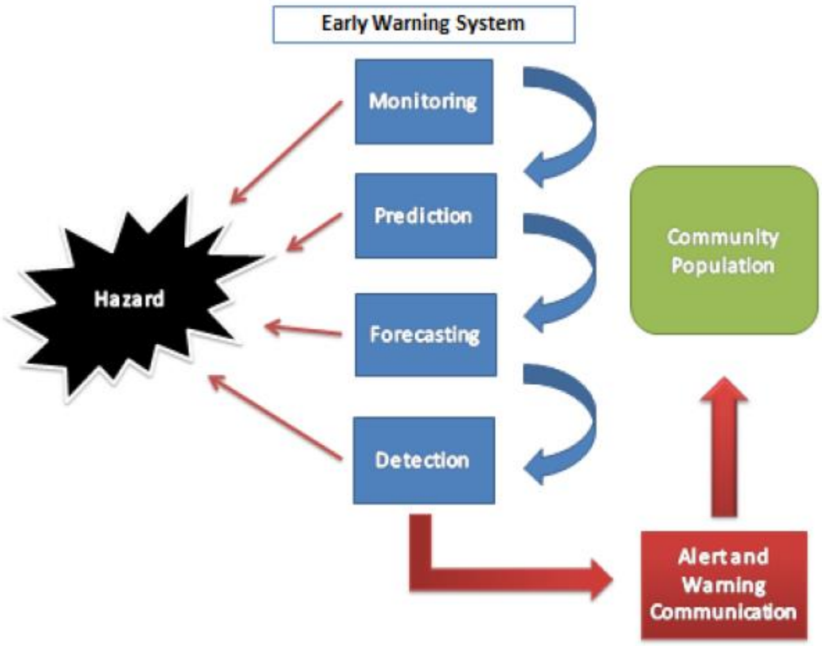
2.2 Historical Perspective of Early Warning Research and Development

The relationship between hazard detection and warning system design and development has evolved over some 70 years of research. In the 1950's and through the 60's research concentrated generally on natural and technological disasters. Natural hazards, be they earthquakes, hurricanes, floods, tornadoes, tsunamis or volcanoes have been studied for hundreds of years by scholars and researchers with expertise in the physical sciences (Anderson et al 1984, Doswell et al. 1993, Powell and Aberson 2001, Nelson 2010). During the 1970's researchers began to refocus their attention from human response to empirical studies learning how individual factors such as age, ethnicity, gender, and others impacted the response (Aguirre 1988, Perry and Lindell 1991, Fothergill 1996, Bateman and Edwards 2002). The progression of research later reflects a further focus shift addressing sender and receiver factors and their relational covariance to warning response (Sorensen 2000, 2006, Collins and Kapucu 2008, Feng and MacGeorge 2010). The perception of risk and why and how people respond or do not respond appropriately to hazard warnings has been approached from a scientific perspective for a much shorter timeframe.

2.3 The Technology of Prediction, Forecasting and Detection

Early warning systems rely on a complex mechanism integrating natural science, technology and behavioural response research. The limited ability of any one of these three components greatly influences the effectiveness of the entire system. Over the past 30 years, varying degrees of success has been attributed to predicting and forecasting of natural and technological disasters (Mileti, 1999). Prediction, forecast and detection processes are hazard specific, which add to the variations addressing their ability to accurately indicate the occurrence of a disaster (see Figure 2.1). The review of the literature related to this segment of the early warning system does not cover technological aspects associated with each hazard. The intent is to provide an overview for understanding the importance technology plays and the integration of process for providing information in developing the warning message and guidance for appropriate public response. Technology is the mechanism for data collection and drives the information dissemination process used to better determine risk and ultimately provide for the development of effective disaster education concepts. This technological focus is often government directed, adding to a lack of input from the community perspective which has led to a noticeable gap when considering the human impacts technology often overlooks or fails to consider. This disconnect is readily noted in the after action assessment report regarding the Joplin tornado of 2011.[1]

Figure 2.1 The Early Warning System



Source: J. Walsh

As the science for monitoring and detecting hazards becomes more precise and sophisticated, application of the data and information produced has the potential for a positive impact on improving people-centred warning processes. Sorensen's (2000) study reviewing hazard-warning systems over a 20-year period illustrates the important integration between prediction and forecasting technology and human response. His research centred on four specific areas; three dealing with improvement in prediction and forecasting, warning integration and warning dissemination, and the fourth addressing warning response. Researching 11 different hazards [see table 2.1] he finds that improvements have been minimal in most cases and that integration between technology (prediction/forecasting) and message warning delivery has produced a "checkered record."

[1] National Weather Service. *NWS Central Region Service Assessment Joplin, Missouri, Tornado – May 22, 2011*.

Table 2.1 Improvements in prediction, forecast, and warning integration

HAZARD	PREDICTION / FORECAST	WARNING
(1)	**(2)**	**(3)**
Flood	Some improvement	Not much improvement
Hurricane	Major improvements	Major improvements
Tornado	Some improvement	Not much improvement
Drought	Not much improvement	Not much improvement
Fire	Not much improvement	Not much improvement
Avalanche	Not much improvement	Not much improvement
Earthquake	Not much improvement	Major improvements
Volcano	Some improvement	Not much improvement
Tsunami	Not much improvement	Not much improvement
Landslide	Some improvement	Not much improvement
Nuclear Power	Major improvements	Major improvements
Hazardous Materials/Chemicals	Major improvements	Not much improvement

Source: Sorensen (2000 p. 119)

Early scientific research of earthquake hazard centred mainly on measuring physical aspects found in earthquake prone regions. Emphasis generally focused on studying geomagnetism, crustal structure, seismicity, heat flow, gas chemistry and electrical potential and conductivity (U.S. Geological Survey, 2009). The development of U.S. prediction modelling resulted from studies conducted from the Parkfield, California region where earthquakes and seismic activity has a significant history (Lindh et al. 1978, Bakun and McEvilly 1979). A number of comparative studies using seismogram data from different earthquakes along the fault led researchers to determine a pattern of earthquake occurrences on a predictable timeline. Along this same time and beyond, the literature offers numerous studies conducted by social scientists researching the correlation between adoption of earthquake hazard adjustments to the risk, looking at several demographic, personal and social influences (Jackson 1977, Nigg 1982, Turner et al. 1986, Mileti and Fitzpatrick 1992, 1993, Farley et al. 1993, Showalter 1993, Mileti and Darlington 1995, 1997). The perception of risk and risk reduction research will be addressed later in the literature review.

The Earthquake Prediction Research Center (EPRC) at the University of Tokyo actively conducts research using techniques to study areas such as spatio-temporal variation of crustal activity, preparatory process leading up to earthquake instability and the development of geophysical observation instrumentation and crust simulators. Technology research serves two purposes, to provide both a scientific and socio-economic distinction. Scientific advances in understanding earthquake dynamics help to produce more reliable results from prediction and forecasting processes. Research conducted by the Japan Meteorological Agency (JMA) studying short-term warning systems, utilising their nationwide network of earthquake sensors, produce warnings ranging from a few seconds to 30 seconds (McNicol 2006). Even extremely short timeframes can produce enough warning to take minimal precautions in high earthquake prone regions.

Much of the research literature devoted to assessing prediction and forecasting of hazards centres on scientific methods of analysis. For example, Nelson (2010) looks at long-term forecasting of earthquakes using paleoseismology – the study of prehistoric earthquakes. His study of fault zones, sediment layers and seismic gaps help determine geographical strain and the potential for earthquake occurrence. However, when assessing short-term prediction of earthquake, difficulties often arise. Nelson attributes prediction obstacles to two factors: 1) the difficulty in monitoring of earthquake processes that occur deep below the surface, and 2) determining consistent patterns in earthquake activity due to the variance in behaviour of earthquakes in different regions and along different fault lines. The related significance of this directly affects knowing how people respond to rapid onset disasters and developing educational strategies on what actions to take.

Goltz et al. (1992) studied what actions people took in the initial stages of the 1987 California Whittier Narrows earthquake. The research included interviews of people who experienced the earthquake in three venues, home, work, and on the road. Their finding indicate that fear was a motivating factor for taking protective action, this was especially true for those who were at home when the earthquake occurred. When testing for self-assessment for preparedness however, no direct association was found between taking cover and the level of preparedness. Although with individuals who felt they were better prepared and were very fearful, 64 percent sought protective cover. The overall conclusion of the study was consistent with disaster research literature (Drabek 1986) reflective of organised and rational behaviour. This is contrary to many beliefs and myths that erroneously describe disaster response behaviours as panic-driven and non-adaptive (Wenger et al. 1975).

The scientific advancements in hurricane and tornado prediction, forecasting and detection have increased significantly over the last two decades. Satellite technology providing real-time geostationary and polar imagery along with advances in forecast modelling provide scientists with data for studying hurricane development, water temperature and current flows, directional paths, and wind strengths. Forecast models vary in complexity and consist of four types of modelling systems; dynamical which is based on numerical computations designed to analyse atmospheric motion, and statistical models which analyse historical relational aspects between storm-specific data (location, speed, date) and storm behavioural patterns (Hurricane Prediction Center 2010). The third type, trajectory models use flow data from other dynamical models to predict hurricane path and direction. The fourth type of modelling system is an ensemble or consensus model designed to use data gathered from several models used in forecast and prediction science.

Tornado prediction and forecasting technology uses a multitude of real-time weather observations platforms consisting of satellite imagery, radar-derived winds, stationary weather stations, and weather balloon packages. These technologies provide precise data needed to locate fronts and drylines, collect moisture and temperature readings and find wind structures, which can rotate thunderstorms into supercells and potentially tornado development (Browning and Fujita 1965). The literature on tornado and thunderstorm development is extensive and complex (Starrett 1951, Doswell III 1985, 1993, Burgess 1993). The research studies devoted to radar development and the numerical cloud models (Weisman and Klemp 1984) helped established the use of radar as a primary technology for severe storm and tornado research and has had a significant effect on severe storm and flash flood warning programs. Radar development made major progression in 1964 with the establishment of the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory (NSSL). A series of radar advancements over the years has led to the use of the Weather Surveillance Radar – 1988 Doppler (WSR-88D) system and continues through to today's NEXRAD-next generation radar.

In their study of the WSR-88D's benefit to weather forecasting, Pollger el al. (1994) studied comparative data using conventional radar and data following deployment of the WSR-88D in five exact locations throughout the southeastern and south central U.S. region. This region is susceptible to severe storms, tornadoes and flash floods. The study used quantitative evaluation consistent with the verification processes and statistical measurements used by the National Weather Service. They found that the use of the WSR-88D provided increase lead times and detection probabilities for severe storms. This was especially significant with respect to improvement of flash flood warning where lead times increased from 12 minutes to 24 minutes.

In a later study of the WSR-88D, Zmic et al. (2004) began researching the future capabilities of the radar using a number of complex testing measurements and algorithms. Collecting data on precipitation measurements and testing procedures for weather forecasting and warnings, they determined that the capabilities of the WSR-88D will help scientists develop more automated ability to precisely identify storm inception, shorten tornado lead time detection, and assist in the further development of numerical and hydrologic models for better prediction of flash floods. However, focus must be an integration of human behaviour and technology requiring more extensive study into how each interacts and are mutually affected by the other. Without the recognition of technology as an influencing factor on human action, its benefits may be misdirected or ineffective.

2.4 Warning System Research

In the early 1960's social science research began studying the effectiveness of hazard warnings (Mack and Baker 1961, Moore et al. 1963, Drabek 1969). These early studies and the approaches to developing more knowledge related to warnings began to focus on organisational system components and processes (Quarantelli 1980, Perry et al. 1981, Rogers 1989, Perry and Godchaux 2005), and identification of factors contributing to the complex relationship of message structure (Perry and Green 1982, Rogers 1985, Nigg 1987, Mileti 1995). These factors commonly addressed consistency and specificity; sender and receiver perspectives addressing understanding, comprehension, credibility and believability; and a host of intervening factors affecting warning response related to socio-economic levels, ethnicity, gender perceptions, hazard experience, knowledge and age.

As warning system research progressed, the characteristics of factors presented themselves in hazard specific focus. This expanded the knowledge of not only how warnings were received and interpreted but how and why those factors may or may not demonstrate linkage and consistency in comparing the research results among the specific hazards. The trend in this inter-hazard research has led to the belief that individuals and communities are more heterogeneous than homogeneous in their response to warnings. In many cases, this affects positive behavioural response based on knowledge, experience, motivation and perception of risk.

The literature contains numerous theoretical models and illustrations defining the warning system process (Worth and McLuckie 1967, Anderson 1969, Rogers 1985a). Mileti and Sorensen (1988) describe four fundamental components that make up this process consisting of: 1) reception of the warning message or alert, 2) understanding/comprehension of the warning, 3) acceptance or belief in the message, and 4) decision to respond. This simple framework is the basis for a complex interaction between message design, dissemination, confirmation and decision making that is influenced by multiple factors within each sequence of events. These “determinants of human response” as outlined by Mileti and Sorensen, provide a theoretical understanding and historical framework for describing how the research evolved. Two main categories relate to sender determinants and receiver determinants, which are further aligned into four sub-category attributes consisting of message design and content; channelling mechanisms for transmitting messages; message dissemination frequency; and source attributes that include both individuals and organizations responsible for delivery of the message. The contextual nature of early warning research however, necessitates the need for further studies inclusive of an interventional approach for determining what best influences positive protective action when encountering a hazard event.

2.4.1 *Message Attributes*

Empirical studies related to message design and context point to five identifiable attributes that are characteristic of warning system messaging: 1) specificity, 2) consistency, 3) accuracy, 4) certainty, and 5) clarity. We see from the literature that message specificity regarding the type of hazard, risk involved, location and appropriate responsive behaviour is essential to achieving proper message content (Fritz 1957, Flynn and Chalmers 1980, Lindell et al. 1980, Perry et al 1982a, Nigg 1987, Bellamy and Harrison 1988, Demarchi and Rota 1990, Gruntfest 1997). Rogers (1985) and Sorensen (1985) conducted research designed to study consistency of the warning message. Each found that it is necessary to maintain static design in both context and structure if the warning is to be properly understood. Belief in the warning is another element that interfaces with other message attributes. Studies that have addressed believability have found that messages disseminated from official sources, and/or sources that are familiar to the recipient, are better accepted and may positively affect responsive behaviours (Mack and Baker 1961, Mileti 1975b, Turner et al. 1981). Warning messages that are personalized to address a targeted audience (Bates 1963, Perry, Lindell and Greene 1983, Nigg 1987) are found to be better received and are conducive to producing positive response behaviour (Mileti et al. 1975, Quarantelli 1980, Turner et al. 1981, Nigg 1987).

Accuracy of message information is a major factor in message design. Although this may seem self-evident and somewhat obvious, the literature delineates accuracy in a more contextual framework. The lack of pertinent and factually relevant information significantly minimises one's ability to comprehend and confirm warning content which may further lead to ultimately responding improperly or not responding at all. The certainty attribute pertains to the sender's confidence that the information contained in the warning message is appropriate. This "certainty" focuses on information segments addressing location, the level of risk and steps to take for responsive action (Turner et al. 1979, Foster 1980, Nigg 1987). Hammer and Schmidlin (2002) in studying a tornado that struck the Oklahoma City, Oklahoma area in 1999 determined that appropriate response behaviour is more influenced when the warnings includes guidance information directing the public on what actions should be taken. Confirmation of the occurrence of the hazard also had a positive influence on people's tendency to respond. However, determining what works more effectively from both an emergency manager perspective and that of individuals with hearing loss could assist in refinement of alert and warning protocols

Reflective in the literature are numerous studies addressing understanding from the public of the warning message content (Berry, 1999a). Proper understanding of message particulars directly influences one's perception of the risk, confirmation, acceptance and public response (Mileti et al 1975, Lehto and Miller 1986, Nigg 1987, Bellamy and Harrison 1988, Berry 1999b).While message attributes are one aspect of a warning system and have occupied major research attention, further components emerged. As message content and style are viewed as important research elements primarily affecting sender characteristics, three other attributes initiated another tier of receiver directed research. The literature derived from these has led to numerous studies that make up additional seminal research from the social sciences related to "warning science." This receiver directed research can be compartmentalized into social attributes of the receiver, psychological attributes and finally, physiological attributes.

2.4.2 *Receiver Attributes*

The receiver social attributes have produced significant literature conducted around four clearly designed areas of research: 1) social networks, consisting of societal framework of the recipient and how those social environments affect response actions, 2) resource attributes, which comprise physical, social and economic resources available to receiver; 3) role factors, which are characterized as education, age, gender, etc. and, 4) cultural attributes reflective through, religious beliefs, ethnicity, language, social, and economic class.

Related to social network research, Anderson et al. (1984) and Aguirre, Wenger and Vigo (1998) studying the evacuation behaviour of occupants in the World Trade Bombing in 1993 found strong social networks increase the likelihood for warning response. However, this appears to contradict their initial study of evacuation behaviour (Wenger, Aguirre and Virgo, 1994) at the WTC bombing in 1993 when they determined that a person with membership in social networks is less likely to respond. The element of social networks influencing behaviour from an ethnicity perspective in a number of hazard venues has also been closely studied. Studies by Dow and Cutter (1998) and Peguero (2006) are two which looked at hurricane evacuation patterns of Hispanics. In their research of dissemination of hurricane mitigation information following hurricanes, Hispanic homeowners preferred receiving disaster information from family members and persons who were of similar ethnicity. This follows along the rational of similar research conducted by Aguirre (1991) in studies related to message acceptance and confirmation related to the Saratoga, Texas tornado.

Access to a variety of social, economic and physical resources can significantly impact behaviour response from a number of perspectives. Edwards (1993) found that in researching preparedness and self-protection behaviour associated with earthquake prediction hazard that one's access to more social resources, related to higher income and higher education, increased warning response. In his 1993 study of earthquake prediction behaviour, Farley arrived at the same conclusion with regard to education, but when adjusting for message believability, he found that at the lower education level**,** there was a more likelihood to believing the warning, compared with the population who possessed a higher level of education. However, Liu et al. (1996) found that the lower the education a person has, the less likely to act when response is needed to a tornado warning.

Income is another factor that has been included in many studies related to warning system response. As a variable, income data is common in studies and its influential impact is of interest. In his study of nuclear warning systems, Sorensen (1982) concluded that a person from a higher socio-economic background is more likely to believe a warning message. Perry and Lindell (1991) in studying ethnicity associated with evacuation warnings concluded that no relationship existed between a person's income and their likelihood to respond, but Duval and Mulilis (1999) found having resources increases the likelihood to respond, but also determined that there was no relationship between having moderate resources and responding behaviour. In surveying 146 individuals who survived an Arkansas tornado where 26 fatalities occurred, Balluz et al. (2000) determined that having access to resources in the form of shelter, sirens or a family plan increases the likelihood of responding appropriately. Riad and Norris (1998) in their study of evacuation decision making processes found no relationship between a person's resources and their likelihood to respond. When adjusting for social network associations, they determined that greater social influence, such as relationship cohesiveness, produced a greater likelihood to respond and that a person experiencing lower social status is more likely to respond as well.

Literature characterising role factors such as education, age, gender, and other social parameters is quite common but the studies addressing the relationships between age and responsive action have produced widely varied conclusions. Some have been negative, some positive with some studies finding no effect at all. The literature addressing age as a determinant for positive warning message response is highly mixed, though offering conclusive results within contextual environments. Freidman's (1961) research into the differentiated reaction to losses between younger and older persons, found the older a person is, the less likely they are to believe and respond to a warning, as did Gruntfest (1977, 1997). Likewise, when Mileti and Darlington (1997) looked at earthquake prediction response they found older aged individuals to be less likely to respond. Dr. Ronald Perry has studied response behaviours for several decades and researched evacuation patterns of individuals in hurricanes and other hazards requiring flight or evacuation involving threatening situations. In his 1990 meta-study of message response research, his findings were contrary to research conducted in the 40's through the 60's which generally indicated that older persons are either more likely or equally likely to comply with evacuation warnings than persons of younger age groups. Perry and Lindell (1997) using data from nine disasters show that individuals over 65 are no less likely to comply with disaster warnings than other age groups. Cutter and Barnes (1982) in their research of the Three Mile Island disaster found older persons are more likely to respond. Overall, the literature is composed of conflictive findings when analysing the correlation between age and warning message response.

Those studies factoring for gender have more consistent findings in that women tend to believe and respond more readily to warnings (Flynn and Chalmers 1980, Farley et al. 1993, Fothergill 1996). However, Mileti and Darlington's (1997) findings are consistent with Duval and Mulilis' (1999) where both concluded that no relationship between a person's gender and their likelihood to responding to a warning message existed in their respective studies. Bateman and Edwards' (2002) study of hurricane evacuation associated with Hurricane Bonnie in 1998 used a series of bivariate and multivariate logistic regression analyses, and determined that women were in fact more likely to evacuate than men. They attribute this to a number of societal constructs differentiating existing roles among women and men. As caregivers they found women have a higher exposure to and perception of risk and therefore were more adept to take responsive measures. This diversity of factors directly influences alert and warning protocols and the development of public policy implemented through the early warning system. Failure to integrate those elements effectively impacts system operators (emergency managers) and the public they serve.

Cultural attributes associated with religious beliefs, ethnicity, language, social and economic class, also have been at the topic of much research and are readily noted in the literature. Nigg's (1987) research focused on the communication of warning and response processes from both an organisational and individual analytical framework. Her findings indicated that persons associated with membership within a minority group are less likely to believe a warning message. Lindell, Perry and Greene (1980) specifically studied the relational association of race and warning response interviewing over 150 flood victims. They found three distinct racial differences in comparisons between Mexican-Americans and whites: 1) more scepticism was found in Mexican-Americans related to believing warning messages, 2) Mexican-Americans were less likely to evacuate, and 3) Mexican-Americans perceived a lower danger of risk. However, Mileti and Darlington (1997) found whites less likely to personalize a warning message than a person of colour.

Studies that show a correlation between message personalisation, believability and response would conflict with the findings of Perry and Green (1983). Perry, Greene and Mushkatel (1983) in their multi-year study of minority response behaviours to disasters found blacks were more likely to respond than non-blacks. In cases where perceived risk was low, blacks still tend to take some protective actions where Mexican-Americans and whites tend to carry on with their normal activities. The seminal study of Benigno Aguirre et al. (1991) Saragosa, Texas tornado in 1987 that killed 30 and injured 121 looked at language in relation to warning response. As a result of his research warning message design, content and dissemination processes underwent significant review and drew attention to the need for ethnicity driven language specific warnings to targeted populations.

Those attributes delineated by recipient activity at the time of message dissemination are found in a number of studies in the literature. Studies have shown that families or family groups, who are together in the same place, at the same time as the warning is issued, are more likely to respond (Dynes et al. 1976, Flynn 1979, Cutter 1987). In Sorensen's (1984) study of nuclear plant emergencies, he found that persons who were home at the time a warning message was delivered were more likely to respond. However, Mitchem (2003) concluded that those involved in recreational activities at the time of the disaster are less likely to hear the warning. The same findings were true for those in travel during message delivery.

The research devoted to message formulation, dissemination and reception is extensive but often in conflict with findings based on contextual environments and individual complexities. There remains a challenge for social scientists and disaster specialists in sorting out those influences that best aid in providing protective response guidance and appropriate decision making.

2.4.3 *Psychological Attributes*

Preparedness issues are significantly impacted by the mental capabilities and capacities possessed by the warning message recipient. Knowledge of the hazard, experience with the hazard, understanding of the warning process, and perception of risk derived from the hazard, all affect how one will react and respond to a specific hazard threat. Anderson (1968) found that the more one is familiar with a specific hazard and has experience with the hazard, a habituation effect may take place, resulting in the likelihood of failure to respond. Glass (1970) reached this conclusion also in his study of psychological aspects found in emergency and disaster situations. Regarding flooding disaster in two communities in Scotland, a study conducted by Ketteridge and Fordham (1998) concluded that the more experience one has with a hazard, the less likelihood there is to respond to the warning. When investigating disaster warnings and response to the 1990 Mt. Unzen volcano in Japan, Yoshii (1992) found that prior hazard experience leads to less likelihood for response.

Rosenthal's (1988) study of Holland's 1953 flood disaster concluded that past experience would lead to more believability and response to a warning message. Likewise, in researching resident preparedness and response issues involving the 1980 Kalamazoo, Michigan tornado, Hodler (1982) concluded that personal experience with tornadoes resulted in more likelihood to respond. Blanchard-Boehm (1998) also found in her study of applying risk communication to probabilities of future earthquakes that prior experience and familiarity with the hazard produces a likely response effect. Burby and Wagoner (1996) found that more knowledge, experience/exposure and perception of risk increase the likelihood of responding to a warning message. However, in a 2001 study conducted by Rincon, Linares and Greenberg regarding the effect of previous hurricane experience affecting preparedness for future hurricanes, they found no statistical differences between one population who had previously experienced Hurricane Andrew and one which did not.

The social psychological perceptions of risk regarding evacuation appear to be formed in a disaster prior to taking protective action according to Fitzpatrick and Mileti (1991). They found that risk perception plays a role in a person defining whether they are in danger and that fleeing the hazard will minimise or reduce the danger. They found a correlation between perception, motivation and responsive action. The increase of risk perception can also be affected by prior emotional injury suffered from a previous disaster. Siegel et al. (2003) studied respondents four years post-disaster from a California earthquake and found that emotional injury from one disaster facilitates preparedness activities related to hazard mitigation for a second disaster. Riad, Norris and Ruback (1999) found that individual characteristics, social influence, risk perception and access to resources, all played a varying role in people’s non-evacuating reasoning. This diverse justification of factors influencing why individuals heed warnings and seek shelter was also confirmed in research related to the 2000 Mozambique floods (Collins and Lucas 2002). This was then extrapolated further for contexts of infectious disease risk reduction in the same region (Williams et al. 2010).

2.4.4 *Physiological Attributes*

At risk and vulnerable populations are at a distinct disadvantage when faced with disaster. Sullivan and Häkkinen (2011) found that mitigation protocols during a disaster are often lacking or too general to be of much value. Tsunami studies of casualty results have focused on gender and the impact they exact on local populations. Yeh (2010) found that mortality rates were higher for females than males of prime ages. This phenomenon is attributed to strength, stamina, and one’s ability to swim and run. However, Alam and Collins (2010) found that in Bangladesh factors related to non-use of cyclone shelters and conservative religious beliefs are also influential in this outcome. A higher proportion of young children and the elderly sustained higher loss of life in tsunamis occurring in India, and Indonesia and Sri Lanka (Guha-Sapir et al. 2006, Nishikiori et al. 2006, Doocy et al. 2007).

For those with limited movement, the capacity to maintain mobility during a disaster event, whether pre- or post-disaster, can place the physiologically challenged individual in considerable peril. Preparedness planning inclusive of vulnerable populations is sparse and improvements in policy and protocol expansion is greatly needed (Fox, 2007, Twigg et al. 2011, Twigg 2014). What seems remarkable is the only recent focus given to disability in disaster risk reduction in the international disasters policy environment (UNISDR 2013). This is reflective of the years of policy gap existent at all levels of governance. Acknowledgement was recognised within documents but lacked the follow through commitment within operational implementation. Of significance to this study, persons with hearing loss are identified as another physiologically vulnerable population. Wood and Weisman (2002) cited the paucity of research devoted to understanding how Deaf and hard of hearing persons receive, comprehend and use alert and warning messages. The use of closed captioning by meteorologists during severe weather reporting poses additional challenges due to characteristic limitations and broadcast utilisation; for example, meteorologists turning their back to the viewers preventing lip reading which results in loss of critical information. It is not just a matter of message transmission but how that message is "…interpreted within the socio-cultural context of the receiver" (Phillips and Morrow 2005, p. 1). Phillips and Morrow offer a quote from a Gallaudet University student to stress the importance of the requirement for deeper understanding of the cultural context needed, "…it is not just a matter of knowing sign language. It takes years of training to become an interpreter who can work with a group like this, and it takes an understanding of the deaf culture to be effective."

As we have seen, the literature is full of research confirming and denying the merits of the characteristics of warning messages. Interestingly, Salter et al. (1993) published findings from their research into severe weather related warning systems in Australia using warning message characteristics. In looking at warning message effectiveness, they determined that risk is the result of social construct and not an objective scientific phenomenon. This raises an interesting issue and may offer a possible answer to the wide range of findings in the literature concerning warning message characteristics and their effects. The literature associated with the behavioural aspects of disasters is quite extensive and as we have seen, extends across numerous specific hazards integrated among social, economic, cultural, ethnological, educational and a host of sociological and psychological factors affecting human response to disasters. However, it remains to be fully understood as to the impacts derived and applied to the systemic environment encompassing disaster science. The complexities at this point are too numerous to offer a clear, definitive direction as to what works best in all situations. The next section explores the literature related to disaster risk reduction, it's fostering of resiliency building and mitigation strategies and the conceptual and operational framework which support and enhance the need for establishing a clear direction for a disaster education emphasis.

2.5 Disaster Risk Reduction

2.5.1 *Historical Framework*

Increased focus on individual, community and world-wide vulnerability due to climate change, socio-economic factors, urbanisation and demographic changes, and technological conditions are very much a reality in today's societal environment. Reducing risk and increasing capacity for responding to disaster events crosses all levels of society and is of interest to developed, developing and lesser developed nations. Disaster risk reduction (DRR) is a world-wide challenge and has been the main focus of numerous international conferences and meetings (IDNDR 1997, HFA 2005, ISDR 2007, WCESD 2009, SFDRR, 2015). Of late, some of the key assemblies have stated the need for reducing risk from disaster under the broad context of sustainable development which has led to the production and emphasis of a number of strategies and approaches designed to address risk reduction and vulnerability on a global basis (UN/ISDR 2006, WDR 2014, SFDRR 2015).

The United Nations (UN) General Assembly provided the impetus by declaring the 1990's the International Decade for Natural Disaster Reduction (IDNDR). This disaster prevention emphasis was the result of increased loss of life and considerable property damage observed during the 1980's. The World Meteorological Organization (WMO), a specialised agency within the UN system, played an important role in the IDNDR preventive strategy as a "necessary framework for the monitoring, prediction, and coordination of the issuance of the warnings of disasters of meteorological and hydrological origin…" (Obasi 1994, p. 1657). This emphasis on preparedness and pre-disaster planning by the WMO assisted the IDNDR in placing a "high priority on improvement of monitoring, research into meteorological and hydrological hazards in order to enhance warning systems, risk assessment, technological exchange, public information, and training." (Ibid., p. 1661).

The Yokohama Strategy and Plan of Action (1994) established a set of Principles designed to highlight stakeholder involvement and participatory inclusion into the process of disaster preparedness and prevention, risk assessment, early warning development and mitigation of disaster effects. Its focus was clearly directed toward the needs of underdeveloped and least developed nations and the responsibility of technology sharing from the international community. The Principles outlined the following conceptual framework for emphasising the introduction of prevention and preparedness measures (Yokohama 1994, p. 6-7):

1. The use of risk assessment as a pivotal element for forming policies and measures of disaster reduction.
2. Reduction of disaster relief is reliant on disaster prevention and preparedness.
3. Development policy and planning at all levels of government organisation should incorporate disaster prevention and preparedness concepts.
4. Top priority should include developing and strengthening of the capacity to prevent, reduce and mitigate disasters focused on continuation and implementation of goals for the Decade.
5. Emphasis of early warning strategies for furtherance of effective disaster prevention and preparedness.
6. Participatory activity of all levels of government enhances more effective preventive measures.
7. Appropriate education and training of the whole community addressing targeted groups can reduce vulnerability.
8. The international community must take responsibility and become an integral participant in providing technical knowledge and assistance in disaster prevention and preparedness activities.
9. As part of sustainable development and its impact on poverty alleviation, environmental protection must be a primary focus of disaster prevention and mitigation.
10. The international community must emphasis the responsibility each country has toward the safekeeping of its population and related infrastructure in protection from the impact of disasters. The international community must also demonstrate its willingness to provide technological, financial and scientific support to the world's developing and least developed countries.

The International Strategy for Disaster Reduction (ISDR) was established by the UN in 2000 to further prevention and preparedness activities associated with disaster risk reduction fostered under the IDNDR. Its main purpose is to promote sustainable development through the reduction of disaster losses and to build resiliency in communities and countries. It has become a focal point of an assembly of nations, organisations, governments, financial institutions and technology groups working together with the objective of reducing disaster risk. Its further development into a systemic framework for operation serves as an implementation platform for the Hyogo Declaration and the Hyogo Framework for Action 2005-2015 (HFA).

The World Conference on Disaster Reduction (WCDR 2005) in Kobe, Japan helped define and streamline a specific set of strategies and approaches for promoting the reduction of impact from disasters through the strengthening of local and national capacities. These involved reducing vulnerabilities and risks to hazards and the establishment of identified mechanisms for building resiliency. The 168 nations in attendance adopted five priorities for action which make up the substance of the HFA. The action items committed the governments to: ensure that disaster risk reduction is a national and a local priority; identify, assess and monitor disaster risks and enhance early warning with a strong institutional basis for implementation; use knowledge, innovation and education to build a culture of safety and resilience at all levels; reduce the underlying risk factors; and, strengthen disaster preparedness for effective response at all levels (HFA 2005). At this year's UN World Conference on Disaster Risk Reduction in Sendai, Japan, the Sendai Framework for Disaster Risk Reduction (2015) expanded the scope of disaster risk reduction to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks. A strong emphasis on this conference and for the next 2015-2030 Sendai Framework period is on worldwide health resilience as stated in one of the framework's priorities.

> "To enhance the resilience of national health systems, including by integrating disaster risk management into primary, secondary and tertiary health care, especially at the local level; developing the capacity of health workers in understanding disaster risk and applying and implementing disaster risk reduction approaches in health work; promoting and enhancing the training capacities in the field of disaster medicine; and supporting and training community health groups in disaster risk reduction approaches in health programmes, in collaboration with other sectors, as well as in the implementation of the International Health Regulations (2005) of the World Health Organization." Priority 3: Investing in disaster risk reduction for resilience, National and local levels, 30(i) p.19.

Of relevance to this thesis is the thematic discussion during the WCDR concerning people-centred early warning systems (EWS). Following along the seminal studies addressing behavioural aspects of warning messaging and reception, the Kobe Report called for the establishment of early warning systems that contain factors which evoke community understanding, acceptance and integration from a people-centred approach. Regardless of the technology utilised, EWS must incorporate factors which reflect community involvement and understanding. Five central elements emerged from this session that help to provide a conceptual framework defining people-centred early warning systems. First, effective EWS must incorporate both a “bottom-up” and “top-down” operational framework. Community support and involvement must incorporate identification of needs, patterns of vulnerabilities, and establish an environment of legitimacy to ensure internalisation for proper responsive actions to occur. Second, the use of intuitive warning techniques is necessary to account for differences in population education levels. Examples using videos of never before encountered eruptions involving volcano hazard helped convince local officials and the community of the seriousness of the situation and resulted in successfully evacuating thousands of individuals.

Third, data collection processes, monitoring responsibilities and warning dissemination should utilise community involvement as a component of early warning. The use of simple technologies such as rainfall and river gauges can help communities monitor hazard indicators and provide a local mechanism for distribution of warning information. Fourth, the expansion of EWS within existing community communications systems provides a multi-function approach for community services. Local radio systems which are already in daily use offer advantages of existing and regularly maintained assets that can be used during emergency situations. Fifth, community education must be part of a comprehensive awareness program. Preparedness and risk reduction depend on a knowledgeable and response capable populace.

These five elements derived from the World Conference on Disaster Reduction emphasise the importance of community input to the framework of the disaster risk reduction concept. The establishment of sustainable development relies on people-centred approaches and strategies designed to reduce risk, encouraging the building of resilient communities and promoting an environment of community, national and international cooperation and collaboration. The demand for linking disaster management with sustainable development was reflected earlier in the rationale behind the world’s first postgraduate programme established at Northumbria University in 2000. This was complemented also by its subsequent launch of the Disaster and Development Centre (DDC) in 2004 and the Disaster and Development Network (DDN) in 2013 also as partner organisations of the UNISDR. The historical background of literature addressing disaster risk reduction clearly outlines the direction, systems and mechanisms for successful outcomes. The literature addressing risk includes much scholarly work (Weinstein and Micolich 1989, Blaikie et al. 1994, Adams 1995, Mulilis and Duval 1997, Wisner et al. 2004, Lindell et al. 2005), organisational and conference reports (HFA 2005, ISDR 2008, Sendai 2015), government documents (AusAID DRR Progress Report 2010) and Not-for-Profit group reports (OECD Stocktaking Report 2008). This array of literature sources and how they integrate within the overall field of disaster study is elaborated in the following section of the literature review. However, risk, its perception and its reduction interact with and affect the sociological and behavioural actions of both individuals and groups. These complex relationships and associations can be further affected by and through disaster education as addressed in the final section of this chapter.

2.5.2 *Integration and Implementation of Disaster Risk Reduction and Risk Perception*

As disaster risk is often comprised of a complex array of social, economic, environmental, political and perceptual factors, the challenge is how to integrate this knowledge comprehensively to identify when, where and with whom early action must be taken (Collins 2009). Much of the current literature addresses individual cognitive processing of risk and the perception of risk, but few studies look at risk perception as a comprehensive association of effects intermingled between household characteristics, hazard proximity, experience, and information sourcing and reception. Studies exploring the relational effects on response to perception of risk involving comparison between multiple hazards is limited as well (Lindell and Hwang, 2008).

Risk perception is often characteristic of hazard experience and knowledge (Siegrist and Gutscher 2006, Bradford et al. 2012, Kellens, Terpstra, and De Maeyer 2013). Although, not all localized and contextual experiential learning can be associated with positive risk perception and proactive response behaviours (Hopkins & Warburton 2015). Overall the literature is varied as to the impact risk perception has on individualised action. Often the contextual aspect of risk perception is viewed from a perspective of the specialist (scientist-technologist), concerned with the estimating the size and consequence of the impact, as opposed to the public interests of individualised safety and survivability (Kletz 1996). The acknowledgement of opposing focus does not negate the reality that disaster risk perception is complex and plays an integral part in the conceptual framework of early warning systems, institutionalisation of process, and factors impacting public response (Douglas, Smith, & Violanti 2000).

As with much of the previous literature we have reviewed, the studies involving risk tend to utilise hazard specific phenomena to help explain causal effects or response behaviour. Lindell and Whitney (2000) in their study of the adoption of hazard adjustments (risk reduction actions) look at correlation of demographics characteristics and perceived risk, perceived seismic hazard knowledge, protection responsibility, actual adoption adjustments, and adoption intentions related to earthquakes. Their findings were mixed in their support of previous studies (Turner et al. 1986, Mileti and O'Brien 1992) citing the existence of systemic differences in adopting adjustments among various segments of the population. They found no significant correlation between respondent's risk perception related to seismic hazard adjustments and their intention to adopt or their actual adoption of hazard adjustments. A meta-analysis of 23 seismic hazard adjustment studies also found little correlation between demographic variables and substantive positive change in seismic hazard behaviour (Lindell and Perry 2000). However, some research counters this position finding definite correlation of household demographics to adaptive action (Dooley et al. 1992, Russell et al. 1995, Spittal et al. 2008).

In studying risk perception regarding flood hazard Grothmann and Reusswig (2006) look at two aspects of adaptation research. Focusing on property damage rather than loss of life issues because of the minimal death rates in Western Europe caused by flooding, their first approach was to look at socio-psychological adaptation related to subjective threat appraisal (risk perception) and coping appraisal.[2] Their second focus was identifying factors used to promote actions for limiting or avoiding property damage due to flooding. The hypothesis was formulated from studies addressing under-responsive actions to avoid risk of injury, death or property damage (Peek and Mileti 2002). They found that just influencing an individual's risk perception may not necessarily produce a proactive response for protection avoidance. People must internalise an individual responsibility for taking private

[2] Grothmann and Reusswig used a socio-psychological model called Protection Motivation Theory (PTM) to study the relation of risk perception to property loss. PMT is one of several models frequently used in risk studies. The others include Person-Relative-to-Event (PrE), Protective Action Decision Model (PADM), Social Cognitive Theory (SCT) and the Transtheoretical Model (TTM). Although other models exist, those used in risk and disaster studies are generally adaptive from the domain of psychological research on health behaviour and health education (Health Belief Model (HBM), AIDS Risk Reduction Model (ARRM)). Literature addressing tools specifically designed for measuring effectiveness of disaster strategies, programs or education is rare. Behaviour measures related to preparedness such as the Mulilis-Lippa Earthquake Preparedness Scale which have undergone validity and reliability scrutiny are extremely limited as well.

precautionary measures reflective of the costs and consequences for non-action. Findings also determined that in order to counter inaction, effective risk communications from authorities must include the message that limitations in public flood protection measures exist. This personalisation of hazard events and the influence of authoritative sources are also expressed by Lindell and Perry (2004).

Of particular interest to this thesis are the relationship between risk, the communication of risk (disaster education) and the effects of that communication for impacting responsive and adaptive behaviour. The effects of risk perception on influencing behavioural adaptation to various hazards are well documented in the literature (Lindell and Perry1990, 2000, Mulilis and Duval 1997, Johnson 1999, Neuwirth et al. 2000, Peacock et al. 2005). In looking at the value of a flood risk communication program in the Netherlands, Terpstra et al. (2009) only found modest support for indicating risk communication significantly impacts risk perception. In turn, addressing risk perception alone, without emphasising specific responsive actions, may not produce proactive behavioural change (Grothmann and Reusswig 2006). However, a number of studies in the literature do support the position that the higher the perception of the risk, the higher the level of responsive behaviour there is (Neuwirth et al. 2000) and the greater likelihood of personalising (Perry and Lindell 1986) and believing (Turn et al. 1981, Perry et al. 1983, Roger 1985) a warning message when received. As we have seen, a substantial amount of literature confirms the positive association between belief in the communication (message) and positive responsive actions.

Factors such as perceived vulnerability, subjective hazard risk knowledge, and past experience related to recognition of risk can influence the effects of a risk communication strategy impacting protection motivation (Martin et al. 2007). Martin believes that to increase risk reduction behaviours, emphasis should be placed on enhanced perceptions of self-efficacy, response efficacy and risk severity rather than emphasising vulnerability. Mitchell and Dacin (1996) determined that personal experience tends to increase one's awareness of risk thereby causing an increase in protection motivation. However, Collins (2015) argues the importance of additionally recognising the role of 'non-experiential learning'. Whilst having experienced the impact of a hazard event greatly enhances ones understanding of its risk and can lead to better preparedness, improved consciousness through systems of meaning and intuition can also have a positive influence on dealing and preparing for complex disasters.

The concept of risk, its perception and the relation it plays in motivating and influencing people’s adaptive and responsive nature to hazard, is an important segment of disaster research. The third section of literature explored here is disaster education. This relatively new topic area in the field of disaster research is becoming a significant element in evolving approaches to reducing risk and mitigating the effects of natural and man-made hazards. As the literature will demonstrate, education is a fundamental component in a real world strategy for developing effective risk management measures and establishing a culture of safety and resilience.

2.6 Disabilities, Vulnerabilities and Disasters

The impacts of disasters on individuals, communities and even countries is well documented and heavily referenced in disaster literature. Those impacts are greatly acerbated for populations most vulnerable and in need of special considerations, assistance and those with unique disabilities. The young, elderly, women with families, the impoverished, and certainly those individuals afflicted with severe loss of hearing, find themselves at considerable disadvantage for coping and surviving any crisis of substantial consequence (Friedsam 1961, 1962, Salter et al. 1993, Blaikie et al. 1994, Fothergill 1996, Fordham 1999, McEntire 2001, Fox et al. 2007, Phillips & Morrow 2007, O’Brien et al. 2008, Sullivan & Häkkinen 2011, Twigg 2014).

The literature defines vulnerability and risk as concepts consisting of various physical, social, economic and environmental factors susceptible to the potential probability of harmful consequences within differing contexts. Mileti (1999) looks at these interactions as a foundational mechanism for building and sustaining resilient communities. The concept of vulnerability also requires an understanding of “the problem” and knowing how one feels; it is a process of having learned the *meaning of vulnerability* (Drabek, 2010, p. 19). Others such as Adger (2006) focus on the need for interventions to increase resiliency and reduce vulnerabilities, whereas Phillips & Morrow (2007) stress the need for integrated research to further understand the complex interactions between risk, disaster impacts, vulnerability and response. Disasters do not impact populations in an equal and non-discriminatory matter. There continues to be a lack of recognition and understanding of the relationship between everyday risks and the reasons vulnerable populations are more adversely affected (Blaikie et al. 1994, O’Brien et al. 2008).

As the emphasis in the literature is reflective of risk perception, risk reduction, vulnerability, resilience, communication and many sub-categories of disaster topical areas, research focus is much more limited with respect to disabilities and the particular challenges faced by individual with disabilities. This limited focus is even more apparent with respect to the response community responsible for their safety and protection. U.S. government sponsored research, with respect to emergency management and disabilities, has occurred with limited regularly for a number of years (U.S. Department of Education, Emergency Management Research and People With Disabilities: A Resource Guide, 2008). Although as we will address later with regard to disaster education, research devoted to the management of disasters and its relationship to individuals with disabilities, lacks in its applied translation into actionable response protocols and processes. The literature focused on disaster and disabilities consists generally on those with physical (mobility) and intellectual disability (Mazzucchelli 2001, Van Willigen et al. 2002, Fox et al. 2007, Rowland 2007) and is reflective to a lesser extent on lessons learned from post-disasters affecting the Deaf and hard of hearing community (White 2006) or preparedness level capacities of those serving individuals with hearing loss (Ivey et al. 2014).

2.7 Disaster Education

Disaster education literature generally consists of two distinct perspectives. The first general area of disaster education literature focuses on documents developed by international organisations like the United Nations International Strategy for Disaster Reduction (UNISDR 2007) and position and progress documents emanating from major conferences such as World Conference on Disaster Reduction, Hyogo Framework for Action (HFA 2005), the Organization for Economic Co-operation and Development (OECD 2008), the World Conference on Education for Sustainable Development (2009), and the Sendai Framework for Disaster Risk Reduction (2015 – 2030). These conference reports and documents establish policy guidelines and organizational framework for the development of disaster education strategies worldwide.

The second area of disaster education literature addresses academic and scholarly research related to a number of topic areas addressing public/community education (Barnes 1999, Nathe et al. 1999, Patton and Johnson 2001, Dufty, 2008), evaluating disaster education effectiveness (Morrissey and Reser 2003, Horan et al. 2010), disaster education in schools (Nathe 2000, Shiwaku 2007, Fuhrmann 2008, Yamori 2009, Twigg 2011) and disaster/hazard education impact on behavioural response (Perry and Lindell 1986, Faupel and Styles 1993, King 2000, Petal 2007).

A subset of the disaster literature incorporates learning materials focusing on specific hazards, earthquake, hurricane, tornado, wildfires, and others. These materials consist of learning tools and publications from multiple sources such as coalitions (National Disaster Education Coalition)[3], non-profits or not-for-profit corporations (Red Cross[4]and Risk RED[5]) and government funded publications (FEMA[6], National Oceanic and Atmospheric Administration[7], Emergency Management Australia (EMA)[8]). The sources of these materials are extensive and many are designed by, and for, specific countries and local occurring hazards.

With few exceptions, the mass of disaster education materials existing today are developed by governmental sources or non-profit organisations. Their focus is directed toward public/community education (non-formal), school-based curricula or materials to be used in a formal school setting or training/technical documents designed for professional personnel. They exist within a variety of media and delivery modalities and can be found originating in numerous countries throughout the world.[9] Although not specifically addressed in this thesis, the process of design and development of disaster education materials as they relate to validity and reliability measurements, do have relevancy. The literature giving attention to this however is sparse. Research associated to education materials generally is found in health

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[3] National Disaster Education Coalition (NDEC) is made up of organizations such as the American Geological Institute, Disability Preparedness Center, International Association of Emergency Managers, National Science Foundation and various governmental agencies) and publishes a guide, *Talking About Disaster: Guide for Standard Messages, 2004. The Guide* is hazard specific and offers proactive instructions on disaster preparedness designed to reduce risk in preventing injury and loss during disaster. The publication undergoes periodic updating and is electronically accessible.

[4] The American Red Cross (ARC) produces numerous education and training documents such as the *Be Red Cross Ready Safety Series* and the *Masters of Disaster Educator's Kit, which* is designed to promote disaster safety and provide preparedness information to teachers and parents.

[5] Risk RED (Risk Reduction Education for Disasters) produces various disaster educational materials for self-study and instructional curricula, fact sheets, disaster toys and games, and marketing materials related to disaster risk reduction for multi-lingual audiences. It also maintains a "Teachers Network" which is a teacher's social network providing access to resources, forums and information sharing related to disaster prevention education.

[6] The Federal Emergency Management Agency's *FEMA for Kids* uses animal figures, games, etc. for teaching children how to prepare for disasters.

[7] NOAA produces numerous publications, booklets and brochures on various weather related topics for educational and informational purposes.

[8] Emergency Management Australia provides extensive community awareness and education publications as well as a comprehensive school education program, *Emergency Management for Schools.*

[9] For a listing of educational programmes and materials found in 13 selected OECD and emerging economic countries see Green and Petal's comprehensive report for the Organization for Economic Co-operation and Development, Stocktaking Report on Risk Awareness and Education on Natural Catastrophes 2008, Annex 2.

behavioural modification studies or research devoted to behavioural changes related to education settings and student motivation.

2.7.1 *International Organisation Focus and Strategic Direction: A Global Focus for Risk Reduction through Disaster Education*

The earlier section under Disaster Risk Reduction covered many of the major foundational world conferences aiming to set the strategies for establishing a culture of safety and building resiliency within nations and communities. The reports and documents derived from these organisational meetings addressing sustainable development and poverty reduction clearly embed the need for including disaster education within the policy framework for disaster risk reduction and development as a product for reducing vulnerabilities and risk to hazards. This acknowledged world strategy is designed to establish partnerships which are inclusive of all nations and that cross all geo-political and socio-economic challenges. As a result, we have seen an important push emphasising the need for establishing disaster education as a fundamental element toward disaster risk reduction.

Disaster education is here viewed as a primary component of a systematic approach to the preparedness and management of disasters and a key strategy, not only for developing and least developed nations, but developed nations as well. A major strategy document produced during the World Conference on Disaster Reduction (WCDR) in Kobe, Japan in 2005 is the Hyogo Framework for Action 2005–2015 (HFA 2005). Among its stated priorities are the use of knowledge, innovation and education as a means for prevention and reduction of disaster risk and the dissemination of information related to hazards and vulnerabilities. It lists 6 key activities addressing education and training:

- Promote the inclusion of disaster risk reduction knowledge in relevant sections of school curricula at all levels and the use of other formal and informal channels to reach youth and children with information; promote the integration of disaster risk reduction as an intrinsic element of the United Nations Decade of Education for Sustainable Development (2005–2015).
- Promote the implementation of local risk assessment and disaster preparedness programmes in schools and institutions of higher education.
- Promote the implementation of programmes and activities in schools for learning how to minimise the effects of hazards.

- Develop training and learning programmes in disaster risk reduction targeted at specific sectors (development planners, emergency managers, local government officials, etc.).
- Promote community-based training initiatives, considering the role of volunteers, as appropriate, to enhance local capacities to mitigate and cope with disasters.
- Ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies; promote gender and cultural sensitivity training as integral components of education and training for disaster risk reduction.

This promotion and emphasis on education and knowledge of risk and risk reduction has been continued in the Sendai Framework for Disaster Risk Reduction (2015 – 2030). One of its guiding principles state:

> "In the post-disaster recovery, rehabilitation and reconstruction phase, it is critical to prevent the creation of and to reduce disaster risk by "Building Back Better" and increasing public education and awareness of disaster risk." Guiding Principles, 19(k). p. 14.

The progression for implementing these priorities was noted in a report of the UN Secretary-General (ISDR 2008) highlighting several accomplishments including the infusion of disaster risk reduction topics into school programmes in Nepal, India, Nigeria, Tajikistan, Kazakhstan and Uzbekistan. The World Conference on Education for Sustainable Development (WCESD 2009) built upon the UNISDR thematic platform regarding knowledge and education by recommending the embedding of the disaster risk reduction concept into education programmes and learning theory as applied to both formal and non-formal education environments. The clearly defined relationship between education and disaster risk reduction is seen as a key strategic component.

> "The aim of Education for Disaster Risk Reduction is to build the human capacities to understand the most likely risks, likelihood of disasters and their potential consequences. Policy decisions to reduce disasters should be based on a sound assessment of risk. However, it takes educated people - at whatever stage of life or age they are – to identify the risks, both in terms of the hazards and vulnerabilities." (WCESD, Concept Note, 2009, p. 9)

Associated with the education/DRR concept is the acknowledgement of the complexity of causal connectivity between knowledge, education and behavioural response. In order to develop and maintain a consistent strategy for moving forward, it emphasises the need for curricula and school integration, teacher training and learning assessment. Of particular importance contained in the conference paper is its emphasis and attention for establishment of measurable outcomes within the formal education context and the need for the development and utilisation of "appropriate teaching and learning materials." This capacity to evaluate behaviour while developing knowledge and skills for reducing exposure to risk are outcomes that have received little attention from the research literature. Within the non-formal education environment, the incorporation of indigenous knowledge and the use of creative educational materials developed from a local context can be an important element for participatory empowerment of community members (UNISDR 2008a). These issues and elements are significant to this thesis and play an important emphasis in defining the need for outcome-based disaster education approaches, materials development and strategies.

Green and Petal (2008) in their report for the Organization for Economic Co-operation and Development note the importance of education initiatives directed toward disaster risk awareness and reduction programmes and emphasise need for outcome-based measurements. They recognise that…[R]egardless of target group or sector of origin, all risk awareness and risk reduction education programs should seek to be tailored to the particular hazards, vulnerabilities and capacities of its citizens, and improved through evidence-based monitoring and evaluation." (p. 3). This endorsement and recognition of the need to bring a formalised assessment of student learning related to disaster education is slowly developing. As the maturation process for incorporating disaster education into formal and non-formal education frameworks progresses and gains in acceptance and implementation; it is hopeful that this focus will encourage and stimulate more advanced research in better determining the relationship between disaster education and protective response.

The final segment of the existing literature is devoted to examining how disaster education is evaluated and what impact it has on protection and preparedness behaviours, perception of risk, hazard knowledge and information. Reducing vulnerability and risk to natural disasters, building resilient communities and establishing a culture of safety all rely on sound, effective and functional education platforms and programmes.

2.7.2 *Emphasis on Disaster Education Research: Its Evolution and Current Utilisation*

The development of education programmes, materials and information related to disasters and hazards has existed for many years with the onset of research conducted by natural scientists, sociologist and behaviourists. From a U.S. perspective much of the earlier disaster education emphasis was dedicated to first-aid and civil defence applications. As social and behavioural research directed toward disasters and hazards developed, the research focus mostly consisted of applied questions and practical concerns (Quarantelli 1987). Information and educational materials related to specific hazards involving suggestions for protective and responsive actions began to emerge. With the establishment of the International Decade for Natural Disaster Reduction (IDNDR) in the 1990's, disaster education became a focal point as an international strategy for promoting resiliency and establishing a culture of safety as a thematic concept worldwide demanding updated research.

As we have seen in the literature thus far, disaster research from a sociological and behavioural perspective has concentrated on risk perception, knowledge, information and protective response. How and why people do or do not evacuate (Drabek 1983, Burnside 2006), take protective action (Grothmann and Reusswig 2004, Chaney and Weaver 2010), respond to risk and risk communications (Mileti et al. 1990, Martin et al. 2007, Terpstra et al. 2009) and heed or ignore warnings (Rogers and Sorensen 1991, Perry and Lindell 2003) all depend on the delivery or dissemination of information or knowledge. However, Handmer (1990) argued that no evidence exists proving the linkage between providing information and changing behaviour or attitude regarding risk; the mixed findings in this area highlight the complexity of the issue and the need for further understanding of these relationships.

Notwithstanding disaster warnings, education is the mechanism most recognised as the systemic process for communicating hazard risk, preparedness and response. Although warnings and education do have common elements, they are distinctive. Warning messages and warning communications are directly related to a hazard event, for example, during the occurrence of a tornado or possible tornadic activity (Tornado Watch or Tornado Warning). Disaster education communications are generally disseminated independently of a specific event and provide information generally pre- or post-event (Mileti et al. 2004). The linkage between disaster education and behaviour in the research has followed along three areas of theoretical study. These relational processes can be found to be directed toward awareness development, learning relative to hazard experience or changing of behaviour through attitude modification. The findings of Nielsen and Lidstone (1998) however, dispute any correlation between these processes and an increase in preparedness or knowledge.

The success of many public disaster education programmes lacks measureable outcomes and clear objectives for determining effectiveness (Mileti 2004). In evaluating disaster education materials associated with NOAA's TsunamiReady™ programme, Horan et al. (2010) studied the impact programme materials had on perception of risk, hazard awareness, preparedness, information seeking, and behavioural change. Their research found that hazard education materials had minimal effect on attitudes and behaviour. However, awareness of the hazard risk was an important factor in predicting change in attitudes and behaviour and that a community's hazard experience along with frequency and severity of the hazard can increase the receptiveness to disaster education efforts. Gregg et al. (2004) also found a positive correlation between preparedness and hazard experience. However, frequency of the event may not always equate to positive behaviour (Paton et al. 2005) but may have some influence.

The difficulties associated with evaluating disaster education programmes emanate from a common problem in social research associated with establishing causality. Measuring intangibles such as attitudes, knowledge and changes in behaviour are more difficult than measuring tangibles and quantifiable data (Twigg 2004). Finding measures that help define and determine success within disaster literature are rare and the lack of assessment tools and techniques is a major contributor to the problem **(**Ibid). Research being conducted within the disaster risk reduction conceptual framework associated with the establishment of Knowledge and Education indicators may provide a foundation for addressing problems associated with evaluation. Within the development field, the dominance of qualitative indicators versus quantitative indicators is viewed as somewhat problematic due to vagueness in the language used and difficulties in measuring specific outcomes (Liebmann and Pavanello 2007).

However, scholarly research in this area gives credence to the need for further study directed toward developing valid and reliable measurement tools related to disaster education.
As has been noted, the literature devoted to studying the direct impact of disaster education programmes to measureable outcomes is limited. The benefits attributable to educational endeavours in the research are mostly ancillary to the thematic focus addressing factors such as perception of risk, hazard knowledge, experience, frequency, or adaptive response. What we find in the literature is that "disaster education" per se is often defined in theoretical contexts associated with preparedness (Bourque et al. 1973), personal planning activities (Perry and Green 1983), awareness and risk perception (Paton and Johnston 2001) and community resilience (Tobin 1999). In a sense, the process of education is viewed as a mechanism for achieving an understanding of the more specific phenomena. This may provide some insight as to the neglect of research attention in this area. The results of this study indicate that emergency managers are limited in the availability and scope of current

disaster education resources. This limitation is believed to be partially the result of the scarcity of research inclusive of measurable outcomes linking disaster education materials and practice to positive protective behaviours. This study reinforces that finding as it relates to the Deaf and hard of hearing community. Disaster education reflective of the needs specific to this group is for the most part non-existent.

Faupel, Kelley and Petee's (1992) study of preparedness can be classified somewhat as an exception. Using hurricane hazard as the research platform, they examined the impact of disaster education from three perspectives. First, they studied its participatory impact; second, hazard experience as a type of education; and third, whether hurricane specific education produced any knowledge transference to other hazard types. Their findings generally supported the belief that disaster education and disaster education materials do have a positive impact on preparedness and that a relationship does exist between prior experience and response. Whilst the experience/response connection is consistent with many studies, the benefit of disaster materials is not as clear cut from the literature and there still remain definite questions as to their real impact (Horan et al. 2010). This is contrary to what is implied by studies from Mileti et al. (1992) and Basolo et al. (2008) who found that dissemination of brochures and the use of other education information items had a positive impact on preparedness activities and protective actions. The use of these materials in formal education settings is well documented as a primary teaching tool and is heavily depended on as a mechanism for disseminating disaster information (Izadkhah and Heshmati 2007, Pandey 2007, Fuhrmann et al. 2008, Petal and Izaskhah 2008).

2.8 Literature Review Summation

The literature associated with the research and study of disasters is quite extensive. From the early sociological emphasis and focus on human interaction with natural disasters and their impact on human behaviour, the literature devoted to disaster research has not only formed patterns of study but also continues as an evolving and widening focus of interest. It can easily be said that disaster research is very much an eclectic, interdisciplinary and multi-integrated phenomenon that incorporates and intersects across all socio-economic, geo-political, cultural, ethnical, and organisational levels. Notwithstanding the literature devoted to earth sciences, the literature related to disasters initially focused on early warning research and developments reflective of sociological and behavioural impacts. Mileti, Sorensen, Drabek, Quarantelli and many others have devoted years of study attempting to understand how and in what way humans interact with various natural and technological hazards. This unfortunately had to expand to addressing human response to the recent increases in terrorism activity throughout the world.

2.8.1 *Warning System Development*

As presented in this review much of the early literature encompassed warning system development. This included numerous studies defining the elements of warning messaging, response actions and impacts relative to sender and receiver attributes, characteristics and factors associated with gender, ethnicity, education, income, and age. Sorensen's (2000) comprehensive compilation of research in this area continues to be viewed as a foundational document for bibliographical reference. As focus expanded into refinement of the behavioural consequences and effects of disaster events, research topics began to mature into more conceptual and contextual awareness addressing risk, perception of risk, resiliency, sustainable development and hazard communication. Although literature dealing with more narrow sociological and behavioural aspects continues to be studied, a shift in disaster research is beginning to expand into more complex societal frameworks of investigation on public policy, strategies, and characteristics of community heterogeneity. The development of resiliency models designed for exploring contingent relationships between community, geographical and cultural factors, and hazard effects continues to move disaster research into expanded directions (Paton et al., 1999; World Disasters Report, 2014).

2.8.2 *Development of Comprehensive Strategies*

The onset of international attention on the increase of disaster events during the 1980s brought a heightened awareness of the need for the development of comprehensive strategies addressing disaster prevention relative to risk reduction, sustainable development, implementation of early warning systems and the establishment of the disaster education emphasis. The literature included numerous reports and status documents outlining international organisation positions and strategies for reducing vulnerabilities and risks to hazards and the establishment of identified mechanisms for building resiliency. The beginning of the International Decade for Natural Disaster Reduction (IDNDR) in the 1990s initiated a series of conference documents which eventually evolved into the Hyogo Framework for Action 2005–2015 (HFA 2005) and Sendai Framework for Disaster Risk Reduction 2015-2030 (SRDRR 2015) and has produced numerous subsequent writings further delineating world policies, strategies and accomplishments. This major international emphasis may not be considered scholarly in the traditional sense but the associated literature addressing this thematic area is significant in its advocating further research into warning systems, disaster risk reduction issues and disaster education concepts.

2.8.3 *Disaster Education*

The third area of literature that was explored involved disaster education more specifically. What is demonstrated is that disaster education is seen as a process for changing knowledge and behaviour. The efficacy of that change is found in the impact produced and the effect it has on individual or group actions. It is truly a "people-centred" phenomenon consisting of individual and social characteristics that play a significant role in how, why, when and to what degree disaster education will impact a response to hazards (Mileti et al. 2004). The literature has several examples where education and educational materials are viewed as a positive influence in providing information enhancing preparedness. However, there exist areas in question as to what exactly is disaster education and is it in fact a legitimate component involving education learning theory.

Nielsen and Lidstone (1998) studied the relationship between public education[10] and disaster management and the existence of an integrated theory that would support evidence that education impacted a specific disaster. They contend that, "[W]hile it may be expected that such emphasis upon public education ensures a comprehensively defined and theorised field, this does not appear to be the case. While it is tempting to construct the last two or three decades as a period when understanding about public education in a disaster context has advanced, the literature cannot support such a claim. An operational definition and theory of public education has remained elusive despite a common sense understanding of public education being readily found in numerous practical instruction manuals and educational guides." [p. 14-15]

What the literature has shown us is that the study of disasters and the human interaction to disaster events is well researched. What we also clearly know is that research is evolving into

[10] The more recent literature referencing the educational process used in a hazard context is often defined as "disaster education"; however, in earlier research the term "public education" may be used interchangeably referencing similar concept. The term "public education" is used many times in a broader sense encompassing public safety educational campaigns addressing such topics as drunk driving, driver safety, health safety or smoking reduction.

related areas of interest expanding our knowledge of risk and the need for further reduction of risk, better understanding vulnerability, human response and behaviour to disasters, building resilient communities, and development and promotion of disaster education programmes in an effort to establish a culture of safety within all nations. However, the complexities of disaster phenomena continue to challenge researchers, practitioners and the public in understanding how to better prepare citizens and communities against disaster events. The essence for saving lives and reducing injuries relies on the implementation of effective warning systems, establishing a sense of community and empowerment, and providing an effective mechanism for educating the public regarding disaster knowledge and protective behaviours.

2.9 The Context of this Thesis

The worldwide strategy for promoting disaster education as a means for increasing disaster risk reduction efforts, building resiliency, strengthening disaster preparedness, and furthering sustainable development is well documented. The increase in disaster education studies and the amount and quality of disaster education materials points to evidence of the importance and focus disaster education attracts in the current day field of study. But what is clearly lacking is definitive research and empirical evidence validating the effectiveness of disaster education's impact on preparedness and protective behaviour. This thesis hopes to provide a clearer understanding of the benefits of disaster education from a scholarly perspective and demonstrate how it affects human response toward disaster using a scientific approach and process. The importance of this is the applied aspects impacting the operations of emergency managers and the needs of the Deaf and hard of hearing community. For an effective early warning system, emergency management and the communities it serves need specific educational tools and processes to fully implement and take advantage of the system components. Effective integration of that system depends on the ability of the sender to articulate the warning message the receiver is to understand and react appropriately. Disaster research and education provide the basis for successful integration of the warning system as it affects the relationship between emergency management and the special needs population.

The lack of literature addressing this topic supports the need for more substantive research in better understanding the true effects of disaster education. Whether the inclusion of structured learning theory or more sophisticated and tested education concepts need to be utilised within the disaster education concept must be reviewed. At the least, the disaster research community must encourage and support research which directly investigates disaster education from a more theoretical and conceptual framework relative to the specificity of user groups. The following chapter will outline the methodology for the research and describe the design and methods used for collecting the data.

2.10 Summary

From a historical perspective, disaster research has had a very short existence compared to other scientific and academic disciplines. That said, the development of the literature demonstrates an evolution of focus consisting of sociological and behavioural investigation into why and how people respond to disaster events. This evolutionary process continues as emphasis shifts between integration of people-centred approaches and issues related to diversified populations, understanding specific hazard phenomena, and the governance and institutionalisation of preparedness and response processes toward normalising populations in anticipation of and following disaster occurrences. The introduction of technological interventions is certainly well documented in the literature and its inclusion in the research of disaster has embedded an element of understanding and knowledge that will continue to change how society and institutions will impact disaster mitigation, community well-being and resilience.

The study of early warning as illustrated in disaster literature is firmly entrenched as a concept, theory and institutional process that are fundamental to disaster research. Whether from the sociological, behavioural, individual hazard, or governance perspective, early warning is a major focus of interest and application at the international and national levels. Within the literature warning system research emphasises the importance of understanding and affecting behaviours towards self-protection, actionable decision making, message design and interpretation, and the ability of technology to aid in influencing positive actions when encountering hazard threats. Research devoted to understanding disaster risk reduction and its impact on individual and group behaviour comprise a large segment of disaster literature. This includes not only individual research but also a large portion of international organisation written policy driven focus.

In concert with disaster risk reduction, the literature on disaster education is well emphasised from an international organisational policy perspective. As a mitigation approach and strategy disaster education is widely documented. However, as research literature, its focus has only been emphasised for a relatively short time span and is recently being studied more in depth and from a more critical scientific viewpoint. What we have seen in this chapter is the evolution of disaster research literature that had its beginnings with a definite social perspective. The sociological impact focused heavily on behavioural factors related to individual reasoning for heeding or not heeding warnings, message development including sender and recipient attributes, and social/cultural characteristics for affecting response behaviours. This research path developed in parallel with natural science researchers as they approached disaster research from a specific hazard. Over time both approaches have resulted in more applied science with an emphasis of combining the findings of both natural science and social/behavioural science in the development of a better people-centred disaster response focus.

Chapter 3. Methodology

"It is the purpose of this little manual, while directing attention to the great dangers of the tornado, to always sweep away false notions regarding its origins and make known what is believed to be the most practical, trustworthy and economical methods of protecting both life and property."
John P. Finley, 1888, *Tornadoes, What They Are, and How to Escape Them*, p. 8.

3.1 Introduction

The focus of the research demanded a two-directional approach for studying early warning processes within the disaster education framework. From a disaster science perspective, disaster education is neither a linear or unilateral construct but rather represents a complex array of pedagogical approaches and foci adaptive to a multiplicity of human interactions and characteristics. For the purpose of this study two separate groups were identified. The first group, emergency management, represented the institutional perspective of the early warning paradigm. The second group, the Deaf and hard of hearing, represented members of the public with identified special needs in terms of warning signals and related education initiatives. The methods applied for designing and developing the process for collection of data for this thesis used similar but distinct approaches. The method used for the emergency managers required a formalised, institutional approach due to the professional character of the bureaucratic structure of the emergency management system. The Deaf and hard of hearing community required integrating hearing loss professionals into the process to gain credible access.

Both the emergency manager group and the Deaf and hard of hearing community operate within clearly established and defined "cultural" environments; each having succinct differences related to group objectives, group goals and perception of needs. Local emergency managers play a significant role in the integration of alerts and warning to the public within the respective jurisdictional boundaries of their counties when severe weather occurs. Individuals who have a hearing loss are particularly affected by circumstances when severe weather tornado alerts and warnings are issued. Both of these groups are minimally studied especially in the context related to tornado phenomenon. The study design and methodological approach selected and utilised in this research reflect both the groups' specific characteristics and their environments.

This study follows an explanatory mixed method design using both quantitative and qualitative data collection. As a methodological approach, the concept of mix method continues to evoke discussion and disagreement. However, its use in this thesis reflects the distinctive groups studied and their diverse environments. The initial phase collected quantitative data from both emergency managers and the hard of hearing community using two separate survey instruments. The emergency manager collection instrument contained question areas related to alert and warning methods and sources identifying key elements and factors in warning protocol. These data were used to study the relationship to factors identified with effective response behaviour associated with severe weather alerts and warnings to tornado hazard. A second phase was conducted to gather qualitative data to further explain and build upon the relational information derived from the quantitative analysis. The qualitative semi- structured interview conducted with emergency managers provided more in depth information helpful in understanding perspective differences between weather enterprise elements and possible system improvements addressing public safety influences.

The hard of hearing (HOH) instrument also used a two phased approach first collecting quantitative survey data looking at relationships between participant awareness, understanding and response factors of alert and warning components and existing weather enterprise system elements and their impact on behavioural response to tornado hazard. The second phase used a qualitative semi- structured interview of individuals from the hard of hearing community to build upon the quantitative data provided from the survey instrument. This information further explored relational and impact influences of individuals within the hard of hearing population as they related to response behaviours to alerts and warnings associated with severe weather such as tornado events.

3.2 Criteria Considerations for Selected Methodology

The nature of social inquiry required the selection of an appropriate method that best allowed for the systematic study of the social groups of interest, in this case, local emergency managers and individuals with hearing challenges. The debate continues on what method constitutes an acceptable mechanism for empirically gathering social data. Varying approaches or strategies may be more suitable depending on the individual characteristics of the study type, population demographics or for a number of suitable reasons associated with needs or research application (Singleton and Straits 2005). Over time different disciplines and fields of study have preferred particular methods for collecting data as demonstrated in many sociologist's preferences toward survey research. The 'pure' sciences rely heavily on experimental design, and in the case of psychological research and subsets of either physical or social science, both experimental and survey research methodologies can be readily utilised.

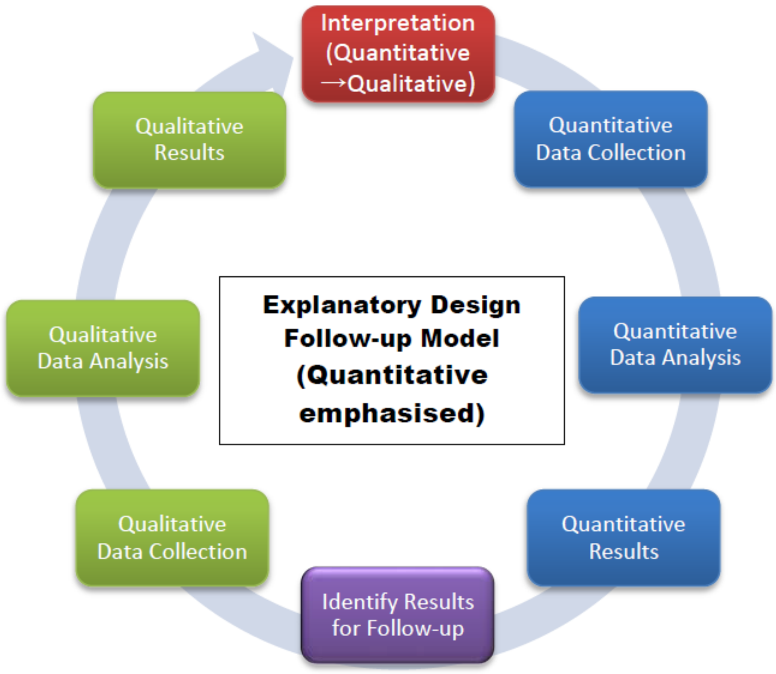
Among modern theorists, the discussion as to one approach or the other and the validity of mixed methodologies (see Section 3.2.1 that follows) remains hotly debated but among mainstream researchers, the argument focuses more on the utility of useful methods. It is also by way of a distinction between quantitative and qualitative research whereby organisation of methodological approach takes place leading to methods and techniques of analysis that provide a framework for investigation. The accepted use of both quantitative and qualitative methods in applied social research can be readily found (Bernard 2000, Robson 2002, Creswell & Plano Clark 2007, Bryman 2008, Frankfort-Nachmias & Nachmias 2008). The thesis consisted of mixed method research utilising a cross-sectional design. The two groups studied provide distinct differences thereby creating separate needs regards methodological approach.

An explanatory design follow-up model (quantitative emphasis) was used as the design structure for conducting the inquiry. This methodology captures the strength of both quantitative and qualitative data and follows the premise that either data research methodology can add to the explanatory elements of results (Creswell 2003). Within the explanatory design there are variants depending on the emphasis of the primary method to collect the data and the selection of the secondary emphasis to build or further explain the results of primary analysis. Figure 3.1 identifies the specific design used in the thesis illustrating the use of quantitative data as the initial source followed by qualitative data used to support the quantitative results.

3.2.1 *Strengths and Weaknesses of a Mixed Methods Approach*

The justification for selecting mixed methods research was based on several factors following careful investigation of the methodology literature. The literature in recent years contains significant study and utilisation into mixed method research (Morse 1991, Morgan 1998, Tashakkori and Teddlie 1998, 2003a, and Creswell et al. 2000). Bryman (2006a) formulated eighteen (18) rationales for utilising mixed methods research after conducting a content analysis of journal articles.

Figure 3.1. Explanatory design (adapted from Creswell and Plano Clark, 2007)



Source: J. Walsh

Robson (2002) looks at research design in fixed (quantitative) and flexible (qualitative) terms. The distinctions illustrate the argument that quantitative research is more focused on "the world of nature" as opposed to people and social structures (Bryman 2008). However, Robson clarifies his view of the fixed approach defining both its design weaknesses and advantages.

> "The relative weakness of fixed designs is that they cannot capture the subtleties and complexities of individual human behaviour. Even single case designs are limited to quantitative measures of a single simple behaviour, or at a small number of such behaviours. The advantage of fixed designs lies in their ability to transcend individual differences and identify patterns and processes which can be linked to social structures and group or organizational features." (p. 98)

Justification for the mixed method selection can be found in both the similarities and contrasts of quantitative and qualitative research. The similarities involve data reduction through either statistical analysis or the development of concepts from the data; the relationship between data and the literature; frequency of occurrence as a measure of analysis; reduction in the likelihood of error; and the appropriateness of the method employed to the research questions. Each of these criteria was applied as they addressed both the emergency manager group and the hard of hearing population.

Of equal importance was the identification of contrasting elements comprising the two research approaches. Table 3.1 provides elements of both approaches and the comparative differences between each. The thesis study considered each of these elements with respect to both the emergency managers and the Deaf and hard of hearing population. Evaluation was assessed to determine the design of the research respective of the group's unique characteristics, demographics, available sampling population and the research intent.

Table 3.1 Contrasting elements of quantitative and qualitative research

RESEARCH PROCESS	QUANTITATIVE	QUALITATIVE
Research Intent	Test Theory (Deduction)	Emergent Theory (Induction)
Use of Literature	Major Role, Problem Justification	Minor Role, Problem Justification
Research Role	Distant	Close
Data Collection	Numbers	Words
Point of Orientation	Researcher	Participant
Data Analysis	Numeral Statistical Analysis	Text, Themes, Larger Patterns
Findings	Generalizable to Population	Contextual Understanding of Behaviour

Source: J. Walsh

The continuum of elements allows for the flexibility in matching and implementing the strengths of each approach to both individual subject groups. The elements are not viewed as opposites but as codified degrees identifying structured requirements.

3.3 Focus Groups

Focus groups are used both in quantitative and qualitative research methods. Their importance in design is that they allow for participants to express and expound on their perspectives regarding the topic of study or on issues that may require further clarification and understanding. Like all methods, their use is predicated on the requirements of the research and may not fit well where the research is designed for another specific purpose or for a different population grouping (Barbour 2007). The focus group is a form of group interview addressing a defined topic with the purpose of generating interactive discussion between participants. Bryman (2008) defines the focus group as a dual method approach whereby in one construct several people meet to discuss multiple topics. He labels this as a group interview. The second construct he calls a focused interview. This consists of homogeneous individuals or groups with similar interests or experiences of a situation and where the interview process is more directed than the group interview. However, the makeup of focus groups is not limited to strictly homogeneous classes of individuals or groups; they also may comprise heterogeneous combinations of people.

Robson (2002) discusses the commonality and differences in using focus groups consisting of participants with both similar and differing backgrounds. Characteristics found in homogeneous groups generally represent facilitated communications, encourages open exchange of ideas and experiences, provides an environment of "safety" for expressing conflicts or concerns, and promotes an atmosphere of unquestioned acceptance of group ideas. Heterogeneous groups characteristically can produce stimulating interactive discussion and create an environment open to new ideas and views. Negatively, they may lend themselves to power imbalances, lead to a lack of respect for others' opinions and destruction of the group process by individuals with dominant personalities.

3.3.1 *Use of Focus Groups*

Focus groups serve several purposes and can fulfil a number of important research functions. As an exploratory tool it can provide a mechanism for searching new research topics and areas of interest. Using subject matter experts as group participants, their knowledge can be utilised to expand existing concepts, theories, or develop new approaches for solving current issues. Focus groups are adaptive and flexible to topics that are difficult to observe, gain access to or do not lend themselves to observational techniques such as perceptions, perspectives, experiences or decision-making. If the topic is of a sensitive nature, focus groups are well-suited for exploring issues where directed interviewing is necessary. As a mixed method, focus groups can be an important source for gathering preliminary data, aid in the development and design of interview guides and surveys (Tashiro 2002) and can provide a useful function for clarifying findings gathered from another method.

3.3.2 *Methodological Issues Related to Focus Groups*

Focus groups have been heavily utilised since the 1920's within marketing research. As such, its development from a methodological perspective has been more concerned with the "how to" and practical applications than data-quality, assertions and conclusions (Robson 2002). Julius Sim (1998) has identified several methodological issues affecting focus groups.

- Moderator/facilitator skills and experience as an interviewer can impact data-quality.
- Data may be a poor indicator of attitude consensus but may identify opinion differences and the reoccurrence of issues across groups.
- The nature and scope of participant views may be identified but the strength of those views may be harder to determine.
- Focus groups capture collective phenomena, not individual phenomena, and inferences transferred to individuals may not translate correctly.
- Data generalisation will be more theoretical rather than empirical or statistical.
- Face-to-face interviews and questionnaire studies capture a difference of social reality from focus groups and should be selected as a method for its "relative appropriateness" to the question asked. Each must be methodologically suited to fulfil the research objectives.

3.4 Design

The objectives of the thesis address a multiplicity of factors and relationships that reflect the complexity of interactions between the generators and disseminators of warnings and their recipients. They are designed to help identify existing gaps, needs and perceptions of the current system, as well as clarify improvements that promote life saving strategies for the public and special needs communities. Thesis objectives:

> **Objective #1**: To assess emergency manager's opinions regarding severe weather/tornado early warning system processes, individual protective actions, and disaster education influences.
>
> **Objective #2**: To determine how the severe weather/tornado early warning system affects protective response behaviours among Deaf and hard of hearing individuals.

Objective #3: To determine how disaster education is integrated within the severe weather/tornado early warning system and its impact on individual protective actions.

These objectives are intended to contribute to expanding an understanding of the theoretical, methodological and policy aspects of the early warning and response conundrum in society.

3.5 Survey Research

Survey questionnaires are a common form of data collection and are frequently used in social research (Fowler 1995, Bernard 2000, Robson 2002, Czaja and Blair 2005, Dillman 2007, Frankfort-Nachmais and Nachmais 2007). As with any collection method it has its advantages and disadvantages. Each of the basic survey forms (self-completion, face-to-face, e-mail and telephone interviews) reflects more of a research strategy rather than a specific method (Robson 2002). Selection is based on practical and tactical considerations related to the population(s) and the environment(s) to be studied. The survey design is also reflective of the research purpose, be it descriptive, explanatory, exploratory or emancipatory. Robson (2002) contends that surveys are not conducive to exploratory studies that require broad range opened-end questions and is a design that is both "inefficient and ineffective" as a procedure (p. 234). However, several studies of an exploratory nature have used survey instruments resulting in satisfactory results as a method for data collection. Creswell and Plano Clark (2007) refer to a study conducted by Bulling (2005) on reactions to tornadoes by responders using a survey instrument in an exploratory design.

Survey research has developed over the last eighty years deriving its structure and design from numerous disciplines such as mathematics, health, market research, criminology, and education. Groves et al. (2004) describes this accumulative evolutionary process of the development of theories and principles guiding the design, development and analysis of survey data for researchers as "survey methodology." Sheehan and Hoy (1999) have recognized the significant potential for using e-surveys, defined as electronic interviews and surveys (Eysenbach and Wyatt 2004), as a legitimate and developing scientific research methodology. As with any emerging method, there exist numerous pros and cons. The review of the literature indicates survey methodology is quickly developing into a commonly used method for both academic and applied researchers (Dillman 2000, Dillman and Bowker 2000, Shannon et al. 2002). The various modes of data collection have undergone a series of changes since the 1960's. Mailed questionnaires were extensively used during the 60's and 70's for census taking by the U.S. government, which found this mode to be less costly than the previously used mode of sending interviewers out to the field to obtain census data in person. As telephone coverage throughout the U.S. increased, market researchers found this mode cheaper than face-to-face surveys and faster than using mailed questionnaires. Telephone surveys fast became the preferred method due to the vast coverage of telephones in U.S. households. However, coverage for low income and transient members of society were underrepresented and continued to pose access problems for that population segment (Groves et al. 2004).

Although seniors (65+) still tend to use landline telephone services, combining this growing trend of increased adults using only mobile telephones with socioeconomically low-income populations and overall increase in mobile only users may adversely affect coverage bias issues using telephone surveys. In comparing landline telephone surveys and mobile phone surveys, Blumberg and Duke (2007) concluded "…coverage bias is not the only source of potential bias in telephone surveys. Nonresponse bias and systematic error due to mode effects may be even greater for mobile phone surveys than for landline surveys, and survey researchers may therefore return to landline telephone surveys with a hope that coverage bias can be further attenuated by statistical adjustments." (p. 748). The explosive usage of the mobile phone in recent years has brought this assertion into question. In an effect to control coverage bias in telephone surveys Duncan and Stasny (2001) used propensity based weight adjustments along with other alternative weight adjustments to compare the error of the standard estimate for assessing the adjustments effectiveness. Because telephone surveys invariably contain some bias due to the exclusion of nontelephone households from the sampling frame, Duncan and Stasny used a logistic regression model to describe propensity for response. This is designed to give higher weighting to sampled households that were more similar to nonrespondents. They found that coverage bias was eliminated through poststratification on variables such as income and education. This did not hold for surveys where telephone penetration was low such as poor or rural areas. They concluded that coverage bias remained a greater concern in these two populations.

The utilisation of a survey instrument in this study for collecting data was based on practicality, ease of data collection and study population limitations. Emergency managers often work under severe time constraints (both in availability and schedule), are extremely mobile, and communicate generally by computer/e-mail. The use of a self-administered questionnaire versus use of a phone survey allowed emergency managers to complete the survey at a time that best suited their schedule, eliminated call-backs, and provided a non-intrusive manner for capturing information without interrupting their work or free time. People with hearing loss would be at a considerable disadvantage using a telephonic survey for collecting data as opposed to using an Internet survey collection mechanism. Only those individuals who have minimal hearing loss would be able to participate in a phone survey, thus creating significant coverage bias.

Czaja and Blair (1998) and Frankfort-Nachmais & Nachmais (2007) have conducted comparative analyses of survey methods. Both include personal and telephone interviews in their comparisons, where Czaja and Blair include mail surveys in their evaluation, Frankfort-Nachmais & Nachmais address self-completion questionnaires in their analysis. Their conclusions addressing criterion related to cost, response rate, control and speed/collection period were found to be similar when comparing personal interviews and telephone interviews.

Bryman (2008) evaluates the self-completed questionnaire to the structured interview and finds self-completed questionnaires tend to have fewer open questions, contain an easy-to-follow design for the respondent and are generally shorter, requiring less time to complete therefore minimising fatigue risk. In addition, advantages include cost and ease of administration and convenience for the respondent and eliminated interviewer bias and effects that can be associated with personal interviews.

Frankfort-Nachmais and Nachmais (2007) concur in relation to costs concerns especially when confronted with a widely dispersed population and agree that interviewer characteristics and techniques may contribute to bias in personal interviews. However, both Frankfort-Nachmais & Nachmais and Bryman agree that question flexibility, the ability to probe, collect supplementary information and higher response rates hold an advantage over personal interviews. Bryman also comments that self-completed questionnaires may not be appropriate for certain populations such as those with language and comprehension issues although he acknowledges this may be an issue related to interviews as well. This point is well taken and may be applicable to this study. Individuals with hearing loss may have difficulty comprehending written words or may have reduced reading levels. However, this may be very individualised and is not a general trend. To off-set this bias, the survey designed for the Deaf and hard of hearing community was embedded with a signed video of the survey questions as well as a written version. This provided an alternative way in which to do the survey and assisted in comprehension issues.

The question of control in questionnaire survey administration can also be a concern (Robson 2002, Frankfort-Nachmais and Nachmais 2007, Bryman 2008) due to such factors as the respondent's ability to answer questions in any order, control their environment and circumstances when and how they answer the survey (including through the intrusion of non-respondents). These factors may be adjusted depending on the distribution and administration mode used. Both the emergency management survey and the Deaf and hard of hearing survey were susceptible to these biases, although neither survey would have been affected by altering the answering sequence based on the question design. As both surveys were self-administered, the possibility of intrusion bias could be a factor.

3.5.1 *Data Collection Methods – Mail v. Email*

The use of postal mail surveys continues to remain a popular method for data collection for researchers (Couper 2005, Dillman et al. 2008). Many studies involved in data collection methodology focus their attention on issues related to response rate, coverage, survey length, inclusion of incentives, costs and efficiency factors such as speed. Until the rapid advanced usage of the Internet, most comparative studies tended to address differences between mail and e-mail surveys (Sheehan and McMillan 1999). This trend in comparative research focus has shifted to now include Web-based and mixed-mode data collection methods (Sheehan 2001, Groves et al. 2004, Converse 2008, Shih and Fan 2008, Dillman et al. 2008). For purposes of comparison within this thesis, e-mail, which can technologically now be embedded within the Web-based software system, is approached as a standalone method for data collection and method analysis.

Mail surveys began being extensively used in the 1940's although this mode was considered time consuming, labour intensive, and their results were often ineffective. The use of mail surveys was often relegated to specialised populations and response rates tended to be low (Dillman et al. 2004). However, as survey design and techniques evolved, use of mail for collecting data became highly developed and readily used by scientific and academic researchers. Technological advances in printing methods allowed for better efficiency which resulted in applying features such as personalization and multiple mailings (Dillman 1978, 2008). This dramatically increased response rates for mailed surveys.

3.5.2 *Email and Web Surveys*

In 2010, 77.3 percent of the U.S. population used the Internet accounting for 239,893,600 users nationwide; that is up from 44.1 percent in 2000.[11] More than 90 percent of Internet users between the ages of 18 and 72, and 74 percent of those 64 and older, send and receive e-mail; this ranks it as the top on-line activity.[12] The use of the Internet as a form of modern communication has grown exponentially ever since it was fully commercialised in the mid 1990's.[13] Its development as a social research methodology has grown significantly since that time (Schaffer and Dillman 1998) and is a common mode for survey research. The use of the Internet to conduct surveys is either through e-mail or through the Web. E-mail surveys utilise two methods for distribution of the questionnaire, either embedding the questionnaire in the e-mail itself or providing the questionnaire as an attachment to the e-mail.

The e-mail itself would contain an introduction describing the purpose of the research, instructions for completing the questionnaire and relevant contact information. Respondents would use notations such as an "x" or "✓" for selecting their answer to the questions or type in their response to an open question. For an embedded questionnaire the respondent only has to click the reply button to automatically return the completed questionnaire to the researcher. This is an advantage over an attached questionnaire where the respondent must electronically reattach the questionnaire to a reply e-mail before sending the completed questionnaire to the researcher. This procedure is not difficult for even new computer learners but failure to reattach the questionnaire to a return reply can be a possible oversight.

One drawback to using e-mail is the requirement of obtaining a respondent's e-mail address. This raises the question of confidentiality. Any returned questionnaire by e-mail transmission will contain the sender's e-mail address. Although this is a form of identification, e-mail address configuration does not always lead to easy recognition or exact identification of the sender. If the address consists of a person's name or some portion of an individual's name, then identification may be an issue. The surveys in this thesis used SurveyMonkey as the survey hosting mechanism. This provided a higher level of confidentiality because e-mail

[11] Source: ITU (International Telecommunication Union). ITU is the United Nations specialized agency for information and communication technologies – ICTs.
[12] Pew Internet and American Life Project (Feb 2009).
[13] http://en.wikipedia.org/wiki/History_of_the_Internet

addresses were not captured from the respondent, however URLs (Uniform Resource Locator) were reported. [14]

Web surveys differ from e-mail generated surveys requiring the respondent to access a website that contains the actual questionnaire. The Web survey format is similar to the e-mail version in that in contains information describing the purpose of the research, instructions for completing the questionnaire and relevant contact information. The design of the questionnaire instrument allows for additional features such as drop-down or pull-down menus for multiple answer selection and “radio buttons” which allow the respondent to click a dot for selecting an answer for closed questions. The Web format also allows for greater flexibility in allowing the respondent to answer open questions where they can type directly into an answer box (Bryman 2008). Other options and features such as colour variations and schematics can make the appearance cleaner and more appealing. Programming features also provide the option of only displaying one question at a time which adds some control in preventing the respondent from scrolling down to view questions further contained in the instrument. When a filtered question is used the questionnaire is designed to automatically skip to the next appropriate question (e.g. answered “Yes” the survey goes to question 8, if answered “No” it skips automatically to question 9).

With increased evolution of Web-based technology, it is one of the fastest innovations sweeping the world as numbers of individuals using the Internet on a weekly or even daily basis increase exponentially. According to the 2008 Nielsen/Netratings 72.5 percent of the U.S. population are considered Internet users. During the short existence of the Internet, it is by far the fastest growing of all modes of communications. As the number of users continues to grow, problems expressed, such as coverage bias factors will continue to diminish. Andrews et al. (2003) in their study of conducting research using electronic survey modes (e-mail and Web-based) found web-based surveys superior to e-mail surveys in several aspects. Although this mode creates more design and technical problems, they concluded that Web-based surveys allow for greater design options and gives researchers greater control over respondents using the survey. Whilst this study utilised the Web-based method for collection of data (SurveyMonkey), e-mail was used extensively in both correspondences with emergency managers throughout Tennessee and with contact sources for communicating with Deaf and hard of hearing organisations.

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[14] The surveys were hosted in a secure formatting protocol thereby providing a higher level of security and confidentiality.

Yun and Trumbo (2000) determined that in comparing postal and electronic surveys, Web-based surveys demonstrated a strong superiority relative to speed of distribution and response cycles. Duffy (2002) attributes the majority of costs of conducting Web-based surveys to the actual survey construction and placement of the survey on the Web. However, these costs decrease substantially once the survey is completed and uploaded to a site. In support of Web-based survey research, Duffy (2002) sees definite advantage in its use due to access to specific and often times hard to find populations, speed of data access, and decreased costs associated with collection and entry of data.

As with other types of methodologies, Web-based surveys have their detractions and their detractors. Several limitations were identified in the findings of the research of the Shannon et al. study in 2002. In their study survey research professionals listed four highlighted concerns.

1. 52 percent of the researchers listed sampling limitations as a potential problem area. Use of this mode requires respondents to have access to computers and be comfortable with computer and software technology. Sampling frames may also not be representative of the general population.
2. Lack of privacy was expressed by 31.3 percent of the researchers. Misinterpretation of survey recipients may perceive it to be junk mail or “spam”. Security of information on the Internet was also listed.
3. 25 percent researchers felt that electronic surveys were open to responses outside the targeted sample. Without the use of passwords they questioned the credibility of the data.
4. The final concern addressed methodological issues related to time requirements and technical skill to develop and implement surveys, formatting, and the limited number of incentives respondents.

Sampling and distribution challenges were also a concern for the study conducted by Andrews et al. (2003) when using Web-based surveys. They suggested using careful analysis to determine use of probability-based or non-probability-based approaches in looking at population. In addition to helping off-set gaps in population bias, they recommend exploring the use of mixed-mode methods. The inclusion of a mixed-method in this study was one reason for that selection; however, each of the two groups studied were comprised of a very

narrow population based on the finite number of Tennessee emergency managers and the limited identified population of those individuals with hearing loss. The actual number of those who are Deaf or hard of hearing is difficult to determine based on the existing data. Notification of the survey was limited to hard of hearing agencies, service organisations and groups aligned with the hearing loss community to minimise these biases.
As with any survey, bias or error is of concern. However, care was taken relative to the design and distribution method of the questionnaires. In this study using a Web-based survey was determined to be an asset based on the frequency of use and the familiarity many individuals have with computers. Computer and Internet use is a major mode of communication for emergency managers as well as many people with hearing loss.

3.6 Mode Characteristics

3.6.1 *Cost*

In comparing data collection modes, cost is another factor which is of high interest to the researcher. Costs associated with surveys are generally typed in two distinct categories; those being fixed costs and variable costs (Groves et al. 2004). Fixed costs are attributed to survey questionnaire development and with pretesting and programming aspects. Variable costs entail operational components of conducting surveys such as interviewing, follow-up with nonrespondents, and all costs related to the sample cases.

Cobanoglu et al. (2000) sent surveys to 300 randomly chosen hospitality professors in an effort to compare mail, fax and web-based (e-mail) survey methods. They found that costs associated with e-mail surveys had significant advantages over mail and fax survey methods. Total cost was calculated to include fixed, unit and variable costs for conducting the surveys studied. Cobanoglu reported that mailed surveys totaled the highest in costs, whereas faxed surveys and Web-based surveys totaled the lowest for overall cost. This proved to be true as it relates to this study. The costs associated with using e-mails and Internet were basically nil.

Groves et al. (2004) acknowledge that electronic surveys claim significantly lower costs than using mail survey; however, they caution that the relative costs between the two may depend on volume of work and the contents of the cost estimate. They contend that e-mail surveys generally have higher fixed costs than mail surveys but if the survey is fully electronic, the per-case costs are close to zero. Schaefer and Dillman (1998) indicate that data collected from e-mail surveys having a mixed mode has a lower cost. Their research also indicates that e-mail surveys are less expensive compared to telephone surveys since postage, printing and interviewer costs are eliminated. In surveying 62 experienced survey researchers regarding their perceptions and recommendations involving the use of electronic survey methodologies, Shannon et al. (2002) found researchers responded "most positively" when asked to rate electronic surveys in terms of reduction of costs. In view of these considerations, the research on which this thesis is based used e-mail/Internet surveys due to cost saving, e-mail and Internet as a common mode of communication, efficiency of data collection software, and the current acceptance of this method as commonly used in both academic and commercial research.

3.6.2 *Response Rates*

One methodological factor which has attracted universal concern is that of response rates. Surveys are no exception and significant study has addressed the issue of response rates as they relate to different administration modes (Lesser and Newton 2002, Shih and Fan 2008, Callas et al. 2010, Lesser et al. 2012). Yammarino et al. (1991) conducted a meta-analysis of 115 studies done between 1940 and 1988 focusing on return rates for mail-questionnaires. Their findings suggest that response rates were increased employing various strategies such as preliminary notification and follow-ups, appeals, inclusion of a return envelope, postage, and monetary incentives. Dillman (1978, 1983) and Salant and Dillman's (1994) development of a nine step "total design method**"** has been used in numerous studies with response rates averaging approximately 73 percent and some studies reporting as high as 90 percent.

For this study, a modified version of Dillman's "total design method" was applied (Table 3.2). Both the emergency management and the hard of hearing questionnaires adopted basically
seven of the nine identified steps, with some adjustments. Each contained a professional appearance using a SurveyMonkey designed format and software. Title page and contact information were included. Question order for the hard of hearing survey followed Dillman's model with demographic questions positioned in the back of the survey; no demographic information was asked in the emergency management survey. Formatting used standard conventions. The emergency management survey was short, containing only six questions. The hard of hearing questionnaire was longer at 20 questions but contained a significant amount of demographic questions which provided needed data that is lacking in research

involving this special needs population. A cover section explaining the purpose of the study and instructions was included. Since both of the surveys were Internet surveys no packaging issues existed. No inducements were offered for participation of respondents although various follow-up contact methods were employed which had positive effects on increasing the overall response rate. See Appendix 1 and 2 for both the emergency management and hard of hearing surveys that were used in this study.

Table 3.2 Strength modes of survey administration

SURVEY ISSUES	FACE-TO-FACE INTERVIEW	POSTAL QUESTIONNAIRE	EMAIL	WEB	PHONE INTERVIEW
Cost	✓	✓✓✓	✓✓✓	✓✓✓	✓✓
Speed of Mode	✓	✓✓	✓✓✓	✓✓✓	✓✓✓
Response Rate	✓✓✓	✓	✓	✓	✓✓
Control of Response Situation	✓✓✓	✓	✓	✓	✓✓
Allows for Use of Visual Aids	✓✓✓	✓✓✓	✓✓	✓✓✓	✓
Impact of Interviewer Bias	✓	✓✓✓	✓✓✓	✓✓✓	✓✓
Ability to Probe	✓✓✓	✓	✓✓	✓	✓✓✓
Ability to Control who Responds	✓✓✓	✓✓	✓✓	✓✓	✓✓✓
Use of Visual Aids	✓✓✓	✓✓✓	✓✓	✓✓✓	✓

Notes: Ticks reflect mode strength as they relate to each survey issue. Three ticks = Strong characteristic, one click = weak characteristic. The modified table was constructed from Dillman (1978), Czaja & Blair (1996), Bernard (2000), Robson (2002) and Frankfort-Nachmais & Nachmais, 2008).

E-mail surveys were first conducted in 1986 when e-mail was initially used as an inter-office messaging tool. The further development of computer and e-mail integration has produced a sophisticated communication tool which is used world-wide. The explosion of the Internet in 1995 led to greater use by the academic community and produced a significant increase in e-mail surveys in the late 1990's. Although the use in e-mail surveys is increasing, the response rates fluctuate depending on the study. In the Sheehan (2001) study the mean response rate showed a decline from the 1995/96 period of 46 percent to 31 percent during the 1998/99 period.

Of importance to this study is the fact that the emergency management survey was targeted to a limited population based on the finite number of county emergency managers in the State of Tennessee (95). The response rate for the emergency manager study was 69.5 percent. The analysis of the data is better considered from the highest percentage of response within this relative small number of respondents. For example, where 98.5 percent of respondents making up approximately 70 percent of all state emergency managers feel local emergency management should be a key integrator of disaster education, gives credence to the possible importance of the responsibility local emergency managers should take as disaster education providers in their local communities. Although the very positive response for emergency manager involvement in community disaster education appears strong, further study of a larger population base would better support this assertion.

Research indicates that response rates for mail surveys are generally higher than rates for e-mail (Couper et al. 1997). Couper reported a response of rate of 42.6 percent for e-mail and 70 percent for mail. In her study of AT&T employees, Parker (1992) found response rates for e-mail at 63 percent compared to a 38 percent response rate for traditional mail. Schaefer and Dillman (1998) in their study on the development and testing of alternative sets of procedures to improve response to mail surveys reported a response rate of 58 percent for the group which received e-mail surveys and 57.5 percent for the group which received a standard mail approach.

Shih and Fin (2008) conducted a meta-analysis examining 35 studies, all occurring within the past ten years that directly compared response rates of traditional mail and e-mail surveys. They found that e-mail surveys generally have on average a 20 percent lower response rates than mail surveys. In comparing Federal household surveys of mailed questionnaires with e-mail and Web based questionnaires Dillman (2010) recognizes the changing attitudes toward data collection methods. He suggests that although response rates are consistently better for mailed questionnaires, the transitioning to e-mail and Web modes, especially using a mixed-method approach when taking into account the decline of hard-line telephone use, is desirable but difficult. However, he cautions that more study is needed. That need for further study may be a reflection on the amount of research focused on web-based and e-mail surveys at the time. Although the arguments opposing Web-based and Internet surveys dealing with sample errors or response bias continues, using Web surveys as a method for collection of research data is becoming an acceptable practice.

3.6.3 *Question Development*

The use of questionnaires can also bring up other issues. Question development can be extremely important. How a question is written is critical to obtaining the data desired. If a question is confusing or too complex, the respondent may not be able to answer the question correctly or may not understand the question (Fowler 1995). This is also the case with face-to face and telephone interviews if questions are improperly developed. However, the difference lies in the ability of the interviewer to offer clarification at the time the interview is being conducted. E-mail and Web self-completed questionnaires do not allow this to occur, the exception being, if a questionnaire is being administered by a proctor who possesses the experience and expertise to clarify a respondent's enquiry. In this study there were a few instances where the Deaf and hard of hearing survey was administered in person. The "proctor" was actually an experienced sign language expert and was knowledgeable of the question development process associated with this study and was able to answer all questions.

The research devoted to survey instrument design and question development and evaluation is extensive. It is as equally extensive for survey research data collection methods utilising face-to-face and telephone interviews as well as those using survey questionnaires. Fowler (1995, 2002) has developed a list of principles for designing good survey instruments from research of relationships between question characteristics and survey error (Figure 3.2). They apply to numerous collection methods and when followed by a testing evaluation procedure can effectively minimise errors associated with interviewing and questionnaire use. These principles serve as a foundation for building survey instruments reflective of features such as questionnaire length, question complexity or asking about two issues in one question structure, the use of unambiguous wording, inclusion of clear and concise instructions, and designing questions that are easy to understand.

Depending on the characteristics of a sample population, topic of enquiry and collection method, variation of question design requires flexibility and careful attention to wording and formatting structure. The issue of question formulation is critical to survey design. This proved to be the case for the development of the two surveys for emergency managers and the Deaf and hard of hearing group used in this study. The use of the focus groups during development assisted in the refinement and clarification of question design and word definition. This was a greater challenge with the Deaf and hard of hearing group and using focus groups to develop the questionnaire for both groups was essential.

The use of Fowler's *Principles for Designing Good Survey Instruments* was valuable as a guidance instrument. Although the instrument used in this study was a Web-based survey, not a face-to-face interview or interviewer administered, Fowler's principles provided a basis for developing a "good" survey. For instance, the development feedback was helpful in making sure each question was worded so that each respondent was interpreting all questions the same (Principle 3). Using survey collection software assisted in ease of reading, answering, and recording answers (Principle 6) as well as allowing for consistent measurement (Principle 7). The software also provided a format whereby questions were communicated exactly the same each time and where multiple choice answers were available, adequate answers were provided for selection (Principle 5).

Table 3.3 Principles for designing good survey instruments

Principles for Designing Good Survey Instruments	
Principle 1	The strength of survey research is asking people about their first hand experiences: what they have done, their current situations, their feelings and perceptions.
Principle 2	Ask one question at a time.
Principle 3	A survey question should be worded so that every respondent is answering the same question.
Principle 4	If a survey is to be interviewer administered, wording of the questions must constitute a complete and adequate script such that, when interviewers read the question as worded, respondents will be fully prepared to answer the question.
Principle 5	Clearly communicate to all respondents the kind of answer that constitutes an adequate answer to a question.
Principle 6	Design survey instruments to make the task of reading questions, following instructions, and recording answers as easy as possible for interviewers and respondents.
Principle 7	Measurement will be better to the extent that people answering questions are oriented to the task in a consistent way.

Source: Floyd J. Fowler (1995) *Improving Survey Questions p.103.*

3.6.4 *Data-Quality*

Data-quality issues are another factor when considering survey instruments. Robson (2002) sees little difference in bias in the sampling frame between the different approaches and finds that face-to-face and telephone interviews allow for relatively easy verification when the respondent falls within a defined population. This assessment is generally compatible with Dillman (1978) and Czaja & Blair's (1996) beliefs but Frankfort-Nachmais & Nachmais (2007) do not rank telephone interviews as high as face-to-face interviews. However, when comparing e-mail and Web questionnaires with both interview approaches, it is evident that the technological designs of e-mail and Web instruments make it difficult to verify and control that the respondents correctly fall within the appropriate sampling population (Robson 2002). E-mail and Web questionnaires also are dependent on reading and/or writing skill requirements not found in interviews, and can lead to response bias to some degree.

3.6.5 *Visual Aids*

The use of visual aids in survey research is a design format that is becoming more frequently applied. With the exception of telephone interviews, most modes are widely compatible. Certain populations, such as the hard of hearing community, find the use of videos depicting a signed questionnaire as a beneficial tool for responding to survey studies. This mode of delivery not only allows for a written questionnaire to be viewed in an electronic format but a video of the signed questionnaire may add another dimension for reaching a difficult population to study. The thesis used an embedded signed (American Sign Language) video (See Appendix 17) of the survey for the Deaf and hard of hearing as part of the survey questionnaire instrument. This was found to be useful and beneficial to the research process. Other types of visual aids such as flash card, photos or charts and graphs can be used to enhance the interview or assist in the explanation of certain topics or questions but were not considered necessary for this research.

3.6.6 *Speed*

Response speed is a further element that impacts both traditional mail and e-mail surveys. Cobanoglu et al. 2000, found that fax methodology was the fastest mode with a speed rate of 4.0 days, followed by e-mail/web method at 5.97 days. However, they found the e-mail/web method recovered time lost very quickly and they attributed this to delays in individuals reading their e-mail. Numerous studies support the speed of e-mail over traditional mail reporting returns taking within two or days (Mehta and Sivadas 1995, Bachmann and Elfrink 1996, Schaefer and Dillman 1998, Yun and Trumbo 2000). In a mixed-mode project, Schaefer and Dillman (1998) reported that e-mail responses arrived before the first completed paper surveys were returned. The speed of using both e-mails and Internet added to both the ability to communicate and to assess the progress of responses quickly and accurately.

3.6.7 *Survey Mode Strengths*

The strengths and weaknesses of survey administration modes depend on numerous factors within the context of the demographic population sample, survey purpose and administrative circumstances (time available, resources, access). Table 3.2 provides an overview of several modes and compares their strengths in relation to issues found in the use of survey methodology for collecting data. Researchers weigh modes differently depending on their individual studies; however, there exists enough overall agreement to develop some general conclusions and determine areas beneficial or detrimental for selecting a specific mode of survey administration.

3.7 *Text Mining and Modern Information Processing Methods*

Disaster related research has evolved from multi-disciplined approaches related to sociological, economic, political, psychological, managerial, and other focal studies of human and organisation interaction. The result has been a fairly prescriptive pathway utilising methodologies well-developed and well-designed within established disciplines. Factors associated with human behaviour [observing, organising, information processing, decision making] create complexities that challenge organisations and systems responsible for public well-being and safety. Those challenges require the exploration and utilisation of new approaches for better understanding the environment and components influencing disaster research.

The focus of this thesis study provided the opportunity for incorporating an innovative methodological perspective for expanding disaster knowledge using text mining integrated with idea recognition and higher cognitive processing. A continued challenge in research today concerns the amount of written information and the time it takes to process it both manually and mentally. The traditional approach to information processing generally involves extensive reliance on manual and individualised methods. This increases the susceptibility to error due to fatigue when the overarching goal is to reduce the information load in order to better manage and synthesise the information. The modern approach is to emphasise organisation of the information utilising computer, software, and technical and intellectual tasks. This procedure enhances better retrieval from original documents and allows for intellectual diversity of resources for studying a problem, perceiving the importance of unanswered questions and provides a clearer means for prioritising specific questions. The modern approach emphasises transparency in preparation allowing intellectual creativity applying measures, criteria, and decisions.

3.7.1 *Process of Text Analysis*

Analysis of text as a formalised process has been on-going for over 60 years. Initially termed “artificial Intelligence”, it has had a varied history of followers and detractors (Nilsson and

Nils 2010). The underlying question reflects the ability to develop and utilise a machine that can duplicate or replicate the human ability to be flexible, adaptive, and capable of providing solutions to understanding problems. The process coined the term "machine intelligence" and has remained somewhat contentious. The method used here differs as such in that the process for analysing text reflects the procedures used in data processing from the perspective of learning as described by Bloom's Taxonomy of Learning (Bloom 1956) and modified by Weiner (1979). The functions consist of:[15]

1. **Recall of Information** – Use of bibliographic databases or worldwide web sites [or other sources] containing original documents and descriptive data variables. Search engines are employed to identify and retrieve copies of desired text.
2. **Analysis of Retrieved Material** -- Use of algorithms to identify and segregate values and relationships existing within the text.
3. **Synthesis of the Primary Elements** – Use of algorithms to combine the data items into new relationships.
4. **Comparison of Formed Syntheses** – Development of measures, criteria, or decision structures enabling description of characteristics depicting the syntheses.
5. **Evaluation of Syntheses** – Development of measures, criteria, or decision structures enabling ranking of syntheses.
6. **Judgment of Syntheses** – Development of measures, criteria, or decision structures enabling identification of the 'best' synthesis for a specific purpose.
7. **Application of Syntheses** – Development of a new description or research strategy using the selected 'best' syntheses.

These operations are reflective of the authors' ideas and if carefully extracted, organised and substantiated can be used to develop description of topics and construct new knowledge-expanding research and analytical strategies. This formalised approach was used in the thesis to extract information and conduct comparative analyses on numerous government documents pertinent to emergency management protocols, operational priorities, and administrative

[15] Weiner, John M., and Gregory P. Beehler. *Methods in Knowledge Utilization*. West Lafayette, IN: XXIV Century, 2009.

duties and requirements. This approach differs significantly from traditional information processing in five ways:[16]

1. The formal process used in selection of vocabulary.
2. The reliance on the power of ideas (i.e., combinations of informative terms within the domain of a sentence).
3. The independence of ideas enabling them to be used in a variety of ways.
4. The acceleration of creative action by eliminating the mechanical wastes in traditional information processing.
5. The assumption that creative and critical thinking are learned behaviors.

The focus on ideas and the use of algorithmic approach for recognising the relevant vocabulary and pertinent ideas saves considerable time and energy in the organisation of data.

3.8 Use of Mixed Modes of Administration

The importance of mix-mode utilisation is understanding not only the research and purpose, and the strengths and weaknesses of each method, but also recognising the existence of limitations, biases or errors that may occur from administration of a specific mode. Of particular importance is the question of whether the data retrieved from using one mode produces results different from use of an additional mode. Of primary concern is the variation of respondent answers attributed to the aggregation of data using two or more modes of administration (Bryman 2008).

The distinctions between quantitative and qualitative data and study methods considered here are not intended to expound on the debatable elements of either strategy, but to explain them in a contextual manner as to illustrate their benefit as applied to the research study involving emergency managers and the Deaf and hard of hearing community.

[16] Taken from the book by Weiner and Walsh, *Ideas, Research Design, and Disaster Research* (working title), in-progress, anticipated publishing date (2015).

Disaster research utilises both the quantitative measures from physical science and the qualitative descriptors from social science. Quantitative methods and data are most frequently used in Natural science. The tendency is to focus on observations that can be described numerically. The intent is to represent physical attributes. Social science has the more challenging task of representing entities of emotional, spiritual, psychological, or cultural phenomenon. The data from such are typically nominal (named). Assignment of numbers to such names is an ordering process rather than an attempt to describe size, shape, or weight.

The social scientist attempts to describe and understand how individuals make sense of the world around them. That provides a framework for attributing relevancy to the social reality that human action is meaningful. This in turn highlights the responsibility of the social scientist to capture individual thinking and attribute and interpret the social environment from the perspectives of the respondents. These actions are essential to the study of disaster-related events. Much of the problem associated with prevention of property, psychological, and health damage can be attributed to individuals' perceptions of danger and risk.

Attempting to describe these attitudes, beliefs, and feelings can be accomplished by assigning descriptive labels to each. In addition, however, each attitude, belief, and feeling can be graded to represent the intensity of the individual's conviction about each. This intensity approximates the numerical scales used in quantitative studies to determine length, width, and height. As such, scaled numbers can be assigned to those degrees of intensity. The combination of labels to represent phenomena and numbers to represent intensities, gives rise to a mixture of data types. This mixture implies combinations of observational behaviours, each appropriate for the type of data being captured.

3.9 Rationale for Self-Completion Questionnaire

Selecting the appropriate methodology for collecting data offers numerous choices and provides many challenges for researchers. In traditional experimental or quasi-experimental designs the researcher exhibits a great deal, if not total control over the participant's length, quality, or location of exposure to a stimulus. The use of Internet or Web-based survey modes eliminates control for these variables. Some more traditional theorists may conclude that Web-based proponents are only using an existing paradigm and applying it to a new technology devoid of methodological concepts or scientific processes. However, the literature argues that researchers and social scientists in particular, are moving away from quasi-experimental designs and utilising more qualitative, ethnographic and more fluid designs (Cobanoglu et al. 2000, Duffy 2002, Eysenbach and Wyatt 2002, Shannon et al. 2002, Andrews et al. 2003, Porter and Whitcomb 2007, Converse et al. 2008, Shih and Fan 2008). Other studies indicate that data validity and reliability from Web-based surveys are comparable to more classical methods (Krantz et al. 1997, Buchanan and Smith 1999, Nathanson and Reinert 1999, Senior et al. 1999, Eysenbach and Wyatt 2002).

Many of the comparative mode studies follow along the entire spectrum from practically-oriented designs to the theoretically-oriented approaches. There is no one-stop shop or perfectly fitted design which allows the researcher to carry out their research project absent of limitations or bias (Groves et al. 2004). The explosive information environment created with the innovation of the World Wide Web has provided researchers with another dimension and tool to capture, process and analyze data in new ways to expand our knowledge and answer the challenges of a complex world. With proper design, effective formatting and attention to issues such as ethics, privacy and confidentiality, data quality, response rates and sampling frames, the use of Web-based surveys can be an effective and scientifically sound mode of research.

In their book titled *Internet, Mail, and Mixed Mode Surveys: The Tailored Design Method* (2009), Dillman, Smyth and Christian sum up the goal of every committed and dedicated researcher in their attempt to select and perfect the most effective electronically applied method for data collection. They state, “Despite all of the change and turbulence, in this new survey environment the goal remains the same as in the past: to design scientifically sound data collection systems that allow us to obtain precise estimates of the behaviors and attitudes of all people in a population by sampling and obtaining results from only a fraction of them. However, the means for doing so have changed in a number of ways.” (p 11)

It is this changing mode of the Web-based survey which is selected as the data collection methodology for this thesis. Its biases are acknowledged in the appropriate context but the advantages are fully utilised in the realisation that as a relatively new data collection method it offers extraordinary versatility and flexibility while providing a research platform to be explored and challenged.

The choice for selecting a self-completion questionnaire is based on several factors associated with study purpose, sampling variables, administrative considerations, heterogeneity of the populations, cost, and data processing accuracy. The research associated with this thesis looked at two very distinct populations, local county emergency managers and individuals representative of the Deaf and hard of hearing community. The emergency managers represented the 95 counties that make up the State of Tennessee covering 106,247 square kilometres. Accessing as a group proved difficult and face-to-face structured interviewing to obtain the highest response was a challenge. Similarly, the hard of hearing group was largely scattered throughout the entire State but accurate locator data for accessing individuals was non-existent. As part of the survey distribution process, a number of professional and social groups affiliated with the Deaf and hard of hearing community were utilised.

3.10 Instruments Used

Analysis of data required utilisation of available software packages. For quantitative analysis, SPSS software provided the most common statistical procedures and functions to help clarify relationships between variables, create clusters, identify trends and provide other statistical information. Its other features include the ability for carrying out various regression and advanced statistical procedures, with multiple characteristics of data identifying complex relationships. SPSS is typical of software that uses functions that allow for flexibility in handling data whilst enabling accurate analyses to help understand the data and better reporting of results. This study relied heavily on SPSS to analyse all of the quantitative data derived from the survey questionnaires.

3.11 Methods Utilised Specific to this Thesis

3.11.1 *Researcher Positioning Within the Thesis Context*

From a background perspective the researcher has had the opportunity to experience first-hand disaster related operations and systems from both a practitioner and an academic perspective covering a time period in excess of 35 years. This experience has included multiple disaster hazards to include natural, manmade and technological phenomena. This has allowed the researcher to observe the institutional, as well as the more people-centred aspects reflective in varied environments and circumstances. Those observations have undoubtedly formed certain biases and opinions which have formed the foundational framework and development of the researcher’s interests, experience and individual outlook as a researcher.

That positioning has both influenced the design of this research and provided a perspective that will hopefully add to the further knowledge development of the early warning system within the unique framework applied to both emergency management and the special needs of the Deaf and hard of hearing population.

3.11.2 *Tennessee Emergency Management Demographics*

The State of Tennessee is made up of 95 counties covering over 109,247 square kilometers. It has 11 counties with populations over 100,000 which include two counties with populations greater than 400,000. Of the 95 counties, fourteen counties have less than 12,000 residents. On a state configuration basis, the emergency management organisations are divided into three emergency management regions: West region – 21 counties, Middle region – 38 counties, and the East region – 36 counties. Each county in the state has emergency management responsibilities and each county has a designated emergency manager responsible for preforming the duties and functions specifically delineated by state statute. The Tennessee state organisation hierarchical framework is headed by the Governor, down through the Tennessee Emergency Management Agency (TEMA), through to the local county, and in few cases, the local municipal emergency manager.

Statutorily the state emergency management agency has some jurisdictional authority over the local emergency manager, although most of that authority is procedurally based. Local emergency managers are autonomous organisationally and do not come under the oversight functionality of the state agency. Their authority is derived by state statute but their responsibility falls under the jurisdiction and authority of local county or municipal governance.

3.11.3 *Relevant Data Objective – Emergency Management*

The evolutionary growth of emergency management is basically in the initial stages of development when compared to other professions related to public safety. As such, it is important to gain an understanding of its dimensions, the cultural nuances, actual and perceived roles and responsibilities, and the organisational components defined within the context of legal, social and political environments. One of the thesis objectives related to role perceptions and system functionality as they pertain to emergency managers.

Objective #1: To assess emergency management opinions regarding severe weather/tornado early warning system processes, individual protective actions, and disaster education influences.

The emergency management system operates within a state planning component referred to as the TEMP (Tennessee Emergency Management Plan). This planning document outlines the roles, responsibilities, planning requirements and functions for operations during disaster. County emergency management agencies are required by law to develop a basic emergency operations plan (BEOP) consistent with the TEMP and an emergency management program to ensure effective response and recovery. The plan must be periodically reviewed and approved by the Tennessee Emergency Management Agency.

3.11.4 *County Emergency Management Plans*

County Emergency Management Plans (Year 2012) were reviewed from 72 county plans on file with the Tennessee Emergency Management Agency. The plans were data mined and searched for any reference to disaster education plans or education programs relating to preparing the public. All county plans follow a common design and format across the state. Education items are found in the Emergency Support Function-2 (Communications) category.

3.11.5 *Duties of the County Emergency Management Agencies*

The county emergency management agency is the first line of defense in responding to emergencies in their jurisdiction. TCA (Tennessee Code Annotated) 58-2-110 requires counties to develop a plan, called a basic emergency operations plan (BEOP), which must be periodically reviewed and approved by TEMA. Conceptually, local emergency management responders deal with an emergency in their jurisdiction with their assets and with as much additional support that may be provided by intrastate mutual aid or assistance under TCA 58-8-101. When the emergency exceeds the local jurisdiction's capability, the county may request additional assistance from higher levels of government. The mayor or his authorised representative, typically the emergency management director, may request formal assistance from other jurisdictions, including state and federal help.

3.11.6 *Survey Methods as Applied to Emergency Managers*

The Emergency Manager (EM) survey consisted of six questions (Appendix 1) related to methods/tools and sources used to communicate tornado and severe weather alerts; as well as questions pertaining to education, preparedness and response categories addressing duties and responsibilities associated with warning operations. The survey questions were designed and developed through a process using a selected group (n=9) of emergency manager experts to pre-test the survey questions. The group consisted of managers representing the counties having the most occurrences of a verifiable tornadic event between 2000 and 2011. The list consists of the 11 counties indicated in Table 3.3:

Table 3.4 Tennessee counties verifiable tornadic events 2000-2011

County	Verifiable Tornadic Events 2000 & 2011
Davidson	15
Hamilton	15
Rutherford	15
Benton	13
Montgomery	13
Lincoln	12
Dyer	11
Gibson	11
Hickman	10
Madison	10
Sumner	10

Initially, less than nine county EMs responded from the group of 11; selection then shifted to counties with the next highest number of occurrences until a total of nine participants were reached. Participants received an introduction letter via e-mail explaining the reason for conducting the survey and that their participation in the pre-test of the survey was designed to measure clarity, reliability and validity. The refinement process was used to separate and independently refine the questions that contain a probable mixing of dimensions, nuances and clarifications The objective was to achieve better linkage of the relationships between the three segments. Based on the responses, the EM experts were sent a revised set of questions for continued evaluation of the instrument. This refinement process continued until a satisfactory finalised version of the survey instrument was obtained. In addition to the review and development assistance from the emergency manager group, the survey was also vetted by two experienced members from the local National Weather Service office.

The survey instrument (Appendix 1) was finalised and announcements via e-mail (Appendix 10) were submitted to the targeted EM population for collection of data. The population who received the survey was local county emergency managers who represent the 95 counties within the State of Tennessee. The survey was distributed as an on-line survey (self-administered) using SurveyMonkey as the collection mechanism. This was selected due to both ease of distribution via the Internet and efficiency in use for the respondent and for retrieving response submittals. Two reminders were sent out during the survey period, approximately two to two and one-half weeks apart. The survey remained open for a period of 45 days. A 70.5 percent response rate was achieved for the 95 county emergency managers who were surveyed.

3.12 Survey Methods as Applied to the Deaf and Hard of Hearing Community

3.12.1 *Tennessee Deaf and Hard of Hearing Demographics*

Accurate demographic information on the number of deaf and hearing loss individuals whom reside in Tennessee does not exist. This is true for national statistical data as well. Estimates on the national level do exist, however those are extrapolated from estimates taken from census data involving subjective interpretation or from data gathered from model-based estimates. The National Institute on Deafness and Other Communication Disorders (NIDCD) found that approximately 17 percent (36 million) adults in the U.S. report some degree of hearing loss.[17] The Gallaudet Research Institute estimates those having hearing problems (including the Deaf and hard of hearing) make up 13 percent of the U.S. population. For a discussion on the difficulties regarding deaf demographic statistics see Appendix 7. U.S. census information estimates 103,809 (2.6%) individuals out of 6.1 million Tennessee residents experience "hearing difficulty."[18]

Defining members of the hearing loss population can have multiple meanings depending on culture, individual perception, mode of communications, degree of hearing loss and other individualising factors. There are however, some standard definitions that are generally accepted. For the purpose of this study the following terminology was used to define the

[17] U.S. Department of Health and Human Services, National Institute on Deafness and Other Communication Disorders (NIDCD), *Quick Statistics*, http://www.nidcd.nih.gov/health/statistics/Pages/quick.aspx. Accessed 16/1/14.

[18] Figures are model-based **estimates** based on American Community Survey 1-Year Estimate data for 2008, for "non-institutionalized civilians." This is the latest information available as of February 2014. All of this data is available at Census.gov.

specific categories of hearing loss. Deaf - refers to members of the Deaf community and Deaf culture. Deaf with a small "d" - refers to people who have significant hearing loss, but are not identified as members of the Deaf community and culture. Hard of Hearing - refers to those with mild to severe hearing losses who probably use speech for communication, will need educational and technological support, and may or may not identify with the Deaf culture.

3.12.2 *Relevant Data Objective – Deaf and Hard of Hearing*

As with most underserved and special needs groups the Deaf and hard of hearing community lacks both the research and operational attention when affected by disaster events. The paucity of both demographic and disaster behavioural data was a motivating factor for exploring and developing disaster related knowledge affecting this community.

> **Objective #2:** To determine how the severe weather/tornado early warning system affects protective response behaviours among Deaf and hard of hearing individuals.

The alert and warning data involving the Deaf and hard of hearing community is both unique, timely in terms of the current focus on early warning, and is intended to add to the scientific knowledge in terms of disaster research related to this special needs population. The method employed for collecting data optimised ethical, cultural, and contextual considerations unique to the Deaf and hard of hearing community. As more disaster research is directed toward those with hearing loss, refinement of the research methods utilised should produce better data and relevant findings.

3.12.3 *Survey Design Process*

The initial survey development team was made up of hearing loss professionals and disaster specialists with both applied and academic experience. The initial working survey contained 15 questions covering topics addressing alert and warning sources, response plans and protective actions, closed captioning, alert and warning devices, disaster education preparedness levels, and demographic information both general and specific to the Deaf and hard of hearing community. Following several iterations of the survey from the development team a focus group of Deaf and hard of hearing individuals was conducted.

The first focus group consisted of eleven (11) individuals who were given a verbal introduction as to the purpose of the survey, privacy and confidentiality rights, how the focus group was to be conducted, and lastly, that their participation was voluntary. The participants were told the session would be recorded and were requested to sign release forms (Appendix 9) prior to participation. One of the original eleven individuals decided not to participate. The focus group was conducted utilising a sign language interpreter. The group was then given a copy of the survey and the researcher reviewed each of the survey questions with the entire group. Participants were encouraged to ask questions and make suggestions regarding each question. Prior to completion of the focus group session, each individual was given the opportunity to submit questions they felt should be included into the survey.

Following the first focus group, the development team then reviewed the results of the session and made further revisions to the survey. In all, three revisions were made following the first focus group. A second focus group was assembled with seven of the initial nine members present to discuss the survey's progress. The same process was followed. The development team made two additional iterations of the survey. The survey was then placed into SurveyMonkey and was then tested by 11 random individuals representing the Deaf and hard of hearing community. Further revisions were made to the survey followed by a second random testing. As a result of the development and testing process the survey for the Deaf and hard of hearing consisted of 20 questions (Appendix 2). The survey was then placed on the SurveyMonkey website utilising a secure link for general distribution and access. The link was distributed via e-mail, verbally and websites to approximately 27 separate groups selected based on hearing loss focus and affiliation with local, state and national organisations (Appendix 12 contains all Tennessee agencies that were contacted). The survey was open to hearing loss individuals only but strict adherence was impossible to enforce and therefore some data source compromise is possible.

3.13 Personal and Follow-up Interviews

Focus groups and personal interviews (Appendix 14) were utilised as part of the research method. During the development of both survey instruments focus groups provided a significant contribution to the original design of the questionnaires and revision of each iteration. Experienced emergency managers made up the EM focus group in order to maximise emergency management expertise and incorporate optimal analytical input related to key issues affecting and influencing the emergency management community regarding warning system challenges. Personal interviews were more commonplace and provided unique opportunities for one-on-one discussion with individual emergency managers for clarification of certain findings and more in-depth exploration of key points. Bringing several emergency managers together to conduct a focus group for follow-up discussion proved challenging although one focus group of emergency managers did occur. Personal interviews eliminated logistical problems, were more expedient, and resulted in quality data.

A limited number of personal interviews were conducted with the Deaf and hard of hearing community. In their case, the contextual environment utilising focus groups were actually more efficient due to the need for interpreters and avoidance of culture concerns of outsider bias. These interviews mostly involved clarification issues regarding questionnaire answers and disaster perspectives of the hearing loss community (see Appendix 6 for additional information regarding the question rationale, supporting references, and expected responses in developing the survey questionnaire). Conducting interviews in a group setting appeared to be more appealing and put the responders more at ease when discussing issues, providing personal experiences, and giving individualised input.

3.14 Institutional Review Board

Because the focus of the research included investigation related to and potentially affecting human subjects, both surveys (emergency management and the Deaf and hard of hearing) underwent review of an Institution Review Board (IRB) in order to protect the human subjects from either physical or psychological harm. Due to the research being conducted in the U.S. and the researcher's school of Northumbria University located in the UK, the IRB approval process was conducted at both Vanderbilt University in the U.S. and Northumbria University. All appropriate documentation was submitted including copies of the surveys, ethics documents, Informed Consent forms, Introduction letters and Participant Information Sheet. Following review of the submitted information, IRB approval was given by both institutions (Appendices 3 and 4).

3.15 Ethical Considerations

Working with human subjects requires conducting a thorough, cognitive planning and design process involving the studied population(s), their environment and the contextual circumstances surrounding the researcher's investigative contacts with those populations.

This study involved two distinctively different populations, emergency managers and a special needs population comprised of individuals who are identified with hearing loss. Emergency managers are response professionals seasoned to calamities and are both physically and psychologically reflective of disaster events. Depending on their individual experience, they are generally expected to perform at times under less than ideal conditions and operate in environments for which most persons are unaccustomed. As governmental employees they are subject to bureaucratic duties and responsibilities, must publicly defend their actions and decisions whilst conducting their business in a very transparent environment. As such, asking their professional opinions regarding emergency management practices and issues in a non-threatening context minimised bias in reactions to survey questionnaires. In most cases, they were eager to provide their input and were enthusiastic throughout the investigative process.

The Deaf and hard of hearing population posed a different set of considerations and required a commitment to both the cultural and physiological environments affecting these individuals. Individuals experiencing hearing loss can be more distrusting, more questioning, and less likely to volunteer their opinions freely. The researcher was informed of these cultural issues during the design of the survey questionnaire and after consulting with several hearing loss professionals while acquiring background information regarding Deaf and hard of hearing populations. The researcher's experience through this process seemed to be predicated on trust, as was informed it would be. Once a rapport was established, operating within this population proved easier. However, with every new group, the establishment of trust was always at the forefront.

These population challenges were thoroughly considered in the design and development of the survey, testing processes, and in the personal interviews and contacts conducted (Appendix 6). Experienced interpreters and hearing loss professionals were utilised at all steps in the research process in order to minimise personal intrusions, cultural insensitivities, and physiological challenges. As an outsider, the researcher utilised these personnel as a liaison to the Deaf and hard of hearing community. This often reduced conflict and uncertainty on the part of the participant. Another technique used in the survey process was the embedding of a signed video of the questionnaire into SurveyMonkey. This allowed the questionnaire to be both visualised and/or read by the respondent depending on the communication preference.

The research design and process was reflective of the desire to accommodate the Deaf and hard of hearing participants in a comfortable and non-threatened manner. The need for and importance of their opinions and input related to disaster issues was repeatedly stressed and emphasised in all phases of the study. Creating an environment supporting participant involvement is illustrative of an approach for further promoting empowered individuals within their communities (Collins et al. 2006).

3.16 Strengths and Limitations of the Data Collection Processes

Challenges existed in the collection of data for both the emergency manager population and the Deaf and hard of hearing community. On the positive side, both groups are vastly under-researched and offered a unique opportunity to explore their interaction and integration within the early warning system framework. The enthusiasm of the participants added to the research environment and created opportunities to explore areas that initially were overlooked in the design of the original research plan. The input of information from individuals representing both groups provided significant data related to early warning system elements which offered specific perspectives from both service providers (emergency managers) and those recipients (hearing loss individuals) of severe weather alerts and tornadoes warnings. The data related to the Deaf and hard of hearing community was especially helpful. This was new data gathered from a segment that is one of the least attended to special needs populations regarding disaster preparedness and response operations. This information is currently being utilised on a local and statewide basis in Tennessee for reassessing and refocusing emergency management procedures and protocols related to this specific special needs community.

Data collection for the emergency management group required the inclusion and assistance of a select number of emergency managers to stimulate trust in the research and gain the support of emergency managers from across the State. Emergency managers are a closed and close group, which required care in both the approach and application of the data collected. Because of the limited number of emergency managers in Tennessee (95), the number of respondents came from an already small population base. In addition, for various reasons some counties were without the services of an emergency manager at the time of the study, further minimising the number of potential respondents. For follow up investigations, focus groups were attempted on several occasions but scheduling as a group activity proved challenging. One focus group was conducted but personal interviews proved to be more effective.

However, emergency managers as a group spoke openly and freely about their opinions and perspectives which allowed for a robust collection of unique research data. Due to the limited number of emergency managers surveyed, general conclusions based on this small sample of emergency managers from only Tennessee should be made with caution. Those interviewed and surveyed were most sincere and honest in their answers. However, further research addressing emergency management and their operations must be conducted on a broader scale and scope.

Collecting data from the Deaf and hard of hearing group was equally challenging but for very different reasons. Establishing trust also was an essential element and proved difficult to develop without the assistance of a trusted member from their individual community group. For very legitimate reasons, their suspicions about wanting their opinions were difficult to overcome with some individuals and groups. The communication barrier posed some unique challenges and required the availability of an interpreter at all times when interviewing or hand distributing the survey questionnaire. Comprehension of the survey questionnaire was another limitation. Although the survey was accompanied with a signed ASL video (Appendix 17), not all of the respondents fully understood the questions. Data results were adjusted when these issues were discovered.

3.17 Summary

This chapter provided an overview of the methodological approaches for scientific research underpinning the specific methodologies utilised in this thesis. The mixed method design using both quantitative and qualitative data collection and analysis, in conjunction with survey questionnaires, provided the analytical framework and process through which to investigate the relationship between emergency management, the Deaf and hard of hearing community and the early warning paradigm as an aspect of disaster education. Selection of an appropriate methodology is both a subjective and pragmatic decision process based upon study objectives, target population and relevant environmental parameters for collecting and retrieving desired data. This chapter provided an account of the specific methods used to collect the data from the target populations studied and to analyse components of the severe weather and tornado alert and warning system. Chapter 4 addresses some of the pertinent areas for understanding early warning system processes, specifics related to tornado hazard within the U.S. impacting communication and individual decision making, together with system elements affecting behavioural response.

Chapter 4. Core Elements of Early Warning and Tornado Hazard as an Inter-Relationship between Warning Enterprise and Human Behaviours

"Early warning systems for some of the world's greatest disaster events have proven to fail when they are most needed. Early warning fails either because correct information is not sent, correct information is not understood by the recipient, or because of choices not to believe or heed the warning." Andrew E. Collins, 2009, *Disaster and Development*, p.206.

4.1 Introduction

The inclusion of this chapter is to provide background material to support a better understanding of the U.S. early warning system components and how they integrate within the framework of this thesis (NSTC 2000, PPW 2004, Hall 2007, Collins & Kapucu 2008). As supplementary information, it supports the following three core aspects of this research:

- Communication strategies for severe weather/tornado warning and alerting dissemination
- Public impacts and influences of preparedness and response processes
- Disaster education and training strategies for public utilisation

As such, knowing how and why aspects of human communication interact within the institutional and technological structure of the early warning system provides a foundation for understanding the relational complexities of system partnerships (Rogers 1989, Mileti & Sorensen 1990). The literature has illustrated the difficult task of both understanding and changing human behaviour relative to individual response to specific hazards. Drabek (2010) points quite clearly to individuals within demographic categories who don't all respond the same under similar conditions or perceive risk in a like manner. Men, women, children, ethnic minorities, the elderly, all are impacted differently relative to varying factors (p.54-61). The research devoted to studying warning science is an evolving process. Identifying the gaps, strengths and weaknesses, and operational interactions of early warning system interactions provides a baseline on which to further grasp the implications for the study findings.

4.2 Communication of Alerts and Warnings

4.2.1 *Warning Terminology*

As the National Weather Service continues to place more research emphasis on the social and behavioural aspects of early warning system factors, they are experimenting with terminology changes within the actual tornado warning message itself (Ferree 2007, Rothfusz et al. 2013). The use of words such as "mass devastation," "unsurvivable" and "catastrophic" and in call-to-action statements in the meteorologist warning are based on the storm's probable severity impact. The terms are designed to emphasise the consequential risks a storm can produce and heighten the potential danger level that people in the storm's path may be exposed to. What researchers are discovering is that issuance of too many warnings dampens the message effect and that often their opinion is that if they acted on every tornado warning that is issued they would constantly be going to a shelter.[19] It is hoped that changing the warning terminology protocols to more dramatic terms may increase people's urgency to take protective actions sooner and more deliberately (NWS Assessment, Joplin 2011)[20].

The possibility exists however that if the new words and call-to-action statements are approved and instituted into the warning message protocols and meteorology vocabulary, over time the same desensitising effects could impact the use of those terms as well. Sustaining appropriate protective action requires continuing reinforcement and the need for a verification process ensuring some degree of effectiveness (Mileti & Sorensen 1990, Mileti 1995). Maintaining a certain level of acceptable human behaviour related to taking protective action during a weather impact event is a continuous challenge for weather and emergency management professionals (NWS 2011). Terminology modification may only be part of the solution. With the multitude of factors affecting human response, the difficulty in attaining acceptable levels of compliance from the public regarding warnings, becomes a matter of policy development, implementation and acceptance outcomes (UNISDR 2006, NRC 2013, Fakhruddin and Chivakidakarn 2014).

[19] Zelman, Joanna. "New Tornado Warnings Based on Storm's Severity Aim to Scare." The Huffington Post. TheHuffingtonPost.com, 31 Mar. 2012. Web. 05 Dec. 2013.

[20] Impact Based Warnings (IBW) will be incorporated in all severe weather and tornado warning announcements provided by the National Weather Service on April 1, 2015. "The goals are to provide more information through the warnings in order to facilitate improved public response and decision making, and to better meet societal needs in the most life-threatening weather events. This effort is in response to key findings from recent service assessments of devastating tornadoes in 2011, particularly the EF-5 tornado in Joplin, MO." http://www.crh.noaa.gov/crh/?n=2013_ibw_info. (Accessed Feb. 22, 2015).

4.2.2 *Communication Effectiveness*

Limitations in current technology prohibit the establishment of a warning system capable of eliminating all physical risk. Under current scientific knowledge and system applications, the best possible system exists for mitigating risk. Challenges continue to exist but efforts for keeping the public informed and protected is an on-going commitment. Severe weather and tornado watch and warning processes in many cases are not yet especially designed to convey specific local risk. Current National Weather Service (NWS) watch and warning polygon configuration[21] is designed to cover potential geographically impacted areas of threat but unless a tornado is visually spotted or identified by radar signature, the exact location and direction of movement maybe difficult to signify the precise touch down point and exact risk of exposure to those on the ground. This is not a critique of those responsible for predicting, detecting and relaying the threat notification of impending danger.

Tornado hazard is a precarious phenomenon whose exact scientific characteristics continue to elude complete understanding of formation and activity. This uncertainty creates an environment whereby notification of its threat and risk to life and property continues to challenge. Communicating that risk is the responsibility of the NWS and local emergency managers. How communications are formulated and disseminated is complex; relying on processes of integration between public and private partnerships. Its effectiveness requires implementation of interactive coordination consisting of scientific data, analysis, and warning message development, which is ultimately transmitted to the public.

This interaction however does not always work as well as intended. Although a great amount of effort is given to developing accurate warning messages and disseminating them as broadly as possible, communication of severe weather and tornado alerts and warnings is not always effective. Dash and Gladwin (2007) feel there are three areas where warning communications could be more effective resulting in better outcomes. The first area addresses the complexity of warning messaging. Referencing Hurricane Isaac in August 2012, Dash and Gladwin believe that often the information disseminated is too complex for the public to understand and lacks risk specificity as to local household impact. Although message content is hazard specific, the receiver of that information must understand what is being disseminated.

[21] Polygon is a geographical boundary used by the National Weather Service to graphically depict and define the locations that are threatened by potential severe weather. Polygons are used in describing both watch and warning areas.

Tornado warnings are more specific as to identifying the direction and general path of the storm, especially if there has been a sighting. However, the quick on-set of the tornado development allows for less time to react. Hurricanes on the other hand, allow for greater notifications but storm surge forecasts are susceptible to other variables such as river levels and floodwaters.

The second area of communication effectiveness Nash and Gladwin address is the specificity of local risk. Often alerts and warnings are issued which encompass a large area of potential threat for a given geographical location. The inability to predict hazard impact for a precise location adds to the uncertainty, confusion and to some degree brings into question the accuracy and veracity of the information being disseminated. Communication factors that leave room for too much interpretation, information gaps or message questioning can negatively impact the decision making ability to taking appropriate protective actions.

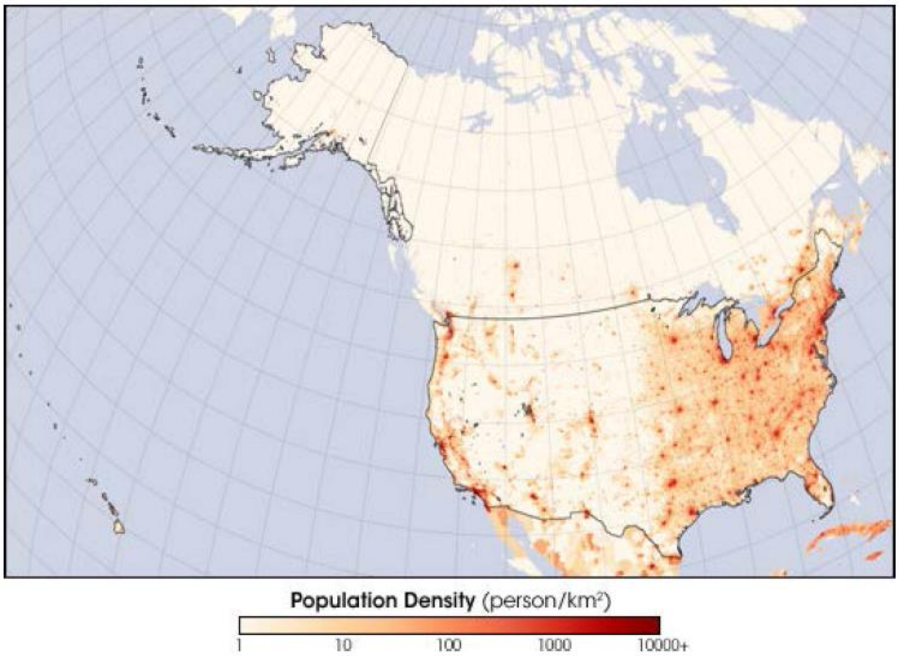
Nash and Gladwin's third communication problem concerns the risk perception differences between the public and research scientists. Each measures and perceives the risk to hazard differently. The scientists' perspective tends to approach risk as a measurement of potential magnitude of hazard impact and the probably of occurrence within a specific geographical location. This requires the use of forecasting and prediction modelling to make a best guess calculation regarding the hazard dynamics. The public on the other hand tends to be concerned as to the storm's immediate impact on their personal safety and disruption to their lives. Effective communication of alerts and warnings is predicated on successful integration of the scientific interpretation of the weather data and its targeted dissemination to the impacted public. When failures to communicate occur, negative consequences can result in loss of confidence in the overall warning system, a need for further validation of information when weather related events develop, and delayed response to taking protective action when the need requires.

4.3 Adequacy of Early Warning Notifications

The increase in deaths and injuries from tornadic activity has increased over the past several years with the highest death since 1936 (552) occurring in 2011 with a reported 553. However, the overall trend historically is showing a downward occurrence of deaths since 1925 and a leveling off since around 1975 (Brooks and Doswell 2002, Brooks 2008). When normalised for population, 2011 showed only 1.8 deaths per 1 million whereas 1936 showed

4.3 deaths per 1 million people. This recent increase spike however may be the result of several factors not wholly attributable to sender-receiver message context. Without speculating the cause, climatic environments within the U.S. have increased the numbers of tornadoes, resulting in greater impacts on individuals and communities. Geographical areas east of the Rocky Mountains have the largest incidence of tornadic activity. Since the population density is greatest within this geographical region, higher populations are at risk from tornado hazard (Figure 4.1).

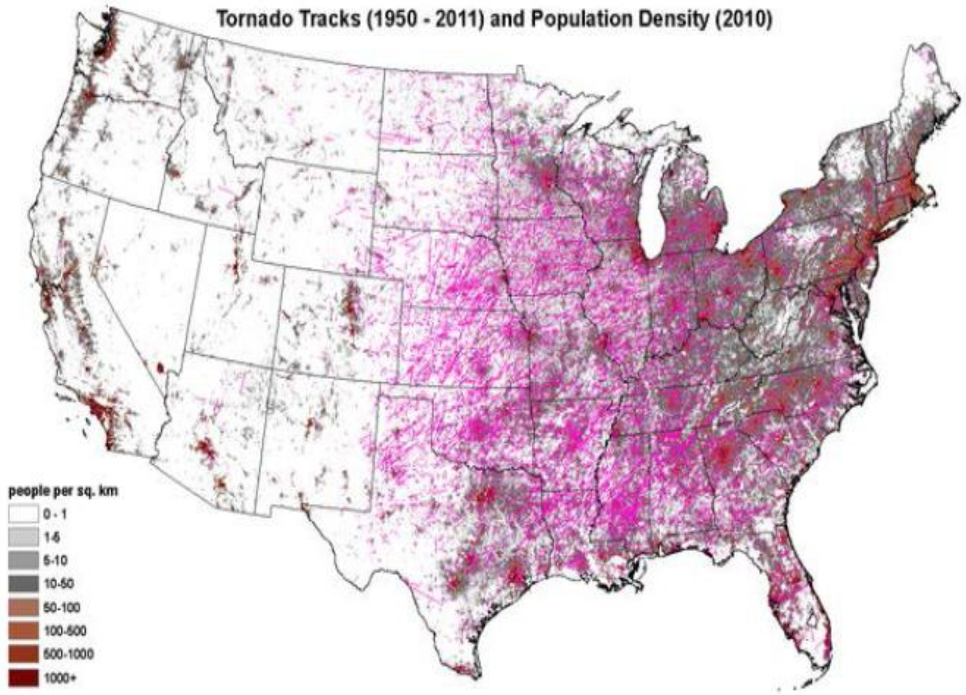
Figure 4.1 – U.S. population density (2005 data)[22]



There are no safe havens from tornadoes; they can occur in any location. In the past, tornadoes often occurred in rural or low population density areas which may account for lower death and injury rates during the earlier periods of tornado recording. Figure 4.2 illustrates statistical data from 1950 to 2011 depicting tornado tracks in relation to population densities for that period. The growth of population associated with the number of tornado occurrences substantially increases the potential for higher numbers of deaths and injuries.

[22] Map charts the number of people per square kilometer of the United States based on population estimates made in 2005. Source: Socioeconomic Data and Applications Center (SEDAC) at Columbia University, Distributed Active Archive Center, NASA Earth Observing System Data and Information System.

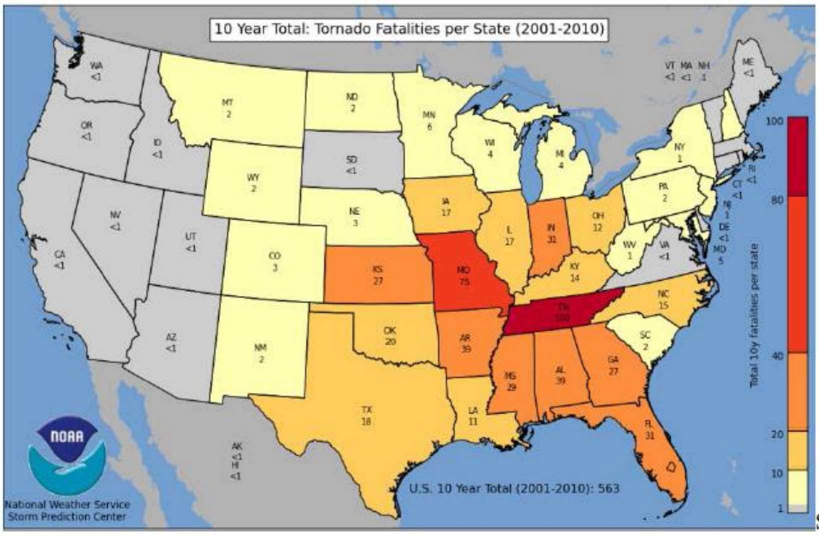
Figure 4.2 - U.S. map of tornado tracks and population density



Source: NOAA/National Weather Service, National Centers for Environmental Prediction, Storm Prediction Center, June 2013

For Tennessee, this phenomenon has produced dramatic results ranking it first in the number of tornado related deaths for the period 2001-2010 (Figure 4.3). Over this period, Tennessee experienced 100 fatalities. However, the numbers tell only part of the story. Emergency managers overwhelming agree that the National Weather Service does an adequate job in issuing severe weather alerts and tornado warnings. They are also in agreement (90 percent) that local television and radio broadcasts do an effective job informing the public on what actions to take during a tornado occurrence (Ibid.). The contrast lies in their almost total agreement that the public needs to better understand tornado terminology related to “watch” and “warning” issuances.

Figure 4.3 - 2001-2010 Tornado deaths per state



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Source: National Weather Service, Storm Prediction Center

This confusion over terminology has existed for quite some time and continues to frustrate both emergency managers and the general public. Even with greater emphasis on reducing the public's misunderstanding, the problem persists (Powell and O'Hair 2008). This is a common complaint and was heavily discussed with the focus group used for vetting the design and question development for the initial survey. On the surface, closed captioning would seem to be relatively easy to produce. However, there are a number of significant challenges associated with speed, specialized terminology, lack of punctuation, background noise, speaker dialect, mispronunciations, and speaker hesitations (Erler 2012). When problems affecting placement and lack of enforced standards are applied, closed captioning can be greatly affected. Because this is such an important aspect to the Deaf and hard of hearing community, the attention given to addressing this component is much needed. News broadcasts are especially susceptible to problems when performing closed captioning services (Jordan et al. 2003, Erler 2012).

As an integral component of news broadcasting, weather related programming, especially during severe weather, can be critical. It is estimated that on an average day approximately 55 minutes of broadcast time is devoted to weather related transmissions. During the threat of severe weather this time period could be substantially extended and during actual tornado warnings, weather reporting may continue for hours.[23] Studies show that the use of closed captioning is a benefit for those with hard of hearing issues (Baker 1985). The current

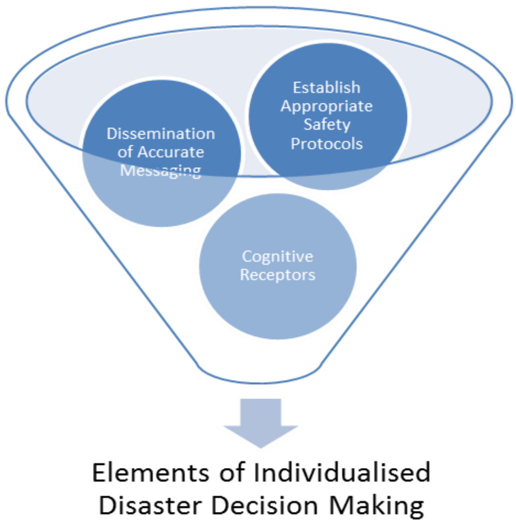
[23] Source: Sandy Boonstra, NewsChannel 5 News Director, Nashville, Tennessee, USA.

dissatisfaction with closed captioning raises concerns relative to severe weather alerts and tornado warnings. The inability for the Deaf and hard of hearing to adequately assess threat notifications effectively and efficiently requires a commitment from all sectors responsible for alert and warning dissemination.

4.3.1 *Confusion and Misunderstanding Associated with Warnings*

The ability to interpret warning messaging is an important factor regarding taking proper protective action. Countless studies have shown that individuals often wait for additional information before they take action. This failure to heed legitimate, timely warning occurs in all disasters, especially those related to natural events. From a preparedness standpoint, failure to properly understand the basics of alerting protocols such as, not knowing the differences between watches and warnings or not knowing what proper safety actions are called for, significantly undermines the basic premise for providing notifications. To address the confusion and misunderstanding issues, three (3) elements impact the overall decision process to act, or to not act (Figure 4.4).

Figure 4.4 – Elements of individualised disaster decision making



Source: J. Walsh

<u>Establishment of Appropriate Safety Protocols</u>

The first element considers the safety protocols for taking proper action. To date, most of the prescribed actions for protecting oneself involving a tornado event have proven solid and effective.[24] At times circumstances or events lead to safety questions derived from a tornado occurrence or incident that brings into question a certain safety protocol. For instance, the use of tornado shelters in schools or what is the optimum notification time an individual needs to seek safety or adequate shelter?[25] Although at times the answers may seem somewhat direct and easy to determine, the more accurate response maybe more complex and difficult to establish.

Few would argue the need for safe rooms or shelters at schools; however, the economic challenges of retrofitting existing structures may be cost prohibited. One may also think that the more time you have warning you of an impending tornado, the better. But determining just how much notification is adequate depends on varied circumstances. Time requirements are contextual and are dependent on individual needs and requirements. Having enough time to pick up a child from school and bring them home to safety for one individual, may not be adequate for another depending on time and distance circumstances. Judging the correct decision under the immediate circumstances requires assessing and analysing multiple factors. Even if the safety protocols are correct, the alert or warning must be clear and specific.

Dissemination of Accurate Messaging

The second element addressing decision making requires the need for accurate, precise notifications to the public. The current early warning system, although not perfect, is becoming more efficient and effective both from a prediction and forecasting perspective with regards to tornadic activity. Even if the severe weather watch or warning message contains relevant information items, failure to fully understand the threat, severity of the risk, the basic elements of the watch or warning message or take the proper protective action, can have profound consequences. Combine this with challenges incurred by Deaf and hard of hearing persons, and it is clear that the ability to make proper lifesaving decisions under severe weather or tornado conditions may be severely hampered. Preparing oneself to make proper decisions and then take proper actions is dependent on cognitively understanding the message, the threat and the risk involved and finally, knowing what to do.

[24] Tornado Safety: http://www.spc.noaa.gov/faq/tornado/#Safety

[25] Oklahoma Schools Lacked Consistent Tornado Shelter Rules, Ben Hallman, http://www.huffingtonpost.com/2013/05/21/oklahoma-schools-tornado-shelters_n_3314821.html, Posted: 05/21/2013 7:12 pm EDT.

Possessing the ability, capacity and willingness to take protective action is generally reliant on individual responsibility. Factors may always enhance or interfere one from taking action during a severe weather alert or tornado warning event; but for most adults, it is a decision of individual consequence. Even when all the early warning system components are correctly formulated and disseminated, the ultimate decision relies on individual determination to act.

Cognitive Reception and Responsible Action

The individual interaction and integration within the early warning system paradigm is the third element comprising the decision making process. Every tornado event involving human interaction instigates a decision process that cognitively directs an individual's actions. The objective of those responsible for initiating and implementing early warning protocols is to encourage individuals in the affected hazard area to heed those warnings and act appropriately. The fundamental challenge is making sure the individual possesses the essential knowledge for understanding the alert or warning, comprehends the threat, and knows what to do under the hazard circumstance.

Modifying complex patterns of human behaviour is difficult. A number of theories and models have been developed, many related to changing unhealthy practices (Rutter and Quine 2002). Several change models exist and have been practiced with varying success. Whitt (1997) has complied of list of variables along with their intervening characteristics that help when applied to changing behaviours. The examples of those changes provide some comparison for the findings in his thesis. As Table 4.1 illustrates, variables influence how and in what context an individual may or may not respond and may impact how decisions are made. Many of the results obtained from this study align closely with Whitt's model and can be interpreted and adapted in relation to the study data.

Table 4.1 Variables, characteristics and behavioral change

KEY ELEMENT	DEFINITION	STRATEGIES FOR BEHAVIOR CHANGE
Threat	Danger or harmful event of which people may or may not be aware	Raise awareness that threat exists, focusing on severity and susceptibility
Fear	Emotional arousal caused by perceiving a significant and personally relevant threat.	Fear can powerfully influence behaviour; if channelled appropriately can be motivator for seeking information and also cause people to deny they are at-risk.
Response Efficacy	Perception that a recommended response will prevent the threat from happening.	Provide evidence of examples that the recommended response will avert the threat.
Self-Efficacy	Perception that they are able to perform a recommended response that will prevent the threat from happening.	Raise individuals' confidence that they can perform response and ensure they can avert threat.
Barriers	Something that would prevent an individual from carrying out a recommended response.	Be aware of physical or cultural barriers that might exist; attempt to remove barriers.
Benefits	Positive consequences of performing recommended response.	Communicate the benefits of performing the recommended response.
Subjective Norms	What an individual thinks other people think they should do.	Understand with whom individuals are likely to comply.
Attitudes	An individual's evaluation or beliefs about a recommended response.	Measure existing attitudes before attempting to change them.
Intentions	An individual's plan to carry out the recommended response.	Determine if intentions are genuine or proxies for actual behaviour.
Cues to Action	External or internal factors that help individual decision-making about a response.	Provide communications that might trigger individuals to make decisions.
Reactance	When an individual reacts against a recommended response.	Ensure individuals do not feel manipulated or are unable to avert the threat.

Source: Witte, K. (1997). [26]

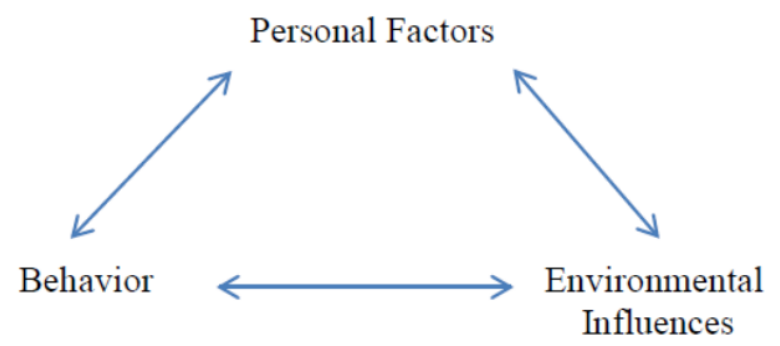
In studying the early warning paradigm in its current form, the National Weather Service and local emergency management can be viewed as "interventionists" in their duties and responsibilities associated with alerting and warning notifications. As integrators, their goal is to positively impact individuals and family groups to heed severe weather alerts and tornado watches and warnings. Through a system of education, training and awareness programs, people should become more knowledgeable of tornadic threat and acceptable to following the proscribed safeguards for protecting oneself from the dangers of tornado events. Of the many

[26] Witte, K. (1997). Research review theory-based interventions and evaluations of outreach efforts [electronic version]. Planning and Evaluating Information Outreach among Minority Communities: Model Development Based on Native Americans in the Pacific Northwest. Retrieved November 30, 2013 from http://nnlm.gov/archive/pnr/eval/witte.html.

types of behaviour change theories, two may have particular relevance when applied to weather related behaviours.

Social cognitive theory (Bandura 1986) (Figure 4.5) subscribes to the theory that individuals are not solely influenced by internal force but are also driven by external forces as well. These external influences are illustrative of interactions between behaviour, personal and environmental factors. Personal factors such as traits, instincts, and individualised motivational drives interact with situational (environmental) factors to create a process of behaviour change.

Figure 4.5 – Social cognitive theory model



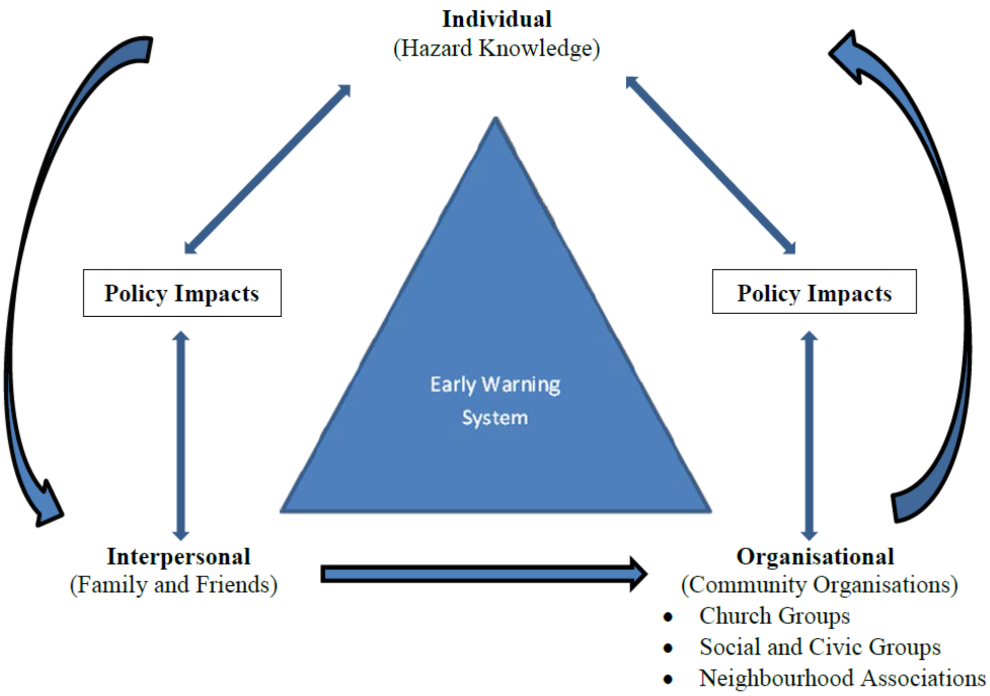
Source: Bandura, A., (1986). Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice-Hall. P. 24.

In the case of severe weather alerts and tornado watches and warnings, influencing factors such as message confusion, lack of understanding of the threat and what proper protective actions to take, over sensitisation, and poor captioning, can all have significant impact on individual decision making. This contextual individualisation poses challenges requiring development of universal, standard protocols easily understood by the average citizen and consistently disseminated across a large geographical spectrum. In addition, segments of the population with special needs, such as the Deaf and hard of hearing communities, require design considerations specific to enhancing their ability to comprehend alerts and warnings, and understanding protective actions to undertake.

Another pertinent change model that has applicability to the severe weather paradigm is the Social Ecological Model. The model helps promote development of programmes utilising social environments and can assist in understanding factors impacting human behaviours. Its premise is that several levels of influence such as individual, interpersonal, organisational, community and public policy affect behaviours which are impacted by and impact the social environment.

The Social Ecological model as a basis to intervention in behavioural change demonstrates the complex interchange between the different levels of influence. As applied to the early warning paradigm (Figure 4.6), examples would include, safety concerns incorporating the need for hazard knowledge at the individual level, engagement of family and friends in preparedness activities at the interpersonal level, and interaction among church groups or neighbourhood associations in both preparedness and response to potential severe weather and tornadic events at the organisational level. These interactions of multiple factors and associations among individuals, group members and community organisations provide the framework for the adoption and implementation of governance policies both formal and informal. How and why people respond and assess threat is often determined through social, economic, political and cultural context (Lindell and Perry 1992, Liu et al. 1996, LeClerc and Joslyn 2015). The interplay at the community level encompasses the broader spectrum of activities involving community social and organisational components engaged in holistic enterprises affecting disaster preparedness, response and mitigation responsibilities.

Figure 4.6 – Disaster warning system reflecting the social ecological model



Source: J. Walsh

The complex interaction of various determinates at all levels leads to the formulation of policy considerations and developments shaping the ability to influence warning protocols and proactive protection action (Basher 2006, Christian 2006, Basha and Rus 2007).

4.4 Heeding Severe Weather Alerts and Tornado Warnings

Disaster researchers have studied human response to warnings in numerous disaster contexts for decades (Perry et al. 1982, Mileti and Sorensen 1990, Balluz et al. 2000, Drabek 2010). Generally, every hazard type has been investigated to determine why and why not individuals exposed to a risk acted or not. Patterns of human response can take many forms and directions. In many cases the perception of risk plays a significant role in responding appropriately. Knowledge and familiarity with a weather hazard will affect their perception of risk and may delay action until they have additional information or develop some kind of confirmation of the alert and warning message.

The more an individual understands, or thinks they understand the risk, the time between the warning and action may be affected. Kuligowski (2014) found in her study of the Joplin 2011 tornado that some survivors took the siren notifications as an alert, and not as a warning of impending danger.[27] Those interviewed stated they did not take action until they perceived danger or were told to take cover. It appeared that only a few were risk averse or overly vigilant at the time the tornado occurred. The study also found that many delayed taking protective action, which limited shelter options, and others who delayed were unable to take shelter at all as the tornado struck.

4.5 Time Relationships Associated with Early Warning System

Perry and Godchaux (2005) raise two characteristics addressing volcanic hazard based on time relationship between residents of nearby volcanos and perception of the immediate risk they pose. Although a volcano may be in close proximity to where individuals live, the cycle of non-eruption activity may exist for long periods of time. Residents may view the volcano as part of the environmental support system of their locale and not as a direct threat to their lives. The volcano threat is therefore viewed within the human timeframe as opposed to the

[27] Kuligowski, E. Technical Investigation of the May 22, 2011, Tornado in Joplin, MO, *Emergency Communications and Public Response*, National Institute of Standards and Technology, U.S Department of Commerce, December 10, 2012 NCST Advisory Committee Meeting.

geological timeframe. The second distinction involves the time segments which naturally occur during a volcano eruption. Several sequential eruptions may occur during an extended period of time, which can extend over years. This prolonged timeframe can have a significant impact on the perception of risk and alters how an individual perceives the threat.

In the case of severe weather and tornadic events the threat and occurrence of activity is a quicker onset and more imminent. The timeframe maybe significantly shorter but the dynamics associated with risk and threat perception is derived similarly. As illustrated in the Joplin, Missouri case, residents are familiar with severe weather and tornado activity throughout the year. Although tornadoes may not touch down directly in the area yearly, there are considerable weather occurrences such that most residents in the regions should be very familiar with severe weather patterns. The work of Kuligowski (2014) and her colleagues confirmed as much whilst indicating that even with advanced warning of a tornado in the immediate vicinity, some residents still did not perceive the risk and threat as immediate.

4.6 Risk and Threat Perception Impacts to Warnings

Although the perception of risk is certainly an important factor for people taking protective action during a threatening event, it is not the only factor that impacts individual or group decision making during a dangerous circumstance. Severe weather and tornadoes have no geological boundaries and have occurred in all 50 States within the U.S., although they are most generally frequent east of the Rocky Mountains. Because of the climatological conditions required for the formation of tornadic activity, even in regions which have a higher incidence of occurrences, few if any individuals come into direct danger on a consistent basis. In regions of the country where weather reporting of severe weather and tornado activity is more frequent, hazard experience and familiarity is generally higher. As has been stated previously, this may lead to the need for additional information before action is taken. In similar cases where severe weather reporting is common place, desensitisation, over-reporting or frequent siren activations may negatively impact individual response to take protective action when necessary.

4.7 Alert and Warning Notifications

The dynamics of tornadic activity are such that developing precise protocols for alerts and warnings intended to meet all possible individual circumstances and requirements, and every built and natural environment context, is virtually impossible. In order to optimise the effects of the warning paradigm operational components and policy implementations, the National Weather Service and local emergency managers are faced with multiple challenges. Issuing too few alerts and warnings during severe weather is often met with criticism; whilst too many are likewise the subject of complaints and ridicule. In order to maintain some equilibrium in the continuum of public scrutiny, the decision-making mind-set is that it is better to error on the side of safety and caution rather than hesitate and fail to notify when needed. With the high incidence of false-positives that exists with tornado forecasting and prediction, conflict and confusion can negatively affect human reactions and response (Doswell et al. 1993, Geere 2013).

4.8 Factors of Public Complacency

The same can be said for public complacency. Over-utilisation or under-utilisation of any protocol whether it be siren activation, media reporting, or alerts and warnings can lead to unpreparedness, apathy or complacency on the part of the public. Extremism at either end of the early warning system is problematic. Even as technological advances allow for better prediction rates and longer warning times, complacency issues are both a concern and a safety factor. The science behind tornado forecasting and prediction is still not accurate enough to specifically identify the exact location and time a potential tornado will form and appear. This window of uncertainty creates enough doubt to lead some to stall or delay taking action when necessary. Combine that with factors associated with lack of hazard knowledge, failure to understand the threat, not knowing what actions to take, or the wilful ignoring of the warning message, and detrimental consequences leading to injury and death may occur.
Examples of public complacency associated with disaster response are generally well documented in various studies and reports (Hammer and Schmidlin 2002, Comstock and Mallonee 2005, Collins and Kapucu, 2008, NWS Service Assessment Report [February] 2009).

Many individuals, even after receiving adequate warning from several sources [i.e. weather radio, TV, sirens and even word of mouth] fail to take responsible protective action. Hurricane hazard produces similar responses related to evacuation processes.
Hurricanes are generally considered a slow developing threat mainly because of the improvement in forecasting and the evolution of satellite technology which allows for prediction times being increased from several days to even weeks. However, even with prolonged alerts and warnings, specific threat information and accurate strike location

information, individuals continue to delay or avoid evacuation notifications. Rebecca Morss (2008) of the National Center for Atmospheric Research in Boulder, Colorado, describes the cause of this inaction to “hurricane fatigue.” This is a condition whereby individuals become the recipient of numerous warnings during a hurricane season and simply refuse to heed the warnings of impending hurricane threats due to warning fatigue and refusal to continue disrupting their lives and leaving their homes.

There are a number of reasons why individuals refuse to respond appropriately to legitimate alerts and warnings from reliable sources. Certainly a lack of understanding of the nature or severity of the threat is often cited, but a person’s own experience with a particular hazard such as a tornado, flood, hurricane, or tsunami, may actually instil a false sense of survivability. Having survived a prior hazard event does not always equate to being more inclined to act appropriately the next time, as individuals often process risk in a contextual manner and perception of risk may vary substantially among people (Dash and Gladwin 2007). What is clear is that examples abound from various events where people continue to dismiss warnings by either ignoring them all together or waiting too long to respond in time. The intention of people to respond is often a result of a complex process of assessing risk, needing further verification, securing the safety of other family members or friends, or misjudging the time needed to seek safety. A common and often stated argument for inaction is the mischaracterisation that people are complacent, but in actuality, the complexity of the decision making process may be too overtaxing for some individuals finding themselves in imminent circumstances.

Assessing risk is not always an objective process even though an individual’s assessment is critical in deciding when and what protective action to take. Tierney (1994) asserts that even though an individual may be required to assess risk on the basis of individual knowledge or acquired information such as, what is a tornado safe place or is elevation of a home high enough to avoid flood waters, that information is interpreted through their social perspective and is not objectively derived. Making viable decisions under duress is an individual characteristic that may provide differing results on an individual basis. The challenge for weather and emergency management professionals is retaining optimal results from alert and warning notifications involving social context and environment.

It is pertinent here to already flag what will be reported by way of the survey findings of this study, that the Deaf and hard of hearing community are individuals that may require the development of a multitude of specific responsive actions based on the special circumstances they face. Results will include those that show that individuals during a severe weather alert or warning may stay inside in a safe place, communicate with family members and turn on a local television station, or a combination of actions. The study also shows that those individuals who have a family emergency response plan are more likely to take some kind of protective action compared to those who do not.

What is also found in the study is that 94 percent of emergency managers attributed non-responsiveness to alerts and warning to complacency. However, in interviews with emergency managers the issue is more complex and appears to be a commonly used description for general inaction on the part of the public. What is found is that the term is widely used for different contexts and responsive actions. Its definition was not necessarily used in a negative expression but more as a description of complexity. Assessing risk involves multiple processes that may contribute to a variety of behavioural responses. What the results of this study indicate is that caution should be used when attributing non-responsiveness to complacency; as its interpretation is subject to many influences and varied behaviours.

4.9 Tornado Siren Challenges

Not all municipalities or counties have or utilise tornado siren as part of their warning system. Warning sirens are expensive to purchase and have added costs associated with maintenance and operation. [28] Sirens are designed to be used as outdoor warning devices; therefore their effectiveness as an indoor warning mechanism is severely limited. Considering the Deaf and hard of hearing community; siren technology is one of the least useful warning mechanisms for alerting this segment of the community.

As part of a multilayered warning system, sirens can and do play a considerable role as a tornado warning protocol. This is especially true in flatter terrain as is found in the plains states or in metropolitan environments, where population densities, outdoor activities and census data may lead to site locations that are more compacted. The use of warning sirens still remains openly discussed among emergency managers. In those counties and cities which have had a siren system in place, their usage seems to remain somewhat steady. In locales

[28] Siren systems can vary depending on several factors associated with coverage desired and type of equipment. Average costs for equipment can run $25,000 upwards per siren location. As a general rule, adequate coverage dictates placing one siren per one square mile. Local terrain, wind and noise levels can affect siren distance output.

where systems have been inoperable or allowed to deteriorate, the decision to repair or upgrade systems is generally a hotly debated topic for local politicians and citizens alike.

Much of the current discussion regarding siren usage centres on cost and receiver response complacency. Whilst cost is both an economic and political consideration and challenge, complacency involves a completely different set of challenges affecting siren effectiveness. In assessing the impacts of the Joplin, Missouri tornado of May 2011, the assessment report found that the initial siren warning was treated with "ambiguity" concerning the risk and that "…most [citizens] chose to further clarify and assess their risk by waiting for, actively seeking, and filtering additional information" before seeking protective shelter (NWS Central Region Service Assessment, April 2011). The report went on to state, "Familiarity with severe weather and the perceived frequency of siren activation not only reflect normalization of threat and/or desensitization to sirens and warnings, but they also establish that initial siren activation has lost a degree of credibility for many residents. Credibility is considered to be one of the most valued characteristics for effective risk communication."

This credibility factor, not only adversely impacts risk perception, but also one's decision making processing for making adequate and timely response to a warning. This perplexing problem continues to require study and lies at the heart of why individuals do or do not respond properly. The refocusing of disaster specialists back to the issues related to receiver influences will undoubtedly broaden the scope of warning science but should help to enlighten practitioners and weather professionals, resulting in development of better and more effective severe weather warning protocols.

Another confusing issue related to warning sirens is the lack of specificity related to what siren warnings actually mean. Many individuals have no understanding of the difference between a siren warning and an "all clear" siren activation. Protocols may vary from one jurisdiction to another adding to more confusion. Unless there is other information received, most individuals may question the meaning of the siren itself. For the Deaf and hard of hearing this places them in even more of a disadvantaged situation adding to more confusion and limited or unclear information.

Siren overlap is another distinct possibility. Because sound has no ability to follow human constructed boundary indicators, certain locales may be susceptible to exposure to multiple jurisdictions operating separate warning siren systems. Siren locations do not follow according to NWS polygon warning system protocols. Some of the newer systems have the ability to be activated by sectors; however, the vast majority of systems are activated on a countywide basis. Depending on the specific location of the tornado threat, countywide activations can lead to unneeded warnings and false-positive messaging.

False-positive warnings account for a majority of forecasting errors which consists of approximately 76 percent of all NWS Tornado Warnings issued. Therefore, only 24 percent of all NWS issued warnings are associated with an observed tornado (Ibid., p. 29). Tornado prediction still remains difficult, even with the enhanced technology and improved forecasting science. The fact is that only a very small majority of supercells (thunderstorms that develop rotation) result in a tornado that touches ground. Even when all [the] factors align, the chances of a tornado hitting the ground are very small. The number of strong, violent tornadoes that occur in a 10,000 square mile area, per year, is 0.1 across the entire U.S., and only 0.6 in Tennessee, the state with the highest frequency. In other words, plenty of supercells never spawn a tornado (Geere 2013).

This relatively low production of observed ground touching tornadoes may be a contributing factor as to why individuals still need additional verification from secondary or tertiary sources before they actually take protective action during a tornado warning. Human nature certainly plays a part but the greater underlining issue may be the need for further development of enhanced warning messaging using words that heighten awareness of the actual threat. The National Weather Service is currently working on new warning protocols that include using words such as "mass devastation," "unsurvivable" and "catastrophic" in their warning messaging in an attempt to achieve maximum attention. These words would only be used during extreme circumstances, for instance when the likelihood of the occurrence of an EF-4 or EF-5 tornado is imminent.[29] This enhanced terminology usage is very applicable to the findings of this thesis. Emergency managers attribute (80 percent) non-responsiveness to early warning notifications to “confusion over severe weather terminology.” This was also noted as a significant factor in the delayed response to the May 2010 tornado that struck Joplin, Missouri. In order to evoke a more urgent sense of response, the National Weather Service is refocusing its research to address this recurrent phenomenon. The impact of this terminology confusion is acerbated when viewed from those who are Deaf

[29] The Enhanced Fujita Scale for Tornado Damage (The Enhanced F-scale) can be found in Appendix 18. For the Enhanced Fujita Scale Damage Indicators see Appendix 19.

or hard of hearing. As this study found, confusion over alerts and warnings is an issue for emergency managers, the public and especially for those with loss of hearing.

Feng and MacGeorge (2010) in studying the influence of message and source factors on responses to advice found that source factors and message factors had independent influences on advice outcomes. The results further indicated that message factors had a "mediation" effect on source factors and as the seriousness of the problem increased, message factors demonstrated stronger impact on advice outcomes. The importance of communicating warnings continues to be an integration of both the source and message content. The factors associated with the perception of imminent threat by the end-user of the warnings remains contextual, in terms of both the individual and the circumstances relative to the hazard event. Therefore, this is consistent with a focus of this thesis that early warning system integration impacts communication strategies, preparedness and response processes and is reliant on more disaster education emphasis.

4.10 Summary

The core elements of the tornado warning system are a complex arrangement of integration between natural phenomena and people-centred interaction. Communication is the fundamental construct that can both solidify or complicate the tenuous relationship between system and human acceptance. The components of the tornado warning system are the result of scientific study derived from climatological occurrences and the knowledge gained through research devoted to understanding why people respond or do not respond to risk. How that risk is communicated and received is crucial to the furtherance of well-being and a safe environment. Chapter 5 introduces the specific data this study produced and provides the basis for understanding the complex relationship between the tornado warning system, emergency management, and the disaster special needs of the Deaf and hard of hearing community.

Chapter 5. Early Warning Systemic Perspectives and Influencing Factors Based on Survey Results and Analysis

"During outbreaks, tornadoes may form and disappear so quickly that affected communities may not receive advance warning of their approach. Frequently the storms down power and telephones lines, disrupting communications. Residents, bombarded by so many messages of impending danger, may become confused or simply ignore the warnings."
Marlene Bradford, 2001, *Scanning the Skies: A History of Tornado Forecasting*, p. 156-157.

5.1 Introduction

The thematic aim of the research is to investigate tornado early warning system impacts and influences on protective behaviours and determine if, and/or how disaster education endeavours affect those responses. The research concentrated on two different and distinct population elements, one institutional being emergency managers, and the other being a warning system receptor comprising a special needs population made up of Deaf and hard of hearing individuals.

The emergency manager group was specifically selected based on their overall role and responsibilities involved in preparedness and response activities relative to severe weather and tornado public warning and alerting functions. Their importance as critical components of the system is underscored by the lack of substantive research focused on the role of the emergency manager. Although a fair amount of literature exists concerning the functionary role emergency managers perform, their relationship and nature relative to the alert and early warning system is cursory at best. As a focus of research, better understanding of their perceived integration, of their perspective impact and relationship with system components and the public they serve, is of importance to disaster research.

Studying the Deaf and hard of hearing population in the context of early warning application offered a unique opportunity to collect new data and contribute knowledge to warning science involving a very much understudied population. From a response framework, little is known of the Deaf and hard of hearing community relative to preparedness needs, response capabilities, disaster education levels, or resilience capacities of this growing societal population. From the researcher's experience, special needs groups and especially those with hearing challenges are severely underserved and unattended to by institutionalised community preparedness and response operations. Their ability to comprehend and cognitively understand warning system communications on which to decide the best protective course of action to take involving weather related hazard is severely hindered under the current warning system framework as will be shown by the collected data. Knowledge of specific system impediments and impacts affecting the Deaf and hard of hearing population may give insight into development of better protocols and practices suited to their particular needs and potentially inform the wider conundrum of engaging through warnings.

5.2 Analysis

Quantitative data was derived from survey research using descriptive statistics. Chi square tests were used to detect significant results and standardised residuals were calculated to determine which table cells are over- or under-represented. Data analysis was conducted using SPSS software for generating frequency tables, contingency tables and crosstabs in comparing variables and their potential relationships. Qualitative data was derived from unstructured and semi-structured individual interviews, open-ended questions, and focus groups.

5.3 Population Characteristics – Emergency Managers

The population characteristics of the emergency manager group for this study consist of the 95 county emergency managers within the State of Tennessee. Each county within the state has a dedicated individual who serves in this capacity and performs the duties relative to the position. Although most counties employ a full-time individual, some counties utilise a part-time position, whilst a few counties assign an individual to a voluntary, part-time role as the emergency manager. Qualifications, duties and responsibilities and minimum training requirements are set by State statute. Emergency managers are appointed officials and serve at the pleasure of the Board of County Commissioners in each county. County emergency managers work in conjunction with the State emergency management agency but are technically autonomous within the scope of hierarchical organisation structure. For the purposes of this study, all 95 county emergency managers were contacted and were requested to participate in an electronic, self-administered survey. Responses were received from 67 emergency managers resulting in a response rate of 70.5 percent.

5.4 Population Characteristics – Deaf and Hard of Hearing

The numbers of Deaf and hard of hearing people in Tennessee is generally underspecified. Therefore, the study design had no previous data on which to gage the potential number of respondents or set a percentage goal for attracting survey interest. The only qualifying parameters for being included in the survey were that respondents be either Deaf or hard of hearing. In an attempt to attract the broadest number of respondents, 27 various entities representing professional organisations, agencies, and social groups associated with the hearing loss community were contacted. This was conducted via e-mail. The survey was open to the general Deaf and hard of hearing population and no professional, social or other affiliation with any hearing loss organisation was required. The survey was designed as an electronic self-administered questionnaire which contained an American Sign Language (ASL) signed video with closed captioning embedded within the survey (see Appendix 17).

5.5 Emergency Manager Survey

5.5.1 *Thesis Objective Pertaining to Emergency Managers:*

To assess emergency management opinions regarding severe weather/tornado early warning system processes, individual protective actions, and disaster education influences.

Hypothesis: Emergency managers perceive a direct relationship between positive tornado early warning system response and disaster education efforts.

The survey developed for distribution to the emergency manager target population was designed to study the perspectives and influences of emergency managers relative to the severe weather and tornado alerting and warning system under the protocols and applications currently used. Studies devoted to the social science aspects of disaster research have shown an important correlation between the perception of risk, reception and understanding of the warning message, and an individual's informed decision to take appropriate responsive action based on receiving information. As professionals, emergency managers were surveyed to help determine how the public can be better informed of threats involving tornadic activity, and to identify better ways for making it clearer for the public to understand and interpret the information they receive. The survey comprised of six questions designed to explore emergency management areas related to disaster education, communications, preparedness, and organisational responsibility.

5.5.2 *Communication Methods for Public Alerting*

The U.S. weather enterprise is comprised of multiple dissemination methods when severe weather alerts such as Tornado Warnings are issued by the National Weather Service. However, knowing which sources emergency managers consider as important and effective as alert and warning disseminators provides information that help determine what the specialists in the field perceive as better methods to be used. The distinction between what government perceives as effective methods of warning dissemination and what specialists in the field deem important may be significant. The emergency managers surveyed were asked to respond to the following question:

> *"The following is a list of methods used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 10 being the least important."*

The design of the question looked for effective message dissemination as opposed to accepting what has evolved from influences that may or may not indicate what is working or needed from a local perspective.

The question provides an indication of what methods being used to disseminate alerting and warning messages are considered more utilised in the field. Obviously variations occur depending on the locale but some trends are related to certain methods being viewed as more effective than others. Those methods least selected in the higher rankings may indicate the lack of usefulness of the method or that it is a less evolved method for dissemination, or other factors.

Table 5.1 illustrates how emergency mangers rank the methods/tools used to communicate severe weather alerts, such as tornado warnings, in order of importance. NOAA Weather Radio was ranked first in their selection. The NOAA Weather Radio receives a broadcast signal that is directly sent by the National Weather Service. Anyone possessing this type of radio will receive up to date severe weather alerts within their locale. Because the radios can

Table 5.1 - Methods/Tools used to communicate severe weather alerts/tornado warnings

METHODS/TOOLS USED	RANK
NOAA Weather Radio	1
Emergency Alert System (EAS)	2
Cellular Phone	3
Mass Telephone Notification	4
SMS Text	5
Alert FM	6
Tornado Siren	7
Social Media	8
Ham Radio	9
Web / Internet	10

Note: 2 (3.0%) missing
n=66

be programmed to receive site specific alerts and warnings, they are considered as a primary method for communicating to the public. Alert and warning messages transmitted in this method are the same that are sent to local TV and radio stations. Therefore, the general public is receiving the same timely weather information as are commercial weather broadcasters. In a survey conducted of Oklahoma emergency managers (League et al. 2010) regarding how they learn if a tornado warning has been issued by the National Weather Service, 81 percent of the respondents listed the NOAA Weather Radio as their primary source.

Cellular phones were ranked as the 3rd choice for emergency managers to communicate severe weather alerts. The Federal Emergency Management Agency recently fully activated its Integrated Public Alerts and Warnings (IPAWS) program, along with its newly-launched Commercial Mobile Alert System (CMAS), on a nationwide basis. Although these programs have been in existence for several years, they were never fully operational until recently. The National Weather Service is currently the main user of the programs issuing weather alerts and warnings on a routine basis. As mobile phone devices are upgraded through the various cell carriers, the automated CMAS service will become more widespread.

The ranking of Web and Internet services as a method for communicating weather alerts and warnings is also of interest. The emergency manager respondents ranked this technology use as last. Although in general, Web and Internet use is increasing, the National Weather Service does not use these modes as their primary delivery mechanism. NOAA Weather Radio and EAS (Emergency Alert System) are their primary means for distributing messages. Other than the ability to directly feed into the Service's weather data radar, emergency managers rely on these two products for receiving alerts and warning, just like the general public. As Web and Internet access becomes more readily available with developments in technology improvements such as smaller laptops, notebooks and other convenience devices, the use of Web and Internet may receive a higher ranking.

5.5.3 *Communication Sources for Public Alerting*

Information related to sources of alerting and warning message dissemination as opposed to methods is an area of interest since an identified problem with message dissemination within the U.S. weather enterprise is the coordination of sources. This private/public partnership often creates conflicts and over sensationalising, such as market share issues affecting TV and radio broadcast competition. The public is often left confused as to how severe the situation actually is, desensitized to the frequently of the alerts and warnings, and inundated with the issuance of false-positive alerting information. Gaining a clearer perception of what is considered an important dissemination communication source for local emergency managers may provide identification of further research focus to address the sourcing problems related to alerting and warning protocols. Emergency managers were asked the following:

> *"The following is a list of sources used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 9 being the least important."*

The variances that developed from the survey are interesting as seen in Table 5.2. Identification of what sources emergency managers rely on for receiving their alerting information as important sheds light on what aspects of the system are seen as effective sources. Those of lower ranking may either indicate problem areas or identify sources that are viewed as least effective or lower performing alerting sources.

Table 5.2 - Sources for disseminating severe weather alerts and warnings

SOURCE	RANK
National Weather Service (NWS)	1
Live Television Broadcast	2
Live Radio Broadcast	3
Dispatch	4
Local Emergency Management Agency	5
Storms Spotters	6
State Emergency Management Agency	7
The Weather Channel	8
Contract Weather Service	9

Note: 2 (3.0%) missing
n=66

As with the methods and tools used for communication alerts and warnings to the public, the National Weather Service was again ranked first. This high ranking again underscores the importance and dependency that emergency managers place on the National Weather Service for disseminating severe weather alerts and warnings. Two distinct groups seem to develop around the second, third and fourth rankings which are Live TV Broadcast, Live Radio Broadcast and dispatch. The second group forms around the 6th ranking for Storm Spotters, State Emergency Management Agency, The Weather Channel, and Contract Weather Service.

5.5.4 *Emergency Manager Perception of Tornado Warning System Elements*

Table 5.3 represents the views of emergency manager's when asked:

> *"Please indicate the level of your agreement [regarding the following statements] on a scale of "Completely agree" to "Completely disagree."*[30]

This was a multi-focused survey question that covered several different alerting topics addressing disaster education, training materials, effectiveness of TV and radio alerting, understanding of terminology, and protective action related to severe weather alerts and tornado warnings. The purpose was to gather data on several different areas that are relevant to alerting protocols and system construction. Receiving feedback from local emergency management specialists provided perspectives regarding perceived roles, warning system functionality, and some insight as to the effectiveness from the emergency management viewpoint regarding tornado hazard education, preparedness, and alerting and warning dissemination.

[30] Answer selection consisted of "Completely Agree", "Generally Agree", Generally Disagree", "Completely Disagree" and "No Opinion." Table 5.4 reflects the percentage merging of the "Agree" and "Disagree" categories.

Table 5.3 - Emergency manager perception of tornado warning system elements

OPINION	AGREE	DISAGREE	NO OPINION
• Current Severe Weather Alerts Adequate	87.9	12.1	0.0
• Emergency Management to Take More Active Education Role	98.5	1.5	0.0
• Existing Tornado Education/Training Materials Effective	83.3	12.1	4.5
• Local Broadcast Television / Radio Effective*	89.8	9.2	0.0
• More Emphasis on Tornado Preparedness in Schools*	93.8	4.6	1.5
• Better Public Understanding of Alerting / Warning Terminology	98.5	1.5	0.0

*One (1.5%) missing
n = 64

Of the 70.5 percent of Tennessee emergency managers who responded to the survey, 98.5 percent agreed that the public needs to clearly understand the distinction between the terminology used by the National Weather Service in tornado alerts and warnings. The difference between a "tornado watch" and a "tornado warning" are significant in terms of prediction and actual formation of a tornado. A watch acknowledges the potential for tornadic activity at a later time period, whereby a "warning" signifies the imminent threat of a verified spotting or radar indication of a tornado.

Addressing the aspect of tornado hazard education, 93.8 percent of the emergency managers agreed that schools should take a more active role in providing tornado education as part of their school activities. This compares to the 98.5 percent agreement that emergency management should take a more active role in public education campaigns directed toward tornado preparedness. Regarding existing tornado education and training materials emergency managers had a less favourable opinion. 12.1 percent of those surveyed disagreed that the existing materials provided by such agencies and organizations as FEMA, the National Weather Service, American Red Cross and others, were being used effectively in preparing the public. Of interest is the response emergency managers gave related to the effectiveness of local TV and radio broadcast in informing the public on what preparedness actions to take during a tornado occurrence. 9.2 percent did not feel local broadcasts were doing an effective job.

5.5.5 *Public Non-responsiveness to Tornado Warnings*

Table 5.4 reflects emergency managers' views on the reasons for public lack of responsiveness when faced with the decision to take protective action during a severe weather related event. Emergency managers were asked the following:

> *"In those situations where an individual does not heed a tornado warning in a timely manner, check the following factors you think contribute to their non-responsiveness. Please indicate the level of your agreement on a scale of "Completely agree" to "Completely disagree."*

A major discussion point continues among disaster professionals concerning why or why not individuals respond in a timely manner to hazard alerts and warnings. With the increased number of deaths and injuries resulting from tornadoes in recent years, this remains a high interest to both the response community and the public at large. Considerable research over the last 60 years has attempted to understand this phenomenon of human behaviour and risk perception (Mileti and O'Brien 1992, Davidson and Freudenburg 1996, Terpstra et al. 2009, Zhang et al. 2009).

Table 5.4 – Public non-responsiveness to tornado warnings[31]

DISASTER MESSAGE ACTION	AGREE	DISAGREE	NO OPINION
Confusion over Severe Weather Terminology	80.3	18.2	1.5
Do Not Understand What Actions to Take	69.7	28.8	1.5
Familiarity with Seasonal Weather Patterns	74.2	22.7	3.1
Ignore the Alerts	66.7	30.3	3.0
Ignore the Sirens*	50.0	30.3	15.2
Lack of Understanding	74.2	22.7	3.1
Media Over-Reporting**	54.5	37.9	3.1
Public Complacency	93.9	3.0	3.1

*Three (4.5%) missing
**Two (3.0%) missing
Not all responses equal 100%
n = 66

The survey question attempted to further that understanding by asking emergency management professionals their perception of the causes for responding or not responding. The greatest consensus among emergency managers regarding non-responsiveness to tornado warnings was public complacency. 94 percent of the responding emergency managers were in agreement that complacency was a major factor. Another factor where emergency managers

[31] Table percentage categories were collapsed for better clarity

were in agreement was public confusion between tornado watches and tornado warnings. 80 percent agreed that there existed considerable confusion over the understanding of the watch/warning terminology, whereas 74 percent agreed that lack of understanding the nature of the threat was a contributing factor. Emergency managers also agreed that familiarity with seasonal weather patterns in their locales lead to non-responsiveness. Where incidents of tornado occurrences increase, the public feels more comfortable and less threatened by the hazard and may therefore become more complacent. This "dampening" effect is often demonstrated in hazard familiarity where a population which experiences regular occurrences of a particular type of hazard can become somewhat desensitised to the risk. For example, people living in geographical areas where earthquakes exist may accept tectonic shifting occurrences as acceptable risks, whereas someone from the Midwestern United States might be greatly unnerved if they would experience such a hazard. Mileti and O'Brien (1992) looked at explaining risk differentiations in post-impact public warning response and those of public response to pre-impact warnings. Individuals not directly impacted by mainshock damage "created a "normalization bias" for non-victims." They attributed this bias to the "constrained" perception of risk for taking protective actions to warnings of potential aftershocks (p.53-54).

Although all of the non-responsiveness categories received more agreed responses, there was some disagreement over a few of the factors. Media over reporting of potential tornado incidents is believed to cause in some cases desensitisation to alerts and warnings. Tornado forecasting has a relatively high incidence of false-positives due to the nature of the hazard phenomena. When severe weather and potential tornado outbreaks are reported, especially regarding TV broadcast coverage, viewers can be inundated with continuous coverage causing some to become desensitised to an alert or warning. Nearly 55 percent of surveyed emergency managers felt that over reporting was a factor attributed to non-responsiveness.

A similar question related to receiving too many alerts and warnings was disagreed by 30 percent of emergency managers. Ignoring tornado sirens due to the frequency of the activation was thought to be a non-responsiveness factor by 50 percent of the emergency managers but 30 percent disagreed with that assessment. Of interest is the 15 percent of "no opinion" respondents. For the other factors reported only 1.5 – 3.1 percent had "no opinion." However, it should be noted that a high number of counties in Tennessee do not have or use tornado sirens as an alerting and warning method. Therefore, the higher "no opinion" responses may be the result of a higher percentage of emergency managers not having access to siren technology.

5.5.6 *Tornado Preparedness Education Responsibility*

Disaster education is a concept that continues to elude substantive, evidence-based research but has been suggested as relevant to preparedness and response solutions for making a safer environment (Perry and Lindell 1986, Green and Petal 2008, Horan et al. 2010). However, just how effective current education approaches are is for the most part speculative. Emergency managers were asked:

> *"In thinking about who should be responsible for educating the public in tornado preparedness, how would you rate the following sources' level of responsibility for preparedness education? Please indicate their level of responsibility on a scale of "Very responsible to "Not responsible."*

Table 5.5 reflects how emergency managers view disaster education within the context of institutional responsibilities. The question asked in the survey was designed to explore the functional aspects of what disaster education really is and who should take more responsibility in educational approaches. Each of the question items addresses an organizational entity that plays a particular role within the current system in providing disaster education to the public in some manner. Whether this evolutionary configuration satisfactorily contributes to the safety of the public is, at best, open for discussion. Determining how disaster education relates to severe weather should be further studied. This is an important continuation of the development of the weather enterprise/alerting and warning paradigm.

Overwhelming 98.5 percent of emergency managers surveyed in Tennessee reported that the National Weather Service and local emergency management agencies are both responsible for tornado preparedness education. 92.4 percent of those surveyed believe that schools

Table 5.5 - Responsibility for tornado preparedness education

ORGANIZATION	RESPONSIBLE	LESS RESPONSIBLE
National Weather Service (NWS)	98.5%	1.5%
Local Emergency Management Agency*	98.5%	0.0%
Local Government	97.0%	3.0%
Schools**	92.4%	4.5%
State Emergency Management Agency**	87.9%	9.1%
Local Broadcast Television	84.8%	15.2%
Local Broadcast Radio	80.3%	19.7%
Federal Emergency Management Agency	75.8%	24.2%
Non-government Organizations (NGOs)	66.7%	33.3%
Private Industry	50.0%	50.0%

*One (1.5%) missing
** Two (3.0%) missing
Not all responses equal 100 percent
n = 66

should be responsible for providing preparedness education as well. Conversely, 50 percent reported that private industry is less responsible for offering this type of education to the public, whereas 33.3 percent of the emergency managers responded that non-governmental organisations such as the American Red Cross, VOAD (Voluntary Organizations Active in Disaster), and faith-based affiliated groups have less of a responsibility to educate the public involving tornado preparedness.

Local broadcast TV and radio also received high responsibility rating from emergency managers regarding tornado education with 84.8 percent and 80.3 percent respectively. Although 24.2 percent of the emergency managers believe the Federal Emergency Management Agency (FEMA) is less responsible for providing tornado preparedness education to the public, FEMA is actually one of the higher profile producers and promoters of hazard education materials in the U.S.

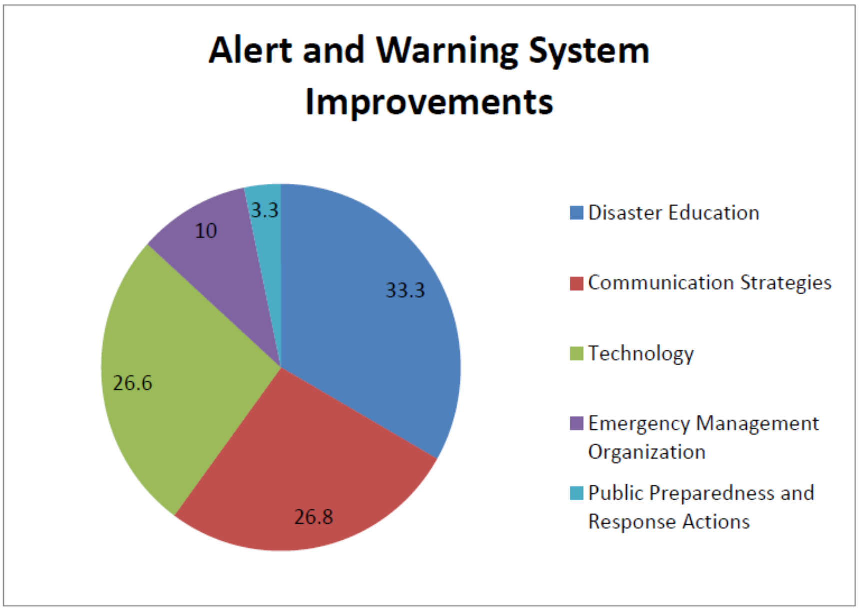
5.5.7 *Severe Weather Alerts and Tornado Warning System Improvements*

Individual emergency managers were given the opportunity to provide their input and views on how they perceive the system and express their thoughts regarding what can be done to improve the system, or make the system different, to be more responsive or effective in its performance. Figure 5.1 is reflective of the comments emergency managers indicated when asked:

> *"Several of the past tornado seasons produced a significant number of tornadic events that resulted in a high occurrence of deaths and injuries in parts of the U.S. As an emergency management specialist, how would you improve the system to provide effective notification leading to better public response to severe weather alerts such as tornado warnings?"*

One of the complaints from professionals in the field is the lack of local input related to changes and proposed implementations that affect their operations. Local emergency managers are generally closer to their constituency and may contribute ideas that impact local needs. There are numerous issues being discussed in the profession as to the proper and most effective way to disseminate alerts and warnings to the public. The exact role emergency management should play in weather alerting is also highly debated. Directly soliciting their ideas and thoughts produced a number of relevant comments from the local perspective.

Figure 5.1 - Alert & warning system improvements (as suggested by Tennessee Emergency Managers)



Source: J. Walsh 2013

Comments were received by 49 respondents generating 60 specific areas of emphasis. Of the comments received, emergency managers indicated that more attention should be given to disaster education directed toward public awareness (33.3%). This was followed by better and improved communication strategies for tornado/severe weather warning and alerting dissemination processes (26.8%); technology related improvements (26.6%); emergency management system related improvements (10.0%); and, better public preparedness and response actions (3.3%).

5.5.8 *Summary of Emergency Management Survey*

Data received from the emergency manager survey clearly indicated certain patterns in their use of warning system components, the overall usefulness of the warning system and a clear consensus of who should be responsible for developing and supporting disaster education as it relates to the populations emergency managers serve. Emergency managers agreed that public complacency plays a major role in the lack of responsiveness to tornado and severe weather warnings. This non-responsiveness was generally attributed to confusion over terminology and failure to clearly understand the warning messages disseminated to the public.

5.6 Deaf and Hard of Hearing Survey

5.6.1 *Thesis Objective Pertaining to the Deaf and Hard of Hearing:*

Determine how the severe weather/tornado early warning system affects protective response behaviours among Deaf and hard of hearing individuals.

Hypothesis: There is a direct relationship between tornado early warning system disaster education and the preparedness and response levels of the Deaf and hard of hearing individuals.

The survey design considered the specific cultural, physical and social uniqueness characteristics associated with the Deaf and hard of hearing community. As a very limited studied special needs community little documented reference to similar studies or analyses was available. The advantage of this challenge provided an opportunity to gather input from both community participants and professionals who serve hearing loss individuals. Tennessee has no data representing Deaf persons regarding demographics reflecting tornado preparedness or response profiles. This study will provide new data that may be used as foundational research for future knowledge addressing the Deaf community. The survey was developed to further understand this population's characteristics and factors impacted by warning system components, individual preparedness, available preparedness education and training opportunities and holistic disaster responsiveness.

5.7 Deaf and Hard Of Hearing Population Survey Demographics

5.7.1 *Deaf and Hard of Hearing Self-Identification*

There are several categories which define the Deaf and hard of hearing population. Although the distinctions are clearly characterized from a clinical perspective, individuals may categorize themselves differently depending on age, perceived sense of hearing loss or other individualistic factors and environments (Holcomb 2013). The answers listed cover the recognized categories within the hard of hearing community. From a clinical standpoint the categories of hearing loss may impact the comprehension of the question and the response given.

When conducting follow-up interviews with several representatives of the Deaf and hard of hearing community and a number of associated professionals, the question was raised as to the number of respondents that self-identified as "Deaf." All thought this number (percentage) of self-identified deaf persons was considerably higher than should be for a true representative number of the surveyed respondents. Terms used to Describe Hearing Problems: Deaf - refers to members of the Deaf community and Deaf culture. Deaf with a small "d" - refers to people who have significant hearing loss, but are not identified as members of the Deaf community and culture. Hard of Hearing - refers to those with mild to severe hearing losses who probably use speech for communication, will need educational and technological support, and may or may not identify with the Deaf culture.

Table 5.6 provides information as to how the respondents categorise themselves according to loss of hearing descriptors. Of the 183 individuals who took the survey, 173 self-identified themselves in the following manner; 81(44.3%) responded as being hard of hearing and 70 (38.3%) identified themselves as deaf,[32] 8 (4.4%) identified as late deafened, and 2 (1.1%) reported as deaf blind.

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[32] Because of this potential bias, statistical comparisons of the self-identification category was eliminated from the study.

Table 5.6 – Self-Identification of the survey respondents

SELF-IDENTIFICATION	NUMBER OF RESPONDENTS
Deaf	70
Deaf Blind	2
Hard of Hearing	81
Late Deafened	8
I Do Not Have Hearing Loss	12

n = 173

5.7.2 *Deaf and Hard of Hearing Primary Mode of Communication*

An individual may use several modes of communication depending on their individual circumstance and the hearing ability of other individuals they are communicating with. The four listed answers are considered the most frequently utilised modes. Understanding what mode they use or the frequency of the mode used may provide information on what gaps exists or what modes disaster professionals should consider using more consistently in communicating with the hard of hearing community. Approximately 17 percent (36 million) of American adults report some degree of hearing loss.[33] Obviously, the one mode fits all concept is not feasible when communicating with this population. The availability of several communications modes for use during a disaster occurrence is critical when considering a diverse and specialised need population such as the deaf and hard of hearing.

Respondents were asked to identify their primary mode of communication (Table 5.7). Thirty-seven percent of the Deaf and hard of hearing respondents reported their primary mode of communication was sign language. Cued speech, a system of hand shapes and movements that can be used to supplement spoken sounds, is used by 28.8 percent of those responding and 17.9 percent advised they primarily use speech reading, proper term for what is more commonly known as "lip reading", as their preferred communication mode. Less than one percent (0.5) of those surveyed listed writing as their primary communication. The comments listed in the other category mainly clarified their individual circumstance or repeated their communication mode preference.

[33] National Institute on Deafness and Other Communication Disorders, March 2010.

Table 5.7 - Primary mode of communication

PRIMARY MODE OF COMMUNICATION	NUMBER OF RESPONDENTS	
Sign Language	68	(37.0%)
Cued Speech	53	(28.8%)
Speech Reading	33	(17.9%)
Writing	1	(0.5%)
Other	28	(15.2%)

One (0.5%) missing
n = 183, n (%)

5.7.3 *Deaf and Hard of Hearing Primary Language*

Survey respondents were asked to identify the primary language they use. Table 5.8 illustrates the languages that were identified. The choices were limited due to the population demographics of the survey region (State of Tennessee). Approximately five percent of the general population in Tennessee speak a language other than English. The top three of the languages spoken other than English make up only 4.8 percent of the population comprising Spanish (2.5%), German (0.4%) and French (0.3%).

Table 5.8 - Primary language used

PRIMARY LANGUAGE USED	NUMBER OF RESPONDENTS	
American Sign Language	79	(42.9%)
English	103	(56.0%)
Spanish	1	(0.5%)
Writing	1	(0.5%)
Other	28	(15.2%)

Note: One (0.5%) missing;
n = 183, n (%)
Not all responses equal 100%

Fifty-six percent of those surveyed selected English as their primary language, followed by 42.9 percent listing American Sign Language (ASL). Less than one percent of the deaf and hard of hearing surveyed chose Spanish as their primary language.

5.7.4 *Deaf and Hard of Hearing Respondent Demographics - Age*

The age covariate is used to look at influences age may play with any of the multiple variables or factors derived from the primary and corollary questions asked in the survey. From the specific data gathered, the influence of age may or may not be viewed as important. From the review of disaster literature, we know that age can have an impact on the method preferred for receiving alerts and warnings or may influence what actions one takes during a severe weather alert or tornado warning (Friedsam 1962, Drabek 2010). How, or if age influences or impacts protective actions of those making up the Deaf and hard of hearing community within this study, is important.

The age categories of the individual respondents are shown in Table 5.9. The highest respondent percentile age range at 19.6 percent were those surveyed between 50 -59 years of age. Respondents ranging between the ages of 40 – 49 and 60 -69 each respectively made up 17.4 percent of the deaf and hard of hearing of those taking the survey. Eleven percent, 11.4 percent of those surveyed were over the age of 70.

Table 5.9 – Respondent age categories

RESPONDENT AGE	NUMBER OF RESPONDENTS
10-19	5 (2.7%)
20-29	14 (7.6%)
30-39	23 (12.5%)
40-49	32 (17.4%)
50-59	36 (19.6%)
60-69	32 (17.4%)
70 +	21 (11.4%)

Note: Twenty-one (11.3%) missing;
n = 163, n (%)
Not all responses equal 100%

5.7.5 *Respondent Demographics - Gender*

Differences associated with gender within disaster related research can be viewed as contextual in many instances whilst studies have indicated succinct difference regarding risk perception, warning message reception and protection action taken when a hazard is encountered (Davidson and Freudenburg 1996, Gladwin and Peacock 1997, Fordham 1999, Bateman and Edwards 2002). Whether there exist significant relationships between certain variables attributed to gender within the Deaf and hard of hearing community is one of the areas of study.

As shown in Table 5.10, of the 183 Deaf and hard of hearing individuals who took the survey, 64.7 percent were female and 34.8 percent were males.

Table 5.10 – Respondent gender

RESPONDENT GENDER	NUMBER OF RESPONDENTS
Female	119 (64.7%)
Male	64 (34.8%)

Note: One (0.5%) missing;
n = 183, n (%)
Not all responses equal 100%

5.7.6 *Respondent Demographics - Race*

According to the latest U.S. national statistics, Whites are more than twice as likely as Blacks to be Deaf or hard of hearing. The overall prevalence for whites is 9.4 percent, compared to blacks at 4.2 percent. The prevalence for non-Hispanics to be deaf or hard of hearing is twice that of Hispanics. The overall prevalence is 9.1% for non- Hispanics and 4.2 percent for Hispanics.[34] Table 5.11 illustrates the ethnicity of those individuals who responded to the survey.

Those taking this survey were mainly White, so the distinctions from these survey results and the estimated racial makeup of the Deaf and hard of hearing population overall may lack commonality. The overall Tennessee racial demographics according to U.S. Census Bureau statistics for 2011 reported Whites made up 79.5 percent of the population, Blacks 16.9 percent, Asian or Pacific Islander 1.9 percent, and Hispanic 4.7 percent.

Table 5.11 – Respondent race

RESPONDENT RACE	NUMBER OF RESPONDENTS
White	148 (80.4%)
Black	11 (6.0%)
Hispanic/Latino	4 (2.2%)
Asian or Pacific Islander	1 (0.5%)

Note: Twenty (10.9%) missing
Not all responses equal 100%

Those respondents taking the survey were 80.4 percent (148) White; similar to the State population. The second largest population ethnic group were Blacks, representing 6.0 percent (11) of the respondents. Hispanic respondents reported at 2.2 percent (4) and less than one percent (1) identified their ethnicity as Asian or Pacific Islander.

[34] *Source: National Center for Health Statistics, Data from the National Interview Survey, Series 10, Number 188, 1994.*

5.8 Communication Factors in Early Warning for the Hard of Hearing

5.8.1 *Source Preferences for Receiving Alerts and Warnings*

Understanding the sources the Deaf and hard of hearing population most frequently use to receive alerts and warnings is an important aspect for evaluating trusted and relied upon modes of communication. The responses help identify those modes most utilised and provide comparative data whether this population is following the same trends as the general population with respect to age and the communication modes they prefer. Of interest was knowing what transmission modes serve and are used by the Deaf and hard of hearing community. Usage data provided insight into what modes they are comfortable with using and what modes may be the most effective for them.

Survey respondents were asked,

> *"What source do you prefer to receive severe weather alerts, such as tornado warnings?"*

Table 5.12 represents their preference for receiving severe weather alerts and warnings. Mobile devices are the most preferred source as 73.4 percent of those surveyed selected this mode of communication. TV station 69.0 percent and Internet 46.7 percent communications followed as the second and third choices. Computer applications 24.5 percent, mass telephone calls 11.4 percent and highway message boards 31.1 percent were listed as the least favoured sources for receiving alerts and warnings.

Table 5.12 - Sources preferred for receiving weather alerts/warnings

SOURCES PREFERRED FOR RECEIVING WEATHER ALERTS / WARNINGS	n = 183 n (%)
Mobile Device (Cell Phone, Tablet, Laptop)	135 (74.3)
Television Station	127 (69.0)
Internet	86 (46.7)
Highway Message Boards	57 (31.1)
Weather Alert Radio	56 (30.4)
Computer Applications	45 (24.5)
Mass Telephone Calls	21(11.4)

Note: One (0.5%) missing

The gender differences regarding source preferences for alerts and warnings are illustrated in Table 5.13.[35] Mobile devices and Internet communication sources showed the largest differential between females and males. Females preferred mobile devices 77.3 percent to males 67.2 percent, whereas male preferred Internet 57.8 percent to females 41.2 percent.

Table 5.13 - Gender & Source of Severe Weather Alerts

Gender	n = 184						
	n = (%)						
	SOURCE OF SEVERE WEATHER ALERTS AND WARNINGS						
	Computer Apps	Highway Boards	Internet	Mass Telephone Calls	Mobile Devices	Television Station	Weather Alert Radio
Female	29 (24.4)	36 (30.3)	49 (41.2)	14 (11.8)	92 (77.3)	80 (67.2)	36 (30.3)
Male	16 (25.0)	21 (32.8)	37 (57.8)	7 (10.9)	43 (67.2)	47 (73.4)	20 (31.3)
Total % Within Source	45 (24.6)	57 (31.1)	86 (47.0)	21 (11.5)	135 (73.8)	127 (69.4)	56 (30.6)
p - value	.925	.721	.032	.867	.138	.385	.889

Note: One (0.5%) missing; Multiple responses were allowed which exceed 100%
Gender % within Source of Severe Weather Alerts
Note: *p* - value .032 shows a significant different at the 95 percent level (i.e. $p<0.05$)

The percentage differences between males and females for alert and warning source preference were relatively equal with respect to computer applications, highway board messages, mass phone calls, and weather alert radio. A greater percentage of males, 73.4 percent versus females 67.2 percent, preferred using TV as their communication source for receiving severe weather alerts and warnings.

5.9 Hard of Hearing Protective Actions to Early Warning Systems

5.9.1 *Protective Action*

Alert and warning messaging is dependent on what the receiver does once the message is received. The question gives some indication whether they understand their options or if there is a need for better understanding of alert or warning messages in general. From the literature we know perception of risk is important in determining the protective action to be taken when an alert or warning is activated (Riad and Norris 1998, Rodriguez et al. 2004, Barker et al.

[35] The level of statistical significance is the level of risk inferred that there is a relationship between two variables in the population from which the sample is taken when in fact no such relationship exists. Probability (p) at $p < 0.01$ means that the researcher is prepared to accept as their level of risk a probability of only 1 in 100 that the results could have arisen by chance. In this case none of the probability levels reach an acceptable level of significance. (Bryman 2008, *Social Research Methods*, Oxford University Press, p. 333-335.

2005). Message design and content, effectiveness of dissemination modes, and training/education gaps, may be impacted by an individual's personal environment and circumstance (Mileti and Sorensen 1990, Sorensen 2000).

Respondents were asked:

> *"What actions do you take when there is a severe weather alert or tornado warning in your area?"*

Table 5.14 shows that 78.3 percent of those responding chose staying in a safe place as their primary action to be taken when there is a severe weather alert or tornado warning in their area. Sixty-five percent elect to turn on their TV following receipt of an alert or warning. Conversely, only 2.7 percent of respondents advised they would do nothing. Almost half of the Deaf and hard of hearing surveyed (47.3%) stated that they would open up communications with other family members.

Table 5.14 - Actions taken during severe weather alert or tornado warning

ACTIONS TAKEN DURING SEVERE WEATHER ALERT OR WARNING	n = 183 n (%)
Stay Inside in a Safe Place	144 (78.3)
Turn on Local Television Station	119 (64.7)
Communicate with Family Members	87 (47.3)
Don't Do Anything	5 (2.7)
Go to Another Location that is Safe	42 (22.8)

Note: One (0.5%) missing
Multiple responses were allowed which exceed 100%

Table 5.15 compares specific protection actions taken following the reception of a severe weather alert or tornado warning with individuals who have or do not have a family response plan. Of those surveyed not having a family emergency response plan, 76.6 percent are likely to stay inside in a safe place following the reception of a tornado warning/severe weather alert compared to 85.7 percent of those who do have a plan. 78.6 percent of those having a response plan are likely to turn on the TV, compared to 61.0 percent of those who do not have a plan. The analysis showed a statistical significant relationship for respondents who have a family emergency response plan and communicate with family (χ^2 =10.1, df =1, p=0.001).[36] A small percentage of respondents (3.5%) who do not have a plan reported they would take no action.

[36] Various statistical tests were run for all survey data collected. The chi-square (χ^2) test was performed to establish confidence that there is a relation between the two variables. The statistical significance in this case comparing the protective action of communicating with family during an alert or warning and having a family emergency response plan resulted in a probability value of .001. This finding suggests that there is only 1 chance in 1000 that there is no relationship between the two variables.

Table 5.15 – Family emergency response plan & protective action taken

Protective Action Taken During Alert or Warning Event	n = 184		*p* - value
	n (%)		
	Family Emergency Response Plan		
	No	Yes	
Communicate with Family	58 (41.1)	29 (69.0)	.001
Don't Do Anything	5 (3.5)	0 (0)	.216
Go to Another Safe Location	29 (20.6)	13 (31.0)	.160
Stay Inside a Safe Place	108 (76.6)	36 (85.7)	.205
Turn on Local Television Station	86 (61.0)	33 (78.6)	.036

Note: One (0.5%) missing

Proportionately, males indicated taking appropriate protective action slightly more often than females after receiving a tornado warning or severe weather alert (Table 5.16). 82.2 percent of males compared to 76.5 percent of females responded that they would stay inside a safe place. 73.4 percent of males responded that they would turn on a local TV station compared to 60.5 percent of the male respondents. Females indicated they would likely communicate with family 48.7 percent where 45.3 percent of males responded they would communicate with family. 23.4 percent of males were slightly more likely to go to another safe location compared to 22.7 percent of females who indicated they would relocate. Although a very small percentage of females 4.2 percent reported they would do nothing if they received a severe weather alert or warning, no males indicated they would take no action under such circumstances. It is important to note that these differences on the basis of gender are quite slight in terms of statistical significance (i.e. significant at the 0.1 level for two variables only)

Table 5.16 – Gender within protective action taken

Gender	n = 184				
	n = (%)				
	PROTECTIVE ACTION TAKEN				
	Communicate with Family Members	Don't Do Anything	Go to Another Location that is Safe	Stay Inside a Safe Place	Turn on Local Television Station
Female	58 (48.7)	5 (4.2)	27 (22.7)	91 (76.5)	72 (60.5)
Male	29 (45.3)	0 (0.0)	15 (23.4)	53 (82.8)	47 (73.4)
Total % Within Source	87 (47.5)	5 (2.7)	42 (23.0)	144 (78.7)	119 (65.0)
p - value	.658	.096	.909	.318	.080

Note: One (0.5%) missing
Gender % within Protective Action Taken

5.10 Closed Captioning Related to Alerts And Warnings

5.10.1 *TV Transmissions Utilising Closed Captioning*

A major problem area for the Deaf and hard of hearing community involves closed captioning which is provided by some television broadcast media during severe weather and tornado coverage. Closed captioning is a typed version of the broadcaster's spoken words appearing somewhere on the TV screen, either in a static display or continuous scroll. As in most alerting and warning messaging, the content is sometimes confusing, non-instructional (protection), or poorly written for comprehension of the hard of hearing population. The user must have minimal reading skills and depending on the interpretation software used to generate the captioning, translation may not always follow the broadcaster's spoken words. Captioning may not be available in some TV markets while message content may be limited containing only the alert; providing no additional information relative to the exact location of the alert/warning hazard or containing no protective action information within caption.

Survey respondents were asked,

> *"If you watch television weather broadcasts as a source for receiving weather alerts and tornado warnings, is the captioning helpful, easy to understand or could be more detailed [in its message]?"*

Table 5.17 addresses the thoroughness issues surrounding closed captioning scrolling on TV transmission for those individuals who are Deaf or hard of hearing. Of the respondents to the survey answering in the affirmative, 65.2 percent found the closed captioning was easy to understand, and 60.3 percent felt the captioning was helpful in providing information on what protective actions to take.

Table 5.17 - Closed captioning thoroughness

CLOSED CAPTIONING THOROUGHNESS	n = 183
	n (%)
Could be more Detailed as what Action to Take	107 (58.2)
Easy to Understand	120 (65.2)
Helpful in what Action to Take?	111 (60.3)

Note: One (0.5%) missing

However, 58.2 percent of respondents stated that closed captioning could provide more detail as to what actions to take. Closed captioning poses several further problems which includes a lack of consistency in its use among the broadcast TV companies. Some companies provide captioning, some do not, and at times those who do may not provide it at all times. Typing errors occur frequently and captioning scrolls may not synchronise accurately with the broadcaster's presentation which can cause difficulty for the hard of hearing viewer to follow the weather reporting accurately.

Table 5.18 shows respondent's experience of TV closed captioned thoroughness subdivided by gender. Proportionally, 76.6 percent of the males responding determined captioning is easy to understand compared to 59.7 percent of females. In determining whether closed captioning was helpful in informing what actions to take, 67.2 percent males responded affirmatively versus 57.1 percent of the females. When asked if closed captioning could be more detailed regarding message content, 62.5 percent of males responded affirmatively, compared to 56.3 percent of the females.

Table 5.18 – Gender & Closed Captioning Thoroughness

Gender	**n = 184**		
	n = (%)		
	CLOSED CAPTIONING THOROUGHNESS		
	More Detailed as to Actions to Take	**Easy to Understand**	**Helpful in Actions to Take**
Female	67 (56.3)	71 (59.7)	68 (57.1)
Male	40 (62.5)	49 (76.6)	43 (67.2)
Total % Within Source	107 (58.5)	120 (65.6)	111 (60.7)
p - value	.417	.022	.185

Note: One (0.5%) missing

Gender % within Closed Captioning Thoroughness

5.10.2 *Quality Rating for Closed Captioning During Weather Broadcasts*

Data from the frequency statistics remained relatively similar for the respondents regarding how they rated the quality of the closed captioning during a severe weather broadcast. Research data providing insight as to the quality of captioning is scarce, although some captioning is software generated, much is written by a live person transcribing/typing the broadcaster's spoken word using a steno keyboard. This can lead to many errors. The fact that the Federal Communications Commission (FCC), who regulates all U.S. interstate and international communications by radio, television, wire, satellite and cable, has no rules regarding caption quality or accuracy is a problem. Several of its (FCC) mandates require stations to make television more accessible for the Deaf and hard of hearing community, but those mandates mainly address the amount of programming to be closed captioned and do not address quality or accessibility issues.

The Deaf and hard of hearing survey asked respondents,

> *"How would you rate the quality of the captioning during a live weather broadcast?"*

Table 5.19 illustrates that only 26.1 percent of the Deaf and hard of hearing respondents rated the quality of closed captioning during severe weather broadcasting as good. 37.5 percent gave it a fair rating and almost one-quarter (23.4%) gave closed captioning a poor rating. This lack of encouraging responses may be indicative of the failure to address the "quality" issue related to closed captioned messages.

Table 5.19 - Closed captioning quality

CLOSED CAPTIONING QUALITY	n = 183
	n (%)
Good	48 (26.1)
Fair	29 (37.5)
Poor	43 (23.4)

Note: Twenty-four (13.0%) missing

Table 5.20 shows responses to closed captioning quality subdivided by gender. Forty-two percent (25) of males rate captioning (good) considerably higher than females 23.0 percent. However, nearly half of females 49.0 percent rated quality as fair compared to 33.3 percent males. The difference narrowed of those noting the captioning quality as poor with 28.0 percent females and 25.0 percent males. Overall, both females and males find the quality of TV closed captioning received during a tornado warning or severe weather alert fair 43.1 percent, good 30.0 percent and poor 26.9 percent.

Table 5.20 – Gender & Closed Captioning Quality

Gender	n = 184 n (%) Closed Captioning Quality			*p* - value
	Good	Fair	Poor	
Female	23 (23.0)	49 (49.0)	28 (28.0)	.037
Male	25 (41.7)	20 (33.3)	15 (25.0)	
All	48 (30.0)	69 (43.1)	43 (26.9)	

Note: Twenty-four (13.0%) missing
Closed Captioning Quality % within Gender

With reference to varying age groups and their indication of closed captioning quality, differences exist within this study (Table 5.21). Younger respondents aged 10-19 notes the quality to be good (75.0%). The 20-29 age group indicate the quality to be equally good, (41.7%) and fair (41.7%). The following age groups note the quality to be fair to poor: ages 50-59, (54.5%) and (21.2%); ages 60-69, (34.5%) and (27.6%); and ages 70+, (52.9%) and (35.3%). The study found both the 30-39 and 40-49 age groups were consistent in their indication of caption quality. Both groups in larger percentages find quality to be fair as opposed to either good or poor. Of all respondents, 69.7 percent noted the TV closed captioning quality to be either fair 43.9 percent or poor 25.9 percent. This may show only minor variations as differences overall are not statistically significant.

Table 5.21 -Age & closed captioning quality

Age	n = 184 n (%) Closed Captioning Quality			% of Total	*p* - value
	Good	Fair	Poor		
10-19	3 (75.0)	0 (0.0)	1 (25.0)	4 (2.5)	.571
20-29	5 (41.7)	5 (41.7)	2 (4.7)	12 (7.5)	
30-39	6 (27.3)	10 (45.5)	6 (27.3)	2 (13.8)	
40-49	8 (27.6)	13 (44.8)	8 (27.6)	29 (18.1)	
50-59	8 (24.2)	18 (54.5)	7 (21.2)	33 (20.6)	
60-69	11 (37.9)	10 (34.5)	8 (27.6)	29 (18.1)	
70 +	2 (11.8)	9 (52.9)	6 (35.3)	17 (10.6)	

Note: Twenty-four (13.0%) missing
Age % within Closed Captioning Quality

5.10.3 *Closed Captioning TV Placement*

Placement of the weather captioning can be a problem area for the Deaf and hard of hearing population. At times it covers up other important graphic information being displayed in the weather broadcast making relevant information display unable to view. When multiple layers of scrolls, crawls, overlays and captioning occur at the same time the effectiveness of HOH captioning is significantly degraded. Because there is no industry standardisation relative to placement on the screen, research is needed to identify more ideal captioning placement for producing consistent viewing effectiveness.

Most TV media provide captioning only under pressure by advocacy groups. There is very little incentive to provide the service otherwise. If the market share of the Deaf and hard of hearing community was significant, media outlets may be more attuned to the problem. This information may also aid in providing additional data for supporting industry standardisation on behalf of this underserved population. The information sought after is intended to provide data that caption placement in its current framework is either satisfactory or not, without specific industry testing and standardisation being applied.

The survey asked Deaf and hard of hearing respondents, "Where do you prefer closed captioning to be placed on your television screen?" Table 5.22 shows the majority of those responding, 67.4 percent preferred that closed captioning scrolls be displayed at the bottom of the TV screen; 23.4 percent preferred it be displayed at the top of the screen. Only 1.1 percent and 2.2 percent of the respondents selected the right side or left side. Closed captioning placement varies considerably depending on the station and individualised network programming. The lack of consistent standardisation causes overlapping and haphazard placement leading to the frequent inability of viewing critical graphic information displayed during severe weather or tornado warning events.

Table 5.22 - Closed captioning location

Preference for Closed Captioning TV Screen Location	n= 183
	n (%)
Top	43 (23.4)
Left Side	4 (2.2)
Right Side	2 (1.1)
Bottom	124 (67.4)

Note: Eleven (6.0%) missing

Table 5.23 shows the preferred TV closed captioning location for tornado warnings and severe weather alerts by gender. Both females (71.8%) and males (71.4%) preferred closed captioning be located on the bottom of the TV screen. The top location was the second most preferred location for females (23.6%) and males (27.0%). The least noted was the right side preferred by only (1.2%) respondents, there being no significant different between the two groups.

Table 5.23 - Gender & Closed Captioning Location

Age	n=184				*p* - value
	n (%)				
	Closed Captioning Location				
	Top	Left Side	Right Side	Bottom	
10 - 19	1 (20.0)	0 (0.0)	0 (0.0)	4 (80.0)	.408
20 - 29	5 (35.7)	0 (0.0)	0 (0.0)	9 (64.3)	
30 - 39	5 (21.7)	0 (0.0)	0 (0.0)	18 (78.3)	
40 - 49	4 (12.5)	1 (3.1)	1 (3.1)	26 (81.3)	
50 - 59	10 (28.6)	0 (0.0)	0 (0.0)	25 (71.4)	
60 - 69	9 (30.0)	1 (3.3)	0 (0.0)	20 (66.7)	
70+	3 (16.7)	0 (0.0)	1 (5.6)	14 (77.8)	
% of Total	43 (24.9)	4 (2.3)	2 (1.2)	124 (71.7)	

Note: Eleven (6.0%) missing
Age % within Closed Captioning Location

Comparison of Deaf and hard of hearing respondents by age regarding closed captioning preference is shown in Table 5.24. Overwhelming the majority of all respondent age groups (77.8%) preferred seeing closed captioning messaging during a severe weather alert or tornado on the bottom of television screen. The second choice was a top location preferred by 24.9 percent of all respondents. There was no significant difference between age groups.

Table 5.24 - Age & closed captioning location

Gender	n=184				% of Total	*p* - value
	n (%)					
	Closed Captioning Location					
	Bottom	Left Side	Right Side	Top		
Female	79 (71.8)	4 (3.6)	1 (0.9)	26 (23.6)	110 (63.6)	.452
Male	45 (71.4)	0 (0.0)	1 (1.6)	17 (27.0)	63 (36.4)	

Note: Eleven (6.0%) missing
Gender % within Closed Captioning Location

5.11 Disaster Education Preparedness Levels for the Deaf and Hard of Hearing

5.11.1 *Emergency Preparedness Programmes*

Survey respondents were asked,

"Please check any of the [following] emergency preparedness classes

you have completed."

The choice selections are listed in Table 5.25. There are two objectives to this question, 1) to focus on the identification of the types of emergency and preparedness training/education the Deaf and hard of hearing population has completed or attended, and 2) to determine if training/education gaps exist. There is very little formalised training that is specific to the hard of hearing population, especially addressing preparedness and response training. Even less prevalent is training directed toward weather related hazard. More favourable responses to this question were in the areas of CPR and first aid training. Comparing secondary data between the general population and the hard of hearing community regarding preparedness and response training has produced some interesting similarities as well as some obvious differences. The Deaf and hard of hearing population are generally more receptive to receiving disaster training than the general population. This receptiveness may be the result of the limit training opportunities provided to them.

Table 5.25– Emergency preparedness classes completed

Emergency Preparedness Classes Completed	**n= 183**
	n (%)
Community Emergency Response Team (CERT)	13 (7.1)
CPR Cardiopulmonary Resuscitation (CPR)	67 (36.4)
First Aid	60 (32.6)
Have Not Completed Any Emergency Preparedness Classes	65 (35.3)
Personal Preparedness Training/Education (FEMA, Red Cross, etc.)	13 (7.1)
Severe Weather/Storm Spotter	20 (10.9)
Other	5 (2.7)

Note: One (0.5%) missing

Availability of formalised training and education programmes are somewhat limited to the Deaf and hard of hearing community. Table 5.26 represents selected emergency preparedness programmes that have been attended by the Deaf and hard of hearing population. One of the more popular preparedness programmes is CPR where 36.4 percent of the respondents reported to having attended a class. One third (32.6%) of those surveyed said they have completed a first aid class. Both Community Emergency Response Team (CERT) training and personal preparedness training received from an organisation such as the Federal Emergency Management Agency or the American Red Cross, was reported by only 7.1 percent of those surveyed. Storm spotter education, which is a relatively new developed training programme in Tennessee, especially for the Deaf and hard of hearing population, was reported as having been completed by 10.9 percent of respondents. However, overall 35.3 percent indicated not having attended or completed any emergency preparedness training.

Comparisons are shown in Table 5.26 between female and male participation in completing emergency preparedness classes. Females (71.4%) note a higher percentage of having not completed any preparedness classes than males (51.6%). 38.7 percent of females responded to having completed CPR class compared to 32.8 percent of males, whilst 37.0 percent of females reported to having completed first aid training compared to 25.0 percent of males.

Table 5.26 - Gender & emergency preparedness classes completed

Gender	**n = 184**					
	n = (%)					
	EMERGENCY PREPAREDNESS CLASSES COMPLETED					
	Community Emergency Response Team	**CPR**	**First Aid**	**Have Not Completed Any Classes**	**Personal Preparedness Training / Education**	**Severe Weather / Storm Spotter**
Female	7 (5.9)	46 (38.7)	44 (37.0)	85 (71.4)	6 (5.0)	12 (10.1)
Male	6 (8.4)	21 (32.8)	16 (25.0)	33 (51.6)	7 (10.9)	8 (12.5)
Total	13(7.1)	67 (36.6)	60 (32.8)	118 (64.5)	13 (7.1)	20 (10.9)
p - value	.380	.434	.100	.007	.139	.617

Note: One (0.5%) missing
Gender % within Classes Completed

The study found a small difference between female and male participation in community response team training classes, female 5.9 percent and male 8.4 percent. The lowest completion for females was personal preparedness training/education classes 5.0 percent and for males 10.9 percent reported having completed community emergency response team training. 10.1 percent of females participated in severe weather/storm spotter training, which was slightly less than male participation at 12.5 percent. However, significantly more females indicated they had not completed any classes ($p<0.01$).

Table 5.27 compares the Deaf and hard of hearing survey respondent age groups having completed preparedness classes. The majority of respondents indicate they have not taken any Emergency preparedness classes (56.3%). Overall, the most active age group completing classes are respondents in the 50-59 group, followed closely by those 60-69. CPR (31.7%) and first aid (28.4%) are the most frequent completed preparedness classes. The least attended classes are community response team training (5.5%) and personal preparedness training/education (6.0%)

Table 5.27 – Age & emergency preparedness classes completed

Age	n = 184 n = (%) EMERGENCY PREPAREDNESS CLASSES COMPLETED					
	Community Emergency Response Team	**CPR**	**First Aid**	**Have Not Completed Any Classes**	**Personal Preparedness Training / Education**	**Severe Weather / Storm Spotter**
10-19	0 (0.0)	3 (60.0)	3 (60.0)	3 (60.0)	0 (0.0)	0 (0.0)
20-29	0 (0.0)	6 (42.9)	7 (50.0)	7 (50.0)	0 (0.0)	3 (21.4)
30-39	1 (4.3)	10 (43.5)	7 (30.4)	14 (60.9)	0 (0.0)	3 (13.0)
40-49	0 (0.0)	80 (25.0)	9 (28.1)	17 (53.1)	3 (9.4)	4 (12.5)
50-59	4 (11.1)	11 (30.6)	13 (36.1)	25 (69.4)	7 (18.4)	3 (8.3)
60-69	3 (9.4)	14 (4.8)	8 (25.0)	23 (71.9)	1 (3.1)	3 (9.4)
70 +	2 (9.5)	6 (28.6)	5 (23.8)	14 (66.7)	0 (0.0)	2 (9.5)
Total	10 (5.5)	58 (31.7)	52 (28.4)	103 (56.3)	11 (6.0)	18 (9.8)

Note: One (0.5%) missing
Multiple responses were allowed which exceed 100 percent

5.11.2 Interest of the Deaf and Hard of Hearing Population in Preparedness Training

It is important to understand what preparedness training and education is important to those that make up the Deaf and hard of hearing community. It can be argued that too often government officials and disaster specialists assume they know what is best for a particular segment of our society. Far too often as well, those intended for specific services are left out of the equation regarding input and decision making priorities. Determining which emergency preparedness education and training programmes appeal to the Deaf and hard of hearing community provides planners, disaster education specialists, and emergency managers insight for relevant preparedness development with input from those making up a diverse population base.

Survey respondents were asked to,

> *"Please check any of the emergency preparedness classes you are interested in taking."*

Table 5.28 illustrates one third (33.7%) of the respondents reported they were interested in attending personal preparedness training, whilst 31.0 percent would like training related to

Community Emergency Response Team (CERT). However, over one quarter (28.8%) of those surveyed stated they were not interested in receiving emergency preparedness training.

Table 5.28 - Interest in emergency preparedness classes

Interest in Emergency Preparedness Classes	n = 183 n (%)
Community Emergency Response Team (CERT)	57 (31.0)
CPR	55 (29.9)
First Aid	45 (26.1)
Not Interested in Taking Any Emergency Preparedness Classes	53 (28.8)
Personal Preparedness Training / Education (FEMA, Red Cross, etc.)	62 (33.7)
Severe Weather / Storm Spotter	50 (27.2)
Other	8 (4.3)

Note: One (0.5%) missing
Multiple responses were allowed which exceed 100 percent

5.11.3 *Comparison of Deaf and Hard of Hearing Individuals Who Have Family Emergency Response Plans and Those Interested in Attending Preparedness Classes*

The study showed that respondents from the Deaf and hard of hearing community that have a family emergency response plan and have an interest in attending preparedness classes is low (Table 5.29). For those responding, community response team training 33.3 percent, CPR 31.0 percent, personal preparedness training/education 33.3 percent, and severe weather/storm spotter training 28.6 percent all received basically similar interest. A small portion of survey respondents (23.8 percent) who reported having an emergency response plan, have no interest in attending preparedness classes.

Table 5.29 – Family emergency response plan & interest in preparedness classes

Family Emergency Response Plan	n = 184					
	n = (%)					
	INTEREST IN PREPAREDNESS CLASSES					
	Community Emergency Response Team	CPR	First Aid	Have Not Completed Any Classes	Personal Preparedness Training / Education	Severe Weather / Storm Spotter
Yes	14 (33.3)	13 (31.0)	10 (23.8)	10 (23.8)	14 (33.3)	12 (28.6)

Note: One (0.5%) missing
Interest in Preparedness Classes % within Family Response Plan

Table 5.30 compares the number of females and males having a family emergency response plan. Females (24.4%) showed a greater tendency than males (20.3%) for having an emergency plan. Of all respondents, only 23.0 percent indicated they have made a family response plan but there appears to be no significant difference between females and males who have emergency response plans for their families.

Table 5.30 - Gender & family emergency response plan

Gender	n = 184 n (%) Family Emergency Response Plan Yes	*p* - value
Female	29 (24.4)	.534
Male	13 (20.3)	
Total	42 (23.0)	

Note: One (0.5%) missing
Emergency Response Plan % within Gender

5.12 Summary

Chapter 5 presented the data findings collected from the two study surveys; one designed for the emergency manager population and the second for the Deaf and hard of hearing community. The aim is to explore early warning impacts and influences regarding protective response behaviours and their relationship with disaster education. Whilst on the one hand emergency managers are actively engaged in their communities' planning, response and recovery operations, they rely heavily on outside organisations to provide much of the early warning functions and operations. Overall emergency managers maintain a high level of agreement on the beneficial role the early warning system provides, however they expressed concerns over public complacency for non-responsiveness to warning notifications. This is attributed to a number of factors but a consensus focused on confusion over warning terminology and lack of understanding on what to do. Although the increase in technology certainly is advancing the overall tornado warning system, emergency managers expressed concerns as to the often over sensationalising of commercial weather reporting which adds to both the confusion and increased fear factor on the part of the public.

The plight of the Deaf and hard of hearing community is further exacerbated by the low levels of available disaster education programs. The data indicates a relatively high level of interest but the current means to attend specially adapted training and education courses is basically, with few exceptions, non-existent. Although there are certain laws and regulatory directives designed to make the EWS more adaptive and responsive to the Deaf and hard of hearing, the lack of enforcement and standardisation is sorely lacking. The data from this study clearly verifies the continued difficulty experienced by the hard of hearing community in following up to date severe weather and tornado warning reporting. The balance between the application and use of technology, emergency manager's perceptions and those of the Deaf and hard of hearing group is indicative of particular gaps in the EWS and disaster education. These gaps may be specific to the hard of hearing at one level, but suggest systemic gaps in the entire efficacy of community education programmes in influencing public reception and response behaviour factors related to the overall early warning paradigm.

The following discussion chapters will address a variety of research questions designed specifically for both emergency management as an institution and integrator, and the special needs community encompassing the Deaf and hard of hearing population.

The emergency manager focus will look at pertinent issues involving warning protocols, communication modes, the role of disaster education and its integration within the early warning system, behavioural factors contributing to public non-responsiveness and systemic changes for improving early warning. The discussion chapter involving the Deaf and hard of hearing individuals centres on communication factors and protective action response, preparedness levels and the affects disaster education has on the lives of this special needs population.

Knowing how the early warning system functions within its institutional framework and understanding its influences within the population it serves is only part of the equation. Why individuals respond or fail to respond in taking protective action during a potentially hazardous event is equally as important. The following discussion chapters bring focus on the interaction and inter-relationship between the early warning system, a special needs population and disaster education.

Chapter 6. Institutional Perspectives on Emergency Management and its Integration within the Tornado Early Warning Processes and Functionalities

> "While parallel [emergency management] processes are operating in many other nations, our knowledge of these remains thin. Cross-societal comparisons of the evolution of emergency management comprise a critical research agenda that awaits any who might accept the challenge."
> Thomas E. Drabek, 2010, *The Human Side of Disaster,* p. 215.

6.1 Introduction

The evolutionary development of the early warning system relative to severe weather and tornado hazard as previously discussed has encompassed a system process composed of public/private coordination and cooperation. From a one dimensional viewpoint its organisational framework is a structure comprised of operational protocols, functional linkages, behavioural factors and policy implementations (See Appendix: 8, "A Literature Map: Early Warning Systems for Tornadoes). A question arises, however, as to whether the interaction between those components helps explain substantive relationships between positive response activities and disaster education or instinctive survival actions stimulated by early warning notification?

The complexity of human communication, cognitive assessment and analysis, and the resulting actions or inactions add to the challenges for achieving positive protective behaviours under hazard events. The findings from this study associated with emergency manager perspectives of early warning system interactions provide further knowledge into understanding beyond the descriptive aspects of system components. Historically, the disaster literature illustrates substantive confirmation of the importance of contextual factors influencing protective behaviours (Quarantelli 1987, Perry and Lindell 1997, Balluz et al. 2000). The existence of context should not be under estimated. However, how and why early warning system influences impact individual behaviour is relevant for assessing effectiveness of policies and protocols designed for operational and response implementation. The broad nature of emergency manager oversight requires development of strategies responsive to diverse community populations. In an effort to define the present and future direction for expanding and improving the severe weather/tornado warning system the study identified three core aspects:

- Communication strategies for severe weather/tornado warning and alerting dissemination
- Public impacts and influences from preparedness and response processes
- Disaster education and training strategies for public utilisation

Changing behaviour is complex and difficult. Considerable factors come into play and multiple degrees of success are often a reality that may not always lead to satisfactory outcomes. The ability to develop and implement a warning system that equally fits a diversity of populations may possibly be an unattainable goal. Nonetheless, emergency managers and disaster professionals are tasked with striving to improve upon an integrated system of warning technology and operational protocols designed to protect lives. The further enhancement of system components necessitates better understanding of the human receptive cognition for responding to severe weather and tornado hazard. The factors that influence and impact those behaviours requires the knowledge and understanding of the contextual parameters existing within the warning paradigm. In this sense, the emergency manager's focus must continue to be directed toward evolving as system integrators for assisting the public in better individual and collective preparedness and response. This is especially true for those populations that have challenges and needs requiring different alerting and warning approaches. The discussion that follows encompasses the study data findings addressing warning system components and their relation to emergency management interactions and interpretations relative to public preparedness and response to severe weather and tornado activity.

6.2 Communication Strategies Related to Alerts and Warnings

6.2.1 *Method Preferences for Community Alerts and Warnings*

Emergency managers were surveyed asking them to rank a list of identified methods used for receiving severe weather and tornado alerts and warnings within their jurisdictions. What the study found was that emergency managers rely heavily on National Weather Service products for keeping themselves up to date on developing weather threats. The U.S. warning system utilises a combination design of public and private integration for warning dissemination that requires a development of protocols impacted by varying levels of bureaucratic and multi-jurisdictional coordination. The primary initiator of these alerts and warnings is the National

Weather Service (NWS) which operates 122 weather forecast offices throughout the country. These offices coordinate and disseminate weather messaging incorporating prediction, forecasting and real-time weather data. They use a combination of methods for distribution of data to emergency management, commercial enterprises and to the general public consisting of NOAA Weather Radio, EAS (Emergency Alert System) and various social media. NWS systems for weather information include:

- National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR)
- NOAA Weather Wire Service (NWWS)
- Emergency Managers Weather Information Network (EMWIN)
- NWS Home Page
- NOAAPORT
- Family of Services (FOS)
- Commercial weather information vendors

Both Weather Radio and EAS system methods were found by this study to be widely used by emergency managers and serve as their primary mechanism for receiving severe weather information. Both methods are readily accessible and are no cost services, except for minimal equipment purchases requiring little or no maintenance upkeep.

Emergency managers in the study reported that messages received by NWS are real-time and offer the emergency manager efficient situational awareness that impacts decision making related to other alerting and notification activities. County emergency managers may rely on a combination of other applications for dissemination of their own county alerts and warnings in conjunction with those of the National Weather Service. In study interviews, emergency managers advised that response agencies and organisations operating jurisdictionally within their county rely on their specific county emergency management agency for supplemental information related to the severe weather event. The local emergency manager may then distribute further warning information via tornado siren, mass notifications, or social media depending on what sources are available. Although various methods are relied upon, utilisation of weather radio, combined with other modes of communication for tornado alerts and warnings, are the most popular (Collins and Kapucu 2008). The importance of these findings is that they bring better clarification for determining the usefulness of the specific system dissemination elements. Often it is presumed what is more beneficial to the system integrators (emergency managers) but little data verify those assessments.

6.2.1.1 *Cellular/Mobile Phone*

The study found emergency managers ranked cellular phone as their 3rd choice as a method for receiving alert and warning information. In 2012 the National Weather Service initiated the Wireless Emergency Alerts (WEA) system. WEA messages are authorised by select government alerting organisations using mobile carriers. Those authorising entities consist of local and state public safety agencies, FEMA, the Department of Homeland Security (DHS), the Federal Communications Commission (FCC), and the National Weather Service. The alerts are broadcasted using cellular towers located within the designated county threat or hazard area.[37] The popularity of mobile phone technology as a source for receiving alerts and warnings was consistent with the findings in the Deaf and hard of hearing survey as well. Respondents in that survey (73.4%) selected mobile devices, to include cellular phones, as their preferred source for receiving alerts and warnings.

6.2.1.1.2 *Wireless Emergency Alerts (WEA) System*

WEA alerts consists of 4 types: extreme weather warnings, local emergencies requiring evacuation or immediate action, AMBER Alerts (child abductions), and Presidential Alerts during a national emergency. A WEA-capable device can be programmed to opt-out for receiving three of the four types of alerts; the Presidential alert is a non-opt-out component. The types of WEA messages that are initiated by the National Weather Service are tsunami warnings (coming late 2013); tornado and flash flood warnings; hurricane, typhoon, dust storm, and extreme wind warnings; and blizzard and ice storm warnings. The WEA message is a 90 character limit text message that provides information related to the agency issuing the alert, the type and time of the alert, and the appropriate protective action you should take. Any WEA-capable mobile phone will receive the signal from the closest transmission tower. Not all phones currently in the market are WEA-capable, only the newest models. Most major manufacturers are voluntarily designing WEA receiving components into all of their new phones and the system is not without flaws and challenges. One emergency manager (EMInt5, M, age >45) >, stated early in 2012,

[37] Storm based warnings utilise a polygon system developed by NWS meteorologists based on data identifying the location parameters of greatest severe weather threat. Polygons do not follow county jurisdictional lines and are solely based on data developed by warning software and are defined by a set of latitude and longitude points. Cellular tower transmissions of WEA alerts are activated if a tower is geographically located within the warning polygon parameters.

> "The WEA system is just not mature enough yet to really gauge its benefit. The initial nationwide test wasn't very successful; people had never heard of it and then all of a sudden their cell phones were emitting this strange sound and no one knew what it was. This is the type of thing that causes us [emergency managers] at the local level a lot of problems. Our county citizens call us when they have a question or problem, not the federal government."

Another emergency manager (EMInt 2, M, age >35) observed,

> "The system [WEA] was rolled out and only the very newest mobile phones were programed to receive the signal. The concept may be OK but there are too many flaws and gaps in both coverage and implementation that are serious problems. The current messages are not specific enough and if you are in a strange location and not familiar with the local geography, receiving one of these alerts is almost counter-productive."

Implementation of this system will only be fully functional when all mobile users own a WEA-capable phone. Also, the existence of a storm or tornado threat within a polygon may not coincide with the actual location of the device in relation to the transmitting tower. The possibility readily exists where the individual possessing the device may actually be located out of the threat or danger area but still receive the warning. Without additional information to access, the warning may actually cause confusion or provide misleading information.
In a conversation with Whit Adamson[38], President of the Tennessee Association of Broadcasters (TAB), Whit had this to say about wireless alerts:

> "In recent years, fewer topics have received more attention in public safety circles than that of emergency notification. Radio and television broadcasters and the associated EAS stakeholders learn from each and every disaster. Mobilizing the public, the first responders and the informers with information from the originators like each individual station or the National Weather Service in times of crisis is an ongoing challenge for public safety officials throughout the country and our state. In the age of "instant information," the public's desire for better, more frequent and constant communications has increased exponentially. A new addition to alerting the public came online earlier this year with the wireless cell entry of "phone sirens", or the Wireless Emergency Alerts (WEA). Formerly referred to as Cellular Mobile Alerting System or CMAS, these can be an important part of our Emergency Alerting System and a valuable referral for additional broadcast warning and safety information."

As the study data point out, the majority of emergency managers surveyed feel the concept of the Wireless Emergency Alerts is a positive technology to pursue and as the public continues

[38] Mr. Adamson has given permission to use his name with regards to this direct quote.

to become more reliant on mobile phone usage emergency managers expect to see cellular communications as an important method for dissemination of alerts and warnings.

6.2.1.2 *Social Media*

Social media is a method that appears to be minimally utilised by Tennessee emergency managers, demonstrated by ranking it eight out of nine methods for receiving alerts and warnings. In a survey (Su et al. 2012) conducted for the National Emergency Managers Association (NEMA) regarding the use of social media in emergency management, the study found that although three-fifths of local emergency management agencies have used social media in a real event, mainly pushing information out to the public, over 90 percent of those events occurred within the 2011-2012 timeframe. This highlights the fact that the relative newness of social media as a communication medium is not well established as either a method or source for transmitting or receiving alerts and warnings. The Su study also showed that 55 percent of county emergency managers trust social media less than other traditional media sources. Although these findings may change over time as familiarity and utility of social media increases, it is a communications medium that requires maturation and greater exposure to emergency managers as an alerting and warning modem. Tennessee emergency managers seemed to share a similar viewpoint. One emergency manager (EMInt6, M, age >40) interviewed felt:

> "As social media becomes more common place, we'll [emergency managers] probably used it more, but right now it's still fairly novel as a method for us. To tell you the truth, the older EMs don't use it much but the younger folks are more comfortable with it. I'm not into all this Facebook and Tweeter communication, but it seems to have some relevancy to the younger people coming into the [emergency management] profession."

Social media has become more popular in recent years and as its use grows, information push from emergency management will continue its expansion (Su, et al. 2012). Communication innovation and technology will undoubtedly influence how severe weather alerts and warnings are distributed in the future. Although older Deaf and hard of hearing individuals continue to lag behind using today's technology, as is the trend for the general population, they do show an ability to increasing its utilisation. The data associated with this study found that older Deaf and hard of hearing individuals similarly rely on mobile devices and Internet as a source for their weather alerts and warnings. The importance of these data help emergency managers direct ongoing focus for disseminating alerts and warning utilising methods that are seen as important to the public. This necessitates a bottom up driven communication method for initiation of severe weather and tornado messaging.

6.2.1.3 *Web/Internet and Ham Radio*

Emergency managers surveyed reported an interesting selection with regard to Web/Internet as a method for alerts and warnings. The study data showed that Web and Internet use was ranked last out of ten choices. With direct and largely immediate access to the National Weather Service either through NOAA weather radio or EAS, the need for accessing alerts through the Internet was reported to be unnecessary. However, emergency managers advised they do frequently use the Internet for viewing weather radar images of local weather. These radar feeds are delayed to some degree and require specialised training and experience regarding interpretation.

The emergency managers interviewed reported that the Internet is mainly used as a secondary or tertiary method for weather information but not as a primary method for receiving alerts and warnings. This data show some of the technology gaps that currently exist. Although the Internet is an integral part of society today, its potential may not be fully utilised under the current EW system operations. Understanding the existing technology application gaps from the emergency management perspective will provide opportunities for exploring better technology transference possibilities in the future.

The ham radio findings offered another conflicting and contradictory illustration from what is observed and found in current disaster preparedness communication policy, not only in Tennessee but throughout the entire country. Ham radio may be an excellent communications backup when all other communication mediums are inoperable but its alerting and warning effectiveness and efficiency are diminished considerably when used as a routine method for monitoring and receiving weather information. Ham radio use requires a trained and licensed operator. Its use by the general public as a communication medium is basically nonexistent. It is even further limited by the fact the NWS does not use ham radio as a main distribution method. Ironically, Tennessee hospital preparedness protocols rely on ham radio as an ancillary communications platform designed for inoperability situations during disaster events. County emergency managers on the other hand, maintain ham radio capabilities but do not consider it a viable, efficient communication medium due to its capacity limitations.

6.2.2 *Source Preferences for Community Alerts and Warnings*

Emergency managers in Tennessee are an integral component of the early warning system and are responsible in part, for alerting their county citizens to the threats of severe weather and tornado hazards. The study found that emergency managers rely heavily on the National Weather Service as both a method and a source for impending weather threats.

Communication sources are organisations or individualised entities that perform a specific messaging function related to dissemination of alerts, warnings or general weather information. The threat of severe weather or tornadic activity will initiate a chain of communication and notification protocols and processes designed to inform emergency managers, commercial broadcast media and the general public to the potential existence of threating weather. The need for building alert and warning capabilities has been part of the U.S. national strategy for several decades.

> "Our national warning capability needs to be focused on the people at risk at any location and at any hour, be universally accessible, safe, easy to use, resilient, reliable, and timely. Numerous technologies exist to do this and in many ways technology is the easiest part of the solution. The bigger challenges are to provide accurate, understandable, specific, and informative warnings and to develop procedures and processes for collecting and disseminating those warnings in standard and secure ways".[39]

These threat integrators operate within both the public and private sectors. Their use by emergency management is dependent on several factors related to immediacy of warning reception, thoroughness/accuracy of content, familiarity with the source, ease of interpretation of information, and cost effectiveness of both information and operation. Local emergency managers are uniquely positioned to communicate directly with the public and provide a mechanism for public verification and confirmation of alert and warning notification. In a survey conducted for Federal Signal Corporation, 58 percent of Americans trusted their local officials for ensuring their public safety needs.[40] The importance of sender-receiver connectivity is an integral element in the overall process for taking appropriate protective action (Aguirre 1988, Sorensen 2000, Betts 2003, Mileti et al. 2004, Sorensen and Sorensen 2006, Brotzge and Erickson 2010).

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[39] *A National Strategy for Integrated Public Warning Policy and Capability.* The Partnership for Public Warning, May 2003.

[40] Federal Signal Corporation, 2013.

6.2.2.1 *National Weather Service (NWS)*

Surveying Tennessee emergency managers, it was discovered they rely heavily on the National Weather Service for providing imminent threat and up to date weather information. They utilise the NWS as the primary source, due mainly to the fact it is tasked with predicting, forecasting and dissemination of weather related information and events for the entire country. Their role is unique and they are the sole governmental entity with the capabilities, capacities and resources to perform the weather system processes and functions needed for severe weather and tornadic surveillance. One emergency manager (EMInt1, M, age >60) interviewed explained it in this manner:

> "In my county we receive all of our related weather information directly from the National Weather Service. During severe weather outbreaks we maintain live feeds looking at their radar and listening to their broadcasts on our weather radio. They're really the only reliable source available to us. They work very close with all the local emergency managers hosting weekly briefings and during severe weather events they will brief us daily, or several times daily if needed."

All weather related services nationally originate with the NWS. Approximately 160 NEXRAD (Next Generation Radar) radars with a range of base reflectivity of 248 nautical miles are located in all 50 U.S. states and territories, in addition to locations in the Azores, South Korea and Okinawa.[41] In essence, the radar system is the source for generating all public and private real-time weather information used in alert and warning messaging.

6.2.2.2 *TV and Radio Broadcasts*

Local weather reporting is a large part of local television and radio broadcasting especially during severe weather occurrences. During such times, live television and radio stations will broadcast NWS alert and warning feeds continuously or more frequently depending on the severity and immediacy of the threat. In this study, emergency managers selected television broadcast as their second source and radio broadcast as their third source. Other studies cite similar results (Hammer and Schmidlin 2002, Collins and Kapucu 2008).

In 2011 Hearst Television conducted a public survey in three markets (Boston, Baltimore and Burlington VT) regarding public use of storm tracking sources for Hurricane Irene. Of the 1400 respondents, 85 percent indicated they actively tracked the storm and its impacts. Of

[41] National Weather Service, Radar Operations Center

those, 50 percent reported “television” as their prime source of information as the storm approached, followed by 16 percent using Internet, 10 percent The Weather Channel, and 5 percent radio. Thirty-one percent reported using radio to receive storm updates whereas 34 percent relied on a smartphone. The survey findings collected for this study show county emergency managers actively use TV and radio broadcasts to keep updated on severe weather developments. But issues are associated with solely relying on media broadcasts, especially television media. As one emergency manager (EMFGI2, M, age>50) commented:

> “Television weather reporting is a good source for receiving weather updates, especially during tornado season. However, I’ve learned not to rely only on them. The competition between TV stations is pretty strong and with all the new graphics it sometimes looks like we are inundated with tornadoes. During times when there may be several storm cells moving through the area, the constant hype can be a little too much. People who really have no training or experience in these types of things can really be misled. It’s confusing to the public and even sometimes for us. Although I will say television broadcasts are helpful overall. Radio can be a good source but probably to a lesser degree.”

The researcher’s personal experience also can substantiate this perception as well. On several occasions participating in meetings or conferences attended by TV and radio broadcasters, they readily admit that media competition between commercial broadcasting companies can be fierce. On any given week day, weather reporting consists of approximately fifty-five minutes of actual airtime content.[42] During any kind of threat of severe weather or when there is an actual tornado warning in a specific area, the coverage can last for hours. Acquiring market share within a broadcast area is an important financial goal for media enterprises and news and weather segments are a high profile market attractor.

The use of high definition graphic displays when reporting severe weather activity is impressive but also overwhelming. The ability to interpret multi-coloured weather radar takes training and skill. To the untrained individual, it can be visually over-stimulating. The findings support the emergency manager viewpoint that television and radio broadcasts are an important source for alerts and warnings but readily recognise the challenges associated with the commercialisation of its product dissemination. Understanding how these factors interrelate within the operational elements of the severe weather/tornado warning system is important.

[42] Source: Sandy Boonstra, NewsChannel 5 News Director, Nashville, TN, USA

On the surface technological enhancements in the weather reporting network are viewed as a positive step in developing better warning protocols. However, creating technology advances alone without investigating the impacts of these changes can add more complexity and create additional problems and dysfunction. The identification of those impacts is directly relevant to clearer understanding why people do or do not heed warnings. The introduction of technology intervention alone may not produce a better solution without the appropriate research to verify applied outcomes.

6.2.2.3 *Local Emergency Management Agencies as Alerting and Warning Source Disseminators*

The study found emergency managers mostly viewed themselves as integrators of alerts and warnings as opposed to primary sources. In speaking with individual county emergency managers, they view their responsibility as one for preparing and responding when severe weather threatens their communities. Different viewpoints do exist between emergency managers from more populated counties having more resources and those with fewer residents. The researcher attended a meeting of Tennessee emergency managers in November 2010 where this issue was discussed. From notes taken from that meeting it was clear that emergency managers from counties that had siren systems or advanced notification systems at their disposal, their perspective role took a more active involvement with making decisions to activate sirens or reverse call systems during severe weather and tornado activity. Those county emergency managers who lack access to those types of system had a different approach and a different concept of what their responsibilities were during severe weather threats. All held the opinion that preparedness, response and education were fundamental responsibilities and duties. However, the availability of notification resources impacted their perspective of where they ranked within the sourcing for alerts and warnings.

6.2.3 *Emergency Manager Perception of Tornado Warning System Elements*

As an integral part of the early warning system, it is important to grasp the perspective of emergency managers and their relationship to a principle objective of the thematic focus of this thesis: ***To assess emergency management opinions regarding severe weather/tornado early warning system processes, individual protective actions, and disaster education influences.*** On the surface this may appear somewhat linear in its approach but analytically it provides a means for establishing why disaster policy is designed, developed and implemented relative to its institutional construct. The argument has been made in some circles that emergency managers are really nothing but policy implementers, but locally their role is much more interactive and focused on making sure their local citizenry is prepared for local threat encounters and response protocols. As one county emergency manager (EMFGI5, M, age >45) explained:

> "During potential tornado activity I have direct responsibility for activating our [county] early warning siren system. There is a lot of verification of weather data from the National Weather Service and local television broadcasts that goes on. I take those decisions very serious and we work all year to respond appropriately under these types of conditions. I know my jurisdiction, my county residents and generally what kinds of programs and activities that our citizens expect. I know the pitfalls and potential problems that go with these weather conditions. I know we sometimes get accused of setting the sirens off too often but if we're going to make a mistake, we're going to error on the side of safety. I know siren alerting has its weaknesses and gaps but we use what we have the best way possible."

This demonstrates the challenges that can be created through the use of technology and the interaction of human behavioural responses that result. Appropriate decision making skills are required under these circumstances by the emergency manager. The data from this study show the complexities that exist in the coordination and implementation of early warning protocols. The existence of gaps within the system applications and elements clearly illustrate the difficulties in balancing the multiple factors at play and the need for better disaster education strategies for improved human/technology integration.

6.2.3.1 *Adequacy of Alerts and Warnings*

The communicating of severe weather alerts and warnings requires the implementation of a set of complex processes that have been refined and conducted hundreds of thousands of times since the inception of the formalised weather system within the U.S. The difficult task is making the connection between the message delivery and reception of the message to the public. Efficient distribution of the message, resulting in the proper protective action being initiated by the receiver, equates to an effective process. In actuality, measuring the effectiveness of alerts and warnings is difficult and tenuous at best.

Key elements involving the early warning system were studied for this thesis from the perspective of emergency managers. What was learned is that 88 percent of the respondents found current severe weather alerts were adequate compared to 12 percent who felt they were inadequate. When specifically asked about the effectiveness of local television and radio broadcasts during severe weather and tornado events only 9 percent of respondents answered negatively compared to 90 percent who respondent that in their opinion, broadcasts were adequate.

The positive leaning of responses to this issue is not necessarily surprising. The researcher's observations of operational preparedness and response policy implications lead me to believe that as local representatives of government, emergency managers function as a sounding board for complaints attributed to system inconsistencies, failures or inefficiencies. Emergency managers are aware of the warning system shortcomings and are much attuned to some of the public confusion created as a result of the warning messaging dissemination by weather reporting broadcasts. Emergency manager (EMInt2, M, age >35) put it this way:

> "Sometimes the weather reporting during a severe storm becomes quite repetitive and really very confusing. As I talk to folks at local training sessions I conduct preparing our community for tornado season, I often get complaints on how confusing everything gets. At times it seems the TV weather people make it more complex instead of just simply passing on the information. The majority of the public just has no background knowledge how this all works. It's what we've all talked about before; they [television broadcasts] just sometimes over-hype their reporting. I know they are just trying to inform and educate people but many of the technical points they are trying to address just go over people's head. We all know it's mostly a marketing thing but they need to all get on the same page; it causes a lot of problems. We need to do a better job identifying what people should know that will be helpful to them. I really don't think we've asked the right questions yet. Don't get me wrong, no one is intentionally trying to mislead anyone; I don't think we've done a good job finding out what the public really needs and wants. Overall the system works pretty well but sometimes the news can overdo things a bit"

6.2.4. *Factors Associated with Public Non-Responsiveness to Alerts and Warnings*

Even with the increase in advances to warning technology the basic reasoning pertaining to lack of individual responsiveness remains a perplexing question for disaster professionals. Perception of risk and reducing risk uncertainty continue to remain an elusive problem. This complexity of system effectiveness as contrasted with disaster literature illustrates the basic integration of the non-responsiveness question (Collins 2009). Collins further explains the communication/risk/response interrelation and dilemma:

> "Early warning is therefore an aspect of disaster management dependent on the development of human awareness and the capacity to decipher information, knowledge and adapt appropriate reactions to risks and warnings. In this sense, all people are part of an early warning system regardless of the formalised development of this field. This is important, not least because human responses to varying risk thresholds are very variable. Early warnings are merely the communication of information for which those listening must then engage individualised risk assessment and reactions. [W]hat we have described as disaster phenomena are invariably the outcome of multiple risk influences. Arguably, no two people interpret risks in an identical fashion. Risk assessment is a function of the perception of threats and rewards, past experience, received knowledge, economic constraints, environment, personality or genetic predisposition." (p.206)

6.2.4.1 *Media Over-Reporting During Severe Weather Outbreaks*

Emergency management respondents acknowledged the distinct possibility that continuous reporting during prolonged severe weather may contribute to the public's non-responsiveness to alerts and warnings. This was illustrated by comments from one emergency manager, EMInt5, M, age>45:

> "I have a suspicion that the media may be at partial fault here. In our constant communications with the National Weather Service during stormy weather we get constant clarification and reinforced detailed updates. The public has to rely on the newscasters for them to interpret. I know at times this causes some confusion or either they just get tired of listening to all the repeat of information that they just tune it out. We really need to figure out how to minimize this problem."

Broadcasters themselves readily admit that commercial television is a very competitive business and successful management within the broadcast industry is largely dependent on market share and TV ratings. Emergency managers attributed over-reporting as a problem with 54 percent of those responding agreeing, compared to 38 percent who disagreed that over-reporting was a factor in public non-responsiveness to alerts and warnings.

Creating and maintaining a viable viewer audience is critical and staying ahead of the competition in weather reporting is directly related to high-end graphics and aggressive reporting during severe weather conditions. With the already high incidence of false-positives associated with tornado forecasting and prediction, the public is often confused and sceptical. When looking at risk, trust of the source and of the information being transmitted is an important factor (Balluz et al. 2000, Dash and Gladwin 2007, Powell and O'Hair 2008).

Often when an under-trained public is viewing radar images of potential tornadic activity being reported on the TV, consisting of numerous rotations and flashing bright colours especially during prolonged weather reporting, a desensitisation effect can occur. Add in countywide siren activation and there is little wonder the public is often confused or nonresponsive.

6.2.4.2 *Misunderstanding of Warning Terminology*

Warning terminology continues to be a major challenge for the public at-large. Of the emergency managers surveyed in this study 98 percent felt that the public need to have a better understanding of the terminology between a "tornado watch" and a "tornado warning." Why the public continues to be confused over these terms is puzzling, especially in light of the considerable education efforts that have been conducted nationally in tornado prone areas. However, the National Weather Service is currently conducting research on using more deliberate terminology referring to a tornado "emergency" which will be "… issued when there is a severe threat to human life and catastrophic damage from an imminent or on-going tornado." As has been discussed previously, multiple contextual factors may contribute to why an individual may or may not take protective action.

6.2.4.3 *Comprehension Issues Related to Alert and Warning Messaging*

The findings from the research for this thesis indicate that the majority of emergency managers are in agreement that much of the public's non-responsiveness to tornado alerts and warnings can be attributed to misunderstanding the warning message or not understanding what actions to take. One emergency manger (EMFGI1, M, age >30) interviewed interpreted the study findings this way:

> "I finding it troubling that some people just don't respond properly when there is a tornado warning issued. The messages coming from the National Weather Service and local news reporting clearly explain what people need to do. After talking to some of my county residents they don't seem to care much until an actual warning is issued and then they start wondering exactly what they should do. It seems a lot of folks, especially if they're driving, don't seem to know what to do in those situations. Others just wait too long to do anything, and then some just assume nothing is going to happen and everything is OK. Then some don't do anything. I guess we just need to keep driving home the message. Really, we're probably not going to reach some people no matter what we do."

Closely associated with the issue of misunderstanding alert and warning messaging, the study found however that 30 percent of emergency managers believe people are not just simply ignoring alerts and siren warning announcements. Based on the responses obtained in this research by many emergency managers the contextual nature of human behaviour during threatening events causes a lot of confusion why individuals are not responding appropriately. Many of the factors already mentioned in this study affect many of the differing outcomes taking place within non-responsiveness issues.

6.2.4.4 *Public Complacency as a Contributor to Public Non-responsiveness*

Study findings indicate that 94 percent of emergency manager respondents overwhelming attribute public non-responsiveness to tornado warnings with public complacency. The researcher's experience working with individuals leads me to believe that non-responsiveness is not a matter of people not caring, but the fact that most individuals are not weather focused except during actual instances of weather threats. Emergency manager, EMInt3, M, age >50) interviewed agreed:

> "I've found a number of reasons why the public is complacent, but I'm not sure I can put my finger on any one thing in particular. With very few exceptions, most people want to do the right thing when bad weather occurs. But since it's not something that occurs frequently, they just go on about their business. Only rarely is anyone directly impacted by experiencing an actual tornado. When they are, they normally react out of instinct or what they have learned."

What was found in this study is that the concept of public complacency was widely regarded as a reason for public non-responsiveness to tornado warnings but the specific reasons were generally less clear. Some emergency managers could only base their beliefs on their experiences while others indicated that most individuals are not focused on weather, other than wanting to know what the temperature is for a given day or interested in the weather forecast to determine how that may affect their activities. One interviewee (EMInt1, M, age >60) stated:

> "I'm not sure it has anything to do with being complacent as we normally define it. I think most folks trust those responsible for handling the weather and take a lot it for granted. They go along their daily routine until faced with something really threatening. Then they make a decision what to do in the moment. The weather is something to ask about and not something to study and gain any expertise in. Maybe complacency is not a negative thing, maybe it is more about being content with the routines of everyday life."

6.2.4.5 *Familiarity with Seasonal Weather Patterns*

From the research developed within this study we know disaster researchers have studied human response to warnings in numerous disaster contexts for decades (Perry et al. 1982, Mileti, Dennis and Sorensen 1990, Balluz et al. 2000, Drabek 2010). Generally, every hazard type has been investigated to determine why and why not individuals exposed to a risk acted or not. Patterns of human response can take many forms and directions. In many cases the perception of risk plays a significant role in responding appropriately. In this research study we found that 74 percent of emergency managers responded that familiarity with seasonal weather patterns was a factor in public non-responsiveness to tornado warnings as opposed to 23 percent who did not.

From the researcher's own experience working for many years in Oklahoma, which has a high incidence of extreme tornadic activity, people do have a different approach to severe weather from other states that experience tornadoes less frequently. This goes for weather broadcasting as well. In talking with people from states that have more incidents of a particular hazard, earthquakes for example, they will tell you visitors who experience an unfamiliar earthquake, are often traumatised and often at a loss in what protective actions to take. Interestingly, knowledge and familiarity, or the lack of, with a weather hazard will affect their perception of risk and may delay action until they have additional information or develop some kind of confirmation of the alert and warning message.

The more an individual understands, or thinks they understand the risk, the time between the warning and action may be affected. Kuligowski (2014) found in her study of the Joplin 2011 tornado that some survivors took the siren notifications as an alert, and not as a warning of impending danger. Those interviewed stated they did not take action until they perceived danger or were told to take cover. It appeared that only a few were risk averse or overly vigilant at the time the tornado occurred. The study also found that many delayed taking protective action, which limited shelter options, and others who delayed were unable to take shelter at all as the tornado struck. Emergency manager (EMInt3, M, age >50) strongly made her point:

> "I think this is a big factor in how people respond to tornado warnings. I'm originally from Kansas and I can tell you people in that part of the country generally are more familiar with tornadoes and have a healthy respect for them. As those in Tennessee are encountering more severe weather and tornado activity, they're getting better with dealing with them but there is a

> big difference in people from both regions. But it can be a double-edged sword for some people. Some take more risks because they think they know how to act during a tornado, they can be over confident and it's gotten some in trouble making some dumb decisions."

6.3 Summary

This chapter focused specifically on the findings derived from the thesis research obtained from local emergency managers regarding their perspectives associated with tornado early system. Their viewpoints provide further knowledge addressing the relational aspects of early warning system components, policy implications and citizen response. Emergency managers are uniquely positioned to offer insight and explanation into the practical application of institutional operations at the local level of emergency management responsibility and functionality.

The next chapter will investigate and report the research findings associated with the special needs population of the Deaf and hard of hearing. The systemic impact of early warning on this particular segment of our population offers a research perspective scarcely studied, little understood, and one that is increasingly growing in numbers as our population ages. Providing a safe environment under tornadic conditions poses numerous challenges for the Deaf and hard of hearing.

The second findings chapter, Chapter 7 - Early Warning System Integrations and its Relationship Affecting the Deaf and Hard of Hearing Community, focuses on disaster education as a component of the tornado early warning system and its integration with both the emergency manager and the Deaf and hard of hearing populations.

Chapter 7. Early Warning System Integration and its Relationship with the Deaf and Hard of Hearing Community

> "Volunteerism and independence from the NWS [National Weather Service] led some television stations to treat the potentially life-threatening situations in a haphazard or flippant manner, while others, especially those in the tornado-prone Midwest and Great Plains states, excelled in their severe weather response." Marlene Bradford, 2001, *Scanning the Skies: A History of Tornado Forecasting*, p. 140.

7.1 Deaf and Hard of Hearing Research Findings and Analysis

7.2 Introduction

The Deaf and hard of hearing community was the second sample group selected to participate in this study. Individuals within the sample group consist of members of the public who possess a hearing loss or are Deaf. No specific criteria were required except meeting either of the two hearing loss conditions. In order to reach the broadest representative sampling for this group, 27 separate agencies, organisations, social groups and independent entities within the State of Tennessee were solicited to encourage any interested individual to participate in an electronic, self-administered survey, specifically designed with an American Sign Language (ASL) signed video with closed captioning embedded within the survey. Although the 27 organisational groups were selected for marketing based on their specialty focus, participation in the survey was open to the general public and not restricted based on member affiliation with a specific group.

The survey presented was specifically designed for people who are Deaf or hard of hearing (HOH) to help develop better alerting and warning processes during severe weather, such as tornado outbreaks. A fundamental resilience goal is to save lives and to understand more clearly the needs of the Deaf and hard of hearing public when severe weather alerts are activated. The information contained in the study identifies and develops a general profile of the hearing loss community in Tennessee regarding tornado preparedness experiences and needs. These data can then be used for future projects designed to help communities with citizens who are Deaf or hard of hearing in their preparedness and response activities. The survey consisted of twenty questions covering general focus areas relative to survey sample population demographics, warning system components, preparedness levels, disaster education and training, and influencing factors. The findings provide insight into how and why this segment of our society responds or does not respond to alerts and warnings and to what extent disaster education influences those behaviours.

7.3 Alert and Warning Messaging Adapted to the Deaf and Hard of Hearing Needs

The study found, as with many special needs groups, the Deaf and hard of hearing require specific adaptations when addressing disaster preparedness applications. In the case of preparing for severe weather and tornadoes, loss of hearing or hearing difficulty places these individuals at a particular disadvantage and risk. Most of the NWS tornado notification protocols rely heavily on sound and the ability to be audibly stimulated to the alerting signal. This is especially applicable when sirens, weather alert radio, or television and radio broadcasts are utilised. The data from the thesis research found 74 percent of the Deaf and hard of hearing individuals surveyed rely on mobile devices to receive severe weather and tornado warnings. This compared to 69 percent who depend on their local television station. However, even as the national emphasis is on the utilisation of the weather radio, the data indicated only 31 percent of those surveyed possess a weather radio. The inability to hear either requires some type of lighting or vibration device to signify the existence of a weather alert notification in progress. With the exception of the weather alert radio, the other notification sources do not provide this capability. The result is missed alerts and warnings.

The survey identified several gaps related to closed captioning technology and the need to develop a standardised set of protocols designed to address the existing problems associated with severe weather and tornado reporting. Deaf and hard of hearing individuals are especially vulnerable in their inability to properly and effectively obtain and receive severe weather alerts and warnings via the broadcast media. The reliability of closed captioning was a major concern brought up consistently during interviews with Deaf and hard of hearing respondents.

7.4 Source Preferences for Receiving Alerts and Warnings

Understanding the sources the deaf and hard of hearing population most frequently use to receive alerts and warnings is an important aspect for evaluating trusted and relied upon modes of communication. The survey responses helped identify those modes most utilised and provided comparative data whether this population is following the same trends as the general population with respect to age and the communication modes they prefer. Of interest was knowing what transmission modes serve and are used by the Deaf and hard of hearing community. Usage data provided insight into identifying what modes they are comfortable with using and what modes may be the most effective for them.

The study data indicate Deaf and hard of hearing individuals rely most heavily on mobile devices such as cellular phones for texting, laptop computers and electronic tablets. As was noted above, the majority of individuals surveyed use mobile devices for receiving weather alerts and warnings; this was followed closely by television monitoring of storm events. Slightly less than half of the respondents, 47 percent prefer receiving weather notifications via Internet. A finding that is of interest and a possible indication for needing further education and access to a current technology, is the percentage of Deaf and hard of hearing respondents who use the NOAA Weather Radio. Only 30 percent reported to rely on the weather radio for receiving severe weather related alerts and warnings. This lack of utilisation of the device is evident in the fact 78 percent of respondents reported either the device was too expensive, were not familiar with the device or did not know where to purchase the device. Because the weather radio must be adapted for the Deaf and hard of hearing with either a strobe light or vibration component, the cost can be prohibitive for many.

7.5 Early Warning System Impacts on Deaf and Hard of Hearing Communication

Acquiring weather related communications by Deaf and hard of hearing individuals has been, and remains a challenge. The study showed the early warning system for disseminating alert and warning information to this particular population continues to be sporadic, filled with technological gaps and is affected by a lack of consistency in enforcement of regulations designed to provide better access and delivery. In addition, the regulatory structure which exists contains considerable loopholes that prevent the Deaf and hard of hearing community from fully benefiting and receiving alerts that are clear, concise and relevant to those with a hearing loss. This issue is further acerbated by the fact that this social segment is growing considerably due to the overall aging of the population.[43] As the study data strongly indicate, processing and design of the closed captioning technology requires a more consistent

[43] U.S. Census Bureau uses the term "hearing difficulties" to describe a wide range of hearing loss. In data retrieved in 2010 it estimated that 32.4% of the US population over 65 years of age had some type of hearing loss. These figures are an extrapolation from the available data and should be viewed as a very rough estimate of the actual numbers.

application to the needs of this growing population. Individuals who have the skill and capacity to utilise the weather transmissions disseminated through television, internet or other communicating sources, though at times with considerable difficulty, generally receive some alerting and warning information. However, their ability to fully comprehend television warnings, as the study data strongly indicate, remain filled with information gaps and difficulties associated with caption placement, scrolling issues and overlapping of visual content.

Television transmissions and live broadcasts of severe weather alerts and warnings were determined to pose particular problems for the Deaf and hard of hearing community attributed to dialogue misunderstanding and misinterpretations. In their study for developing a new captioning model process called “emotive captioning”, Fels et al. (2005) found “[W]ithout continual access to conversation modifiers and access to the paralinguistic components of human conversation, people who are deaf and hard of hearing may misinterpret or misunderstand the semantics of television and come away from their viewing unsatisfied.” (p. 2331).

The Deaf and hard of hearing continually rely on facial expression and sign language utterances for understanding and interpretation of what is being presented. From the study, it is known that current captioning software used by most television broadcasting stations provides “text only” captioning. Severe weather alerts and warnings during a given period can produce stressful situations for the public and this is especially true for deaf and hard of hearing individuals. Under these conditions, television weather broadcasts can run for extended periods of time, displaying a variety of graphic radar formats. To the general public, these reporting segments can become over-sensitising, confusing and difficult to follow. For those Deaf and hard of hearing, this environment highlights the difficulties of comprehension and understanding of the warning broadcast processes, terminology, and the array of visual presentation.

As one survey respondent (D/HFGI6, F, age >40) stated (through ASL interpretation) regarding comprehension and understanding of captioning:

> “As with ALL captioning, there are commonly errors - usually just spelling errors that are not so bad that they render the message incomprehensible. And there is often enough of a delay between the image of on screen with the words being spoken and the text of the captioning that the captioning

> doesn't match what's going on in the video at the same time, sometimes making it confusing."

Another (D/HFGI1, M, >30) stated:

> "Sometimes captioning is delayed so the radar map doesn't match what is being said. On local stations, the combination of delays, typing errors, and skipped words can make the messages confusing. Sometimes what is received on my TV looks more like computer code than sentences. Also, captioning at the bottom covers up important on-screen graphics."

The majority (70%) of the Deaf and hard of hearing individuals surveyed in this study rated the quality of the captioning as either fair or poor. However, in a survey conducted by Jordan et al (2003) for The Annenberg Public Policy Center of the University of Pennsylvania, they found that Deaf and hard of hearing respondents "…place a high value on the provision of closed captions for local and national news." Even though an overwhelming number of respondents surveyed also wanted closed captioning to be available for all broadcast programming, the relevant significance is that weather reporting is a major portion of all news programming. A heavy reliance as a source for weather related information to include alerts and warnings for the public comes from television broadcasts. This high utilisation of television weather reporting supports the importance of continued emphasis in researching the impact of closed captioning issues. This is especially true as it pertains to the impacts of severe weather alerting and warning processes affecting the Deaf and hard of hearing community.

In this study respondents made several comments to the open ended question related to closed captioning quality. One respondent (D/HFGI9, F, >45) stated:

> "Often it's not clear or messed up…cc [closed captions] were shown on top then on bottom up and down…letters mixed up…need [to] hire professional cc person for better quality...sometimes no cc during live weather news."

Others commented as follows:

> "Because it is live, there are a lot of misspellings and inaccurate captioning going on. Make no mistake, we appreciate the captioning, but it is frustrating when you are trying to obtain information and it is not clear. Also, they put the captions on the bottom of the screen, blocking out other information that is helpful to us." D/HInt3, M, age >40)

> "A lot of times during weather warning, closed captions tend to overlap other important messages either on top or bottom of TV screens depending

> on TV stations making it difficult to follow. Please keep both CC and TV messages separate." (D/HInt5, F, age >50)

> "Not all channels in the Knoxville area do closed captioning during a live weather broadcast...and it seems that live closed captioning only occurs during certain live weather broadcasts. In addition, many of the news stations use "tickers" at the bottom of the screen and many times, the closed captioning covers the ticker."[44] (D/HFGI4, M, age >55)

Even when an individual with hearing loss is viewing television with closed caption capabilities, often the problems associated with placement, overlapping, and interpretation gaps cause considerable disruption related to understanding, comprehension and confusion. With fast on-set hazards such as severe weather and tornadoes, the inability to receive clear, directed alert messages is a major concern. The National Weather Service, the broadcast media and emergency management must adopt corrective strategies for allowing those with hearing loss to effectively receive, understand and be able to respond appropriately when protective actions are needed.

7.6 Weather Related Communication Equipment for the Deaf and Hard of Hearing

From the survey data it was learned the Deaf and hard of hearing community relies heavily on mobile devices, television broadcasts, and to some extent, the Internet for receiving their severe weather alerts and warnings. The increase in available technology will continue to add to the overall utilisation of mobile applications. Since these technologies are largely visual, those with hearing loss are very capable of using these devices without difficulty. As one hearing professional (D/HInt2, F, age >50) interviewed relayed:

> "You would be amazed at how proficient many Deaf and hard of hearing individuals are when it comes to using text messaging, laptops, notebooks and just about any kind of 'typing enabled' compatible electronic device. Something will be said on the television or said in a meeting, and they'll all be madly typing on their mobile devices in response. It really is amazing to watch."

With the inclusion of vibration capabilities in all devices, alerting and warning notifications do not require added processes for use by the Deaf and hard of hearing community. Social media resources such as Twitter, Facebook, text messages and others are becoming more

[44] A "ticker" is a scrolling message embedded on the television screen containing an assortment of alert and warning information.

frequently utilised as well.[45] Research continues to address finding better processes, technologies and educational approaches associated with severe weather alerts and warnings, such as developing strategies to improve online forecasting tools, and exploring factors that explain why some people seek shelter when receiving a tornado warning and others do not.[46] As is indicated in the study findings, the use of technology by the institutionalised weather system does not always correlate with effective and efficient delivery of alerts and warnings and accurate comprehension by the Deaf and hard of hearing population.

7.6.1 *Weather Alert Radio*

Weather alert radio usage by NOAA and the National Weather Service goes back to the 1950's when its primary recipients were commercial marine and aviation users needing weather information. Beginning in the mid-1990s and into the early 2000s, emphasis began for expanding the use of weather alert radio more to individual home and business use. In the last decade this expansion has led to a concerted effort by the both the National Weather Service and local emergency managers to encourage the use of weather alert radios by the public as a major source for receiving severe weather alerts and warnings. This "push" is increasingly being expanded into the Deaf and hard of hearing community. This study found that only 30 percent of the respondents surveyed utilise the weather radio. One Deaf individual (D/HFGI7, F, age >20) interviewed had this to say:

> "The accessories [vibration device and strobe light] for the radio are expensive, and to give me adequate coverage in my house would require purchasing several radios to put in several rooms I spend the most time in. It's not as easy as using my mobile phone where I can keep it with me all the time. At night when I'm sleeping, the weather radio would work fine if I have the strobe and vibrator attached to it."

The alert and warning protocols related to weather alert radio now encompass an all-hazard approach that includes geographically applicable hazard transmissions, Amber and Silver alerts (which include child abductions and missing elderly), and imminent threat transmissions. The evolution of the radio popularity and its expanded alerting categories has increased a greater reliance of its use and participation as a primary source of weather and

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45 National Research Council. *Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps*. Washington, DC: The National Academies Press, 2013

46 One research project funded by NOAA in August 2012 will study how Twitter can be used to share weather updates and the pros and cons of using Twitter in severe weather forecasting operations. The research will also look at the content of tweets about severe weather events, and will assess the possible use of Twitter data in detecting and tracking storms, issuing warnings, and damage assessment following a storm.

hazard related information. What was discovered through several interviews with Deaf and hard of hearing individuals is that as more emphasis is placed on weather radio education and training specifically tailored for the hearing loss population, the acceptance and use of these devices is slowly increasing. In several discussions that have taken place with representatives of the Nashville, TN office of the National Weather Service, more research and focus is being directed toward better application of this technology for use by the Deaf and hard of hearing community.

Although there are no verifiable statistics available related to the actual percentages of individuals owning weather alert radios, it is estimated that between 5 and 10 percent of the population in the U.S. has a radio. This percentage estimate is increased to 15 percent in locations such as Oklahoma and tornado alley (Midwestern U.S.) which experience a greater number of severe weather and tornado occurrences on average.[47] As this information is take from 2004 data, it is believed that those estimates may be somewhat low due to the increased emphasis for use of weather alert radios over the past 10 years. As we know from this study, approximately 30 percent of the Deaf and hard of hearing survey respondents owned a weather alert radio. However, it should be noted that several of these respondents were interested in preparedness and response activities and therefore the responses may not accurately reflect the true ownership of weather radio percentage of the overall Deaf and hard of hearing population. In the researcher's experience and opinion, the estimate is most likely less than the general population at-large, but use is increasing as programmes for promoting weather radios within the hearing loss communities are increasing.

7.6.2 *Prohibition to Weather Alert Radio for the Deaf and Hard of Hearing*

The value for having access to timely and accurate information during severe weather is well documented in the literature. The ability to make informed decisions whether to take protective action or not is directly related to understanding the threat and potential risk involved. Acquiring that information through a weather alert radio can greatly improve the decision making process and possibly avoid injury or death. The research found the majority of respondents, over 70 percent, did not own a weather alert radio for receiving severe weather alerts. The reasons fall into two categories, cost and the lack of knowledge or lack of familiarity with the device.

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[47] "Experts: Emergency Alert System a 'Mess'" Associated Press, 27 June 2004. Web. 13 Oct. 2008. <http://www.foxnews.com/story/2004/06/27/experts-emergency-alert-system-mess/>.

Acquiring a weather alert radio unit without the hearing loss accessories will cost the purchaser in the range of $30-70 USD depending on the make and model. Add in the hearing loss accessories such as strobe light, bed shaker, pillow vibrator, or transmitter and the price can easily increase in excess of $250-350 USD. For many in the Deaf and hard of hearing community this price mark is prohibitive. Another reason given for not owning a weather alert radio was many Deaf and hard of hearing individuals did not have knowledge of this alerting device. This lack of knowledge is reflective not only of the failure to involve this group in the awareness and preparedness programmes available but also underscores the need for specially designed education and training focus tailored to the Deaf and hard of hearing community. However, this gap is slowly being addressed by the National Weather Service with specialised training in Storm Spotter Training for the Deaf and hard of hearing and training sessions for programming weather alert radios in selected location around the country.[48]

Mention has been made throughout this study of the various factors that have been identified through the survey and interviews taken that impact the utilisation of NOAA Weather Radios by the Deaf and hard of hearing community. What has been learned is that the dissemination processes for alerts and warnings through this technology is effective; however, application for this particular special population needs considerable refinement related to education, training and operation of the device, i.e. programming. The research has identified those gaps and has brought to light some useful context for better inclusion of the Deaf and hard of hearing into the mainstream of early warning system services.

7.7 Preparedness Factors Associated with the Deaf and Hard of Hearing Population

One focus of the study addressed the preparedness levels of the Deaf and hard of hearing community from those who responded to the study survey. This is one area where little is known and was of particular importance to both the professionals associated with hearing loss and interested individuals within the community itself. Until most recently, there was no related research being conducted and as yet, no results have been published. The results of this study are reflective only of those individuals surveyed and interviewed. In gathering background research for designing and developing the survey, it was found that disaster

[48] *NWS Office in Nashville Offers Storm Spotter Training for the Deaf and Hard of Hearing*. National Weather Service, Southern Region Headquarters. Feb. 3, 2012 http://www.srh.noaa.gov/srh/srnews/stories/2012/signing.htm.

related programmes and trainings specific to the Deaf and hard of hearing are mainly non-existent. In those few instances where this special needs population does attend preparedness programmes, the training materials generally are not adapted to the hearing loss community. The Nashville, TN area is one of the few within the U.S. that is making efforts to integrate the Deaf and hard of hearing community into its mainstream preparedness programmes. Because of this, caution should be given for transferring the findings of this study to the general Deaf and hard of hearing population at-large. The amount of research having been conducted for this population nationwide just does not exist for making an accurate comparison.

The study found that a little over a third of the respondents had not completed any type of preparedness class (Community Emergency Response Team (CERT), CPR, First Aid, etc.). This compared to approximately a third who reported taking a first aid class and a third having attended a CPR class. 11 percent of those surveyed were found to have attended a severe weather/storm spotter class. Again, Tennessee is one of the few states where storm spotter classes have been specifically developed and conducted for the Deaf and hard of hearing. Overall females (71%) were found to have a higher percentage for not having completed any preparedness class compared to males (52%). However, a higher percentage of females were shown to have completed CPR and first aid classes than males. Although the differences were relatively close in comparison, there was a 12 percent increase in participation in female completion of first aid classes compared to male participation.

When taking into account age relative to preparedness classes completed, study data indicated that every age bracket reported at least 50 percent of their respondents had not completed any type of preparedness classes. This is reflective in the lowest reported age group (20-29) at 50 percent and the highest reported age group (60-69) at 72 percent. When one hard of hearing individual (D/HFGI10, F, age >25) was asked why the interest level in attending preparedness classes seemed to be rather low, she responded this way:

> "There just isn't any classes made for those of us that have difficulty hearing or are Deaf. All of the classes except for the recent ones [CERT and storm spotter training] are not really suited for us. If there were more classes for us I think there would be more interest. When we talk about being prepared a lot of people want to be. You've seen the attendance at some of the special trainings for us; they're well attended."

What can be derived from the findings is that the overall data collected follows along the assessment attributed to most underserved population within the disaster paradigm; services are minimal, system applications are generally deficient, and there exists a strong opinion that their needs are not met. The degree of difference between the Deaf and hard of hearing population compared to other special need groups is unclear. What is discernible from this study however is the need for further institutional prioritisation of disaster related services for the hearing loss community relative to the early warning system. The following chapter highlights these observations in its focus on the overall study findings associated with disaster education and training.

7.8 Summary

The study data shows us that although mobile devices are heavily used by the Deaf and hard of hearing population, there use for receiving early warning message is much lower. The likelihood for this discrepancy is the lack of mobile applications and the limited notification protocols that are disseminated for use by this special needs group. However, this gap is slowly being addressed as new technological innovations are being developed and implemented. The early warning challenges however still remain critical and woefully under addressed for the Deaf and hard of hearing population. The study findings also illustrate the inadequacy of closed captioning usage by commercial enterprises when reporting severe weather and tornado warnings even with legal and administrative directives in existent. The inability to fully understand and comprehend TV warnings during severe weather places this special needs group at a considerable disadvantage from the rest of the population. The acquisition of appropriate warning equipment continues to be a challenge due to cost and overall availability. However, positives do exist such as the growing interest of the Deaf and hard of hearing community's desire for additional disaster education and training. Coupled with emergency management's better awareness of the growing numbers of hard of hearing within the overall population; greater attention to developing preparedness and response to this specific needs group is slowly increasing.

Chapter 8. Disaster Education as a Preparedness Focus for Institutional and Individual Utilisation and Implementation Strategy

"…in 1954, tornado forecasts had become common. [F]or the entire process to be effective, it needed three more ingredients: a system for spotting tornadoes, a method for warning the public of the storm's approach, and a strategy for educating the public." Marlene Bradford, 2001, *Scanning the Skies: A History of Tornado Forecasting,* p. 102.

8.1 Introduction

Disaster education continues to remain a basic global component for the establishment and enhancement of resilience strategies. Its inclusion in every major international document representing disaster risk reduction illustrates the importance and weight given to promoting its continued emphasis as a foundational pillar for disaster preparedness, sustainable development and resilience building (Yokohama Strategy and Plan of Action 1994, WCDR 2005, UNISDR 2007, OECD 2008, Hyogo Framework for Action 2005-2015, SFDRR 2015-2030).

As stated earlier, one of the core aspects of the thesis relates to disaster education and training strategies for public utilisation. From a practical and contextual perspective, disaster education is difficult to define, hard to determine exactly what it is, and even harder to gauge its beneficial characteristics relative to identifiable and attributable outcomes. The by-product of the disaster education concept is an accumulation of disaster materials consisting of brochures, pamphlets, training videos and films, websites, and descriptive actions to be undertaken in the event one encounters a specific hazard. Its components are reflective of standard education and training philosophy designed to input knowledge, guide behaviour in an appropriate manner and direction and instil a sense of preparedness for safely surviving a hazard (Walia 2008).

Disaster education and training is often macro-focused utilising broad social media and marketing techniques rather than community based approaches (Glik 2007).
This pattern is prevalent in the disaster education and training environment. It is argued here that what is required is a more substantive approach encompassing specific quality indicators and measurements directed toward evidence-based outcomes. Eisenman et al. (2009)

emphasise the need for using “empirically valid methods for improving disaster preparedness”, as well as other community-based approaches. Development of education programs that are narrowly focused to include a neighbourhood and community perspective with localised input, appear to promote hazard adjustments and better preparedness activity (Dufty 2008, Terpstra 2009).

8.2 Utilisation of Disaster Education as a Core Element of Preparedness Strategy

The findings from this research resulted in a number of both expected and unexpected data. The measurable outcomes of past research related to disaster education offer cursory knowledge on the practical benefits of our current strategy. The use of existing educational materials by emergency management professionals is reliant generally on external publishers, representative of the few organisations who provide information focused on hazard specific phenomena (FEMA, NOAA, American Red Cross, CDC). As one emergency manager (EMInt6, M, age >40) interviewed stated:

> “I use the [education] materials that I can find off the Internet. Some of them seem to be pretty good but if you asked me if they work and people follow their advice, I couldn’t tell you. I’m guessing some do and some don’t. When I conduct tornado training in my county I tell them where they can find the information on the Internet and what actions they should take if there is a tornado watch or tornado warning. I try to conduct trainings during tornado season in as many places as I can but we’re limited in this county with money and manpower.”

As we saw in Table 5.5 regarding how emergency mangers view who is responsible for tornado preparedness education, local emphasis is highly placed in the continuum of responsibility. Emergency managers were asked:

> “*In thinking about who should be responsible for educating the public in tornado preparedness, how would you rate the following sources’ level of responsibility for preparedness education? Please indicate their level of responsibility on a scale of “Very responsible to "Not responsible*.”

Ninety-eight percent (98.5%) responded that local emergency managers should play a significant role in public education. This was equalled in percentage of response with the National Weather Service and followed closely by local government and schools. As one emergency manager (EMFGI2, M, age >50) put it:

> “I believe that most emergency managers look at educating the public as a major role of our job responsibilities. Generally speaking, we are the ones that the public trusts and relies on to take care of them when these types of

> disaster [tornado] events occur. I try to give them the best advice I can and we really try to get everyone trained and educated so they know what to do. I think we do a fairly good job but you can't always get everyone to pay attention."

With regards to the quality of the educational materials used one emergency manager (EMInt3, M, age >50) who was interviewed said:

> "I just use what's out there. I don't have time to develop anything and I assume that whoever wrote it knows what they're talking about. This is the information that FEMA and the National Weather Service is putting out so I figure it's OK. The problem is a lot of people don't plan ahead and so even if you give it to them they may not take it to heart. But I think that most people want to protect themselves so we keep trying to get more folks educated over time."

Regarding the Deaf and hard of hearing community, the researcher's experience indicates that completion of any preparedness training, or training directed toward severe weather is extremely limited. Barely 7 percent of the respondents to the study survey reported having taken any personal preparedness education or training course; with an equal number reporting the same for having attended any type of community emergency response team training. As one hard of hearing person (D/Int1, F, age >40) responded:

> "There are very few educational or training opportunities that are specific to people who can't hear. There aren't any programs for us so all that is available are programs for people who hear. Occasionally they have an interpreter but only very few times. Most of the times we have to take someone with us that can sign for us. It's not a good situation; no one really cares if we are prepared or not, so the ones who want to learn they have to figure out how to do it, the rest just go on about their business."[49]

The study findings give credence to that claim. Interviews with emergency managers verify this as well. There is not a deliberate attempt on the part of emergency management professionals to exclude education and training services from the Deaf and hard of hearing population; however, in actuality, special needs populations in general are extensively underserved in both planning activities and operational considerations. This occurs as a result of limited funding, lack of knowledge of specific needs and failure to understand the physical, psychological and cultural ramifications resulting from hearing loss. As one emergency manager (EMInt5, M, age >45) interviewed put it:

[49] Since the interview was conducted, in the Nashville area the National Weather Service and a local organization representing Deaf and hard of hearing individuals interested in providing preparedness classes specifically tailored to that population called EARS (Emergency Awareness and Readiness Services for the Deaf and Hard of Hearing), have restructured two existing programmes, Storm Spotter training and Community Emergency Response Team training, for the loss of hearing community. Both programmes exceeded capacity level attendance.

> “We do the best we can with what we have, but honestly we don’t come in contact with too many people who are deaf or can’t hear well. Most of the time they are with someone who can hear. When we do encounter those folks during a disaster situation, we help them as much as we can. If we can get an interpreter to help we do, but a lot of times there is no one available. We make do”

8.3 Quandary of Disaster Education Responsibility

The question of who is responsible for providing disaster education remains a diverse issue dependent on perspectives of governance, resources and system configuration. The U.S. disaster education system is a mix of public-private partnership, local emphasis verses Federal direction, and non-governmental organisation interest and focus. Academic involvement generally revolves around hazard research from a scientific, social and behavioural perspective, and for the most part refrains from materials development unless it is associated with academic research. However, exceptions do exist in specific cases.

This study specifically looked at the question of disaster education responsibility. Interestingly, local emergency managers surveyed felt a serious requirement to incorporate educating the public in disaster related issues as a major component of local control and leadership. One local emergency manager (EMFGI1, M, age >30) stated:

> “Absolutely it is a responsibility of the local emergency management agency to educate the public in their county as to how to prepare and respond to a weather disaster, for that matter, to any disaster. Every tornado season I travel all over my county and conduct training classes on what to look for regarding severe weather and what actions to take if a tornado warning occurs in their area. We rely on the National Weather Service to provide us with the forecasts and notifications of severe weather, but we at the local level have an on-going responsibility to prepare our local citizens.”

Another emergency manager EMInt3, M, age >50) added:

> “The public can find education and training materials concerning tornadoes on the Internet sites from the National Weather Service, FEMA, Red Cross and a host of other websites. But the bottom line is that we local emergency management professionals have the responsibility to our local citizens. They expect us to be involved and count on us for guidance and leadership. That’s our job.”

There is no doubt that the main initiator of weather focused information and education lies with the NOAA and the National Weather Service. Within the U.S. early warning system they are the primary agency responsible for severe weather predictive, forecasting, detection and alerting. It is through their research, technology generation and analysis that alerts and warnings are formulated and disseminated. However, the integration of that effort with private television, radio and local and state emergency management forms the interactive organisational framework for early warning notification of potential weather related hazard risk.

Educating the public of the risks involving wind, water, winter storms and other climatological impacts remains a cooperative and collaborative enterprise. Another component that emergency managers feel is instrumental in disaster education are schools. Of those managers who responded to the study survey, 92.4 percent listed school as needing to be responsible for providing tornado education. Schools offer a natural environment for establishing and implementing disaster education programmes (Ronan et al. 2001, 2003, Shiwaku and Shaw 2007, Finnis et al. 2010). Educating children as part of their school curriculum has a proven track record and instilling in children the risks involved and the proper protective actions to take during severe weather and tornadic activity is sound disaster education strategy. Knowledge gained through school education promotion carries over to households and extended family and neighbours.

The actual practice provides a different picture. Disaster focused curriculum within K-12 education levels is mostly viewed as an extra-curricular activity. Minimal time is devoted to disaster preparedness other than cursory attention. Science based classes may touch on certain aspects of weather related or hazard threats but for the most part, they are not included in core curriculum. As the research literature indicates, educating our children about hazard is beneficial, but the follow through implementation as a course of action and disaster strategy is vastly underutilised, at least from a U.S. perspective.

In addition to the National Weather System (NWS), local emergency management and schools, television and radio broadcasting organisations are an important venue for disaster education. These media enterprises are a fundamental component in the larger early warning system and play a primary role for dissemination of NWS weather alerts and warnings. Their meteorological expertise and identification as a major source for up-to-date weather reporting establishes them as legitimate educators and distributors of weather related knowledge. Their media exposure on daily weather reporting provides a unique platform to aid in the overall education and training strategy directed toward educating the public to the risks of severe weather and tornado activity.

In conversation with several NWS employees, education of the public is becoming an important responsibility undertaken along with their other duties. Education is evolving as a component of an overall philosophy that prediction, forecasting, detection and warning is part of a greater people-centred paradigm that is more than just a purely scientific focus but one that requires greater integration of human factors and considerations. This human focus over the past several years, resulting from the increase in tornado related deaths, has created awareness that human behaviour to tornado alerts and warnings is not an exogenous phenomenon separate from tornado science and warning processes (NWS Service Assessment, Joplin 2011). One NWS employee (NWS1, M, age >45) explained it this manner:

> "Education efforts up until a few years ago mainly involved giving a few talks about weather and explaining what we did at the National Weather Service. That has changed a lot. Although our primary mission is to predict and forecast the weather, we now try to work more closely with emergency managers providing education and training opportunities helping them become more knowledgeable in such things as radar interpretation, complex weather patterns and using the array of computer applications provided by NOAA and the NWS. We also do considerably more with regard to the general public, consisting of basic and advanced storm spotter classes. Here in Nashville as you know, we've even restructured that program to accommodate the Deaf and hard of hearing community. So to answer your question, yes, we believe education of both professionals and the public is very much a part of our responsibility."

8.4 Disaster Education Challenges for the Deaf and Hard of Hearing

As with any special needs group, providing specialized education and training programmes related to disaster hazard and the associated risks is a challenge. The Deaf and hard of hearing community are particularly vulnerable when it comes to quick on-set hazards such as severe weather and tornadoes. Because most of the alert and warning technologies and operational protocols are auditory based, the inability to hear is a serious problem (Wood and Wiseman 2003). This study exposed the serious gap faced by those with hearing loss as to the number of disaster education programmes available to them and disaster materials designed specifically for their needs.[50] Working with Deaf and hard of hearing individuals over the past several years, directly as a result of this research and volunteering time in a local disaster focused group for the hearing loss community, a common and constant complaint was

[50] Two important products resulted from this particular research study. The survey produced for collecting these data included a video of the survey signed in American Sign Language (ASL) and an instructional video on how to program an NOAA Weather Radio also signed in ASL was developed. The instructional video can be accessed at: http://www.youtube.com/watch?v=A4izxOnKnug .

expressed regarding the lack of attention for their needs involving severe weather events. This included training, educational materials and formalised emergency preparedness involvement by local emergency managers. Although headway has been progressing through the work by groups such as the EARS (Emergency Awareness and Readiness Services) organisation, overall efforts and focus remain sparse.

Whether the alerting mechanism is a tornado siren, or television or radio audio tone, the inability to hear the alert notification places those individuals at a major disadvantage. Mitigation of that disadvantage requires strategies designed to utilise technologies and input knowledge of risk and appropriate action to be taken. For the most part specialised education and training programmes designed to provide weather related knowledge and survivor skills for the Deaf and hard of hearing are minimal at best. Although web based tornado hazard materials can be found, they mainly follow standard perfunctory protocols for what to do in the case of a tornado and are generally not designed for the Deaf and hard of hearing.

As this study indicates, the specific challenges faced by the Deaf and hard of hearing in such circumstances has either not been studied sufficiently or does not exist. The practical, notwithstanding the psychological impacts, are devoid in the education and training materials currently existing in the mainstream sources. This dilemma is however slowly being addressed as more awareness of the needs and requirements for those with hearing loss are brought to the attention of disaster professionals and those responsible for the safety of the public. These research data demonstrate the slow progression of emergency managers including processes addressing hearing loss challenges in their response plans, however there is no indication that deliberate inattention exists. As more emergency managers become knowledgeable and understanding of the needs, they are becoming more proactive in the institutionalisation of both training and education focused on the Deaf and hard of hearing community.

The National Weather Service is one organization that has recognised this problem and is conducting programmes to train storm spotters and weather knowledgeable individuals in the Deaf and hard of hearing population.[51] As this programme expands across the country the deficit of training opportunities for this specialised population will hopefully gain attention. The paucity of disaster education programmes for the Deaf and hard of hearing population is

[51] NWS Office in Nashville, Feb 2012.

a major oversight of those responsible for preparing our communities. This oversight can only be rectified through awareness and commitment.

8.5 Summary

The impact of disaster education remains mostly an unquantifiable measurement as an effective strategy for preparedness and response to severe weather and tornadic events. The data findings derived from this study indicate a severe gap in available sources, verifiable outcome based results and strategies focused on special needs of identified challenged populations. This lack of substantive information provides a pathway forward for improving and refocusing disaster education as a major strategy for risk reduction and establishing positive behavioural response to early warning processes. A core aspect of this research was a focus on disaster education and training strategies for public utilisation. Although the level of scientific knowledge and application of disaster education requires closer scrutiny for establishing it has a fundamental strategy within the disaster risk reduction construct, its utilisation as an essential element will only improve as it undergoes legitimate investigation of its structure, design, benefit, and effective use. The role disaster education actually attributes to the present system gives insight into its relevancy and challenges for further development and implementation as a key component in disaster warning strategy.

The study identified that emergency managers possess a sincere desire to make better use of disaster education principles and pedagogy for providing disaster information to the citizens of their counties. The scarcity of disaster education resources impedes this transference of knowledge and this is especially true in the context of the Deaf and hard of hearing community. As we prepare emergency managers in their expanded roles as integrators and implementers of disaster policy and processes, the importance of disaster education will increase as a key force in people-centred approaches to disaster risk reduction and community well-being.

Chapter 9. Impacts of Early Warning Reception and Response Behaviours: Discussion of a System of Institutional Challenges and Personal Responsibility

> "Organized-disorganization…[I] have seen evidence of this same pattern many times, many places. I am convinced that a core managerial problem constituting a critical sector of emergency management in a nation like ours, revolves around this response pattern." Thomas E. Drabek, 2010, *The Human Side of Disaster*, p. 146.

9.1 Introduction

Forecasting and prediction of impending hazard remains an important focus and basic component of the early warning system. Heeding those alerts and warnings in an effective and personally responsible manner fulfils the main objective and goal of preparedness and response professionals, researchers, and scientists in minimising needless deaths and injuries. What we have found through this study is that a disaster education emphasis as a fundamental strategy of risk reduction and preparedness continues to face both institutional and individual challenges. Whilst efforts continue to develop a higher understanding of the correlation between better detection and alerting of tornado hazard related to a safer and more prepared public; deaths and injuries continue despite breakthroughs in technology and warning processes.

It has been known for some time, and confirmed through this research study, that special needs populations have always been underserved; what we have found by studying the Deaf and hard of hearing community within the framework of the tornado early warning system is that it is a population of growing numbers boosted by an aging society. As a unique community, they are the recipient of an early warning system that was never designed to function within a hearing loss environment. However, they are a population that passionately desires disaster education programmes that will allow them to develop their skills and knowledge to function safely in severe weather situations and disaster events. What has also been learned through this study is that emergency managers require a better understanding of special needs populations both in general and with respect to the Deaf and hard of hearing community, and that preparedness programmes must be specifically tailored to these populations. In this context, the approach that one programme fits all has shown to be nonapplicable and ineffective as a disaster education strategy for addressing preparedness requirements.

The progression of hazard early warning research has evolved in both scientific and behavioural frameworks resulting in better and more accurate forecasting and prediction of climatological phenomena. It has also led to the identification of more detailed proactive protection actions to be initiated when encountering severe weather or tornadic activity. However, the complexities associated with implementation of the warning paradigm illustrate the challenge that continues to exist. The advances gained in technological improvements and scientific knowledge have led to better detection and forecasting of severe weather and tornado events. Whilst these positives assist in adding to a more efficient system in the aggregate, what we saw from the May 20, 2013 Moore, Oklahoma tornado was that longer advanced notification and warning lead times do not always equate to proper protective actions being taken (Murphy 2012). As a result, an added element into the protective action formula now focuses on determining “optimal” warning time given the multiple influences affecting response as addressed in this thesis.

9.2 Communication for the Deaf and Hard of Hearing

Mobile communications have transformed how much of the developed world operates on a daily basis. The Deaf and hard of hearing are no exception and use mobile devices and laptop computers much the same as the hearing population. In fact, this study found that mobile devices such as cellular phones, laptop computers and iPads are the preferred method for receiving alerts and warnings during severe weather and tornadic activity. The mobility component appears to be a major factor for its high selection and usability. As the NWS continues to promote and utilise this mode for transmitting warning messages throughout the country, the trend will likely continue.

The Deaf and hard of hearing community’s heavy reliance on mobile devices, television broadcasts, and to some extent the Internet, for receiving their severe weather alerts and warnings as this study found, is indicative of the further inclusion for technological innovation adapted to special needs preparedness applications. The increase in available technology will continue to add to the overall utilisation of mobile applications. Since these technologies are largely visual, those with hearing loss are very capable of using these devices without difficulty. With the inclusion of vibration capabilities in all devices, alerting and warning notifications do not require added processes for use by the Deaf and hard of hearing community.

Social media resources such as Twitter, Facebook, text messages and others are becoming more frequently utilised as well. Research continues to address finding better processes, technologies and educational approaches associated with severe weather alerts and warnings, such as developing strategies to improve online forecasting tools, and exploring factors that explain why some people seek shelter when receiving a tornado warning and others do not.

9.3 Public Complacency to Alerts and Warnings

A major question remains in the behavioural and warning science arenas as to why individuals do, or do not heed severe weather alerts and warnings. Even though it has been a research focus of study for many years by many researchers, the ability to produce an evidence-based answer remains elusive (Sorensen 2000, Partnership for Public Warning 2003, Sherman-Morris 2009, Drabek 2010). The numerous factors associated with this phenomenon add to the difficulty in reaching a satisfactory resolution. The emergency managers surveyed agreed that severe weather coverage by TV broadcasters contributed to the public's failure to heed alerts and warnings. As one emergency manager (EMFGI3, M, age >35) stated:

> "Sometimes news reporting of weather alerts and warning can do as much damage as good. The competition between the various television stations really develops into a contest of who can raise the most alarm during an incident. With all the graphics displayed sometimes you'd think we were experiencing the apocalypse. It mostly detracts with what we all are trying to do and a lot of time confuses and frustrates the public. Especially if there are several fronts moving through. It just wears the public out sometimes."

We know through this study that emergency managers place a high degree of agreement in that complacency is a major contributor for failure to act behaviourally to alerts and warning. However, there are several others such as confusion over warning terminology, lack of understanding, familiarity with seasonal weather patterns, or confusion on what action to take that may contribute as well. What we do know is that context within a situational event significantly impacts individual behaviour.

9.4 Preparing for Tornado and Severe Weather Events

The findings derived from the research for this thesis continues to support the concept that preparedness consists of incorporating preventive and mitigation measures designed to minimise loss of life, injury, and damage to property as the result of a naturally occurring event or a man-made or technological disaster. However, determining what consists of adequate protection or preparedness is a more nebulous undertaking. The factors involved can be complex allowing for numerous considerations for developing a strategy for mitigating all the possible risks and consequences. There is no one formula or pathway for protection from all the possible risks resulting from tornado and severe weather related events. Measuring adequacy in one's attempt for preparing to survive a disaster is often subjective, contextual and highly affected by a host of individual and complexly interrelated factors.

However, even within a comprehensive array of individualised elements, measuring one's preparedness level is not an impossible task. Preparedness depends on awareness of circumstances and the ability to make decisions appropriately to react when needed. As this study points out, having the ability to make sound decisions requires the ability to receive clear and accurate information from a trusted and reliable source. What we found by studying the Deaf and hard of hearing is that the inability to access that information is prohibitive to assessing the dangers adequately. Normally when an individual is confronted with a warning to take protective action, the decision making process may take numerous directions, assessing the surrounding environment, assimilating facts, determining the validity of the warning, and identifying available options. Preparedness relies on prior knowledge of the needs associated when confronting a specific hazard. Understanding warning terminology, knowing the location of safe places, or maintaining sufficient water and food supplies for surviving the duration of the disaster event, all contribute to increasing the level of preparedness. The preparedness process entails more than just deciding if and when to act, it may in fact provide the means needed to maintain the ability to act.

9.5 Education Components Affecting Tornado Preparedness and Individual Response

Overall, disaster education is an area that is frequently denoted for being a foundation pillar responsible for establishing changes in attitudes and behaviour in preparing individuals and communities to develop a culture of hazard safety. Its attention in the multitude of

International planning and strategic documents and reports is often paramount to a fundamental core principle (Yokohama 1994, HFA 2005, WCDR 2005, OECD 2008). Education in general is often categorised as a basic component of societal existence that characterises a community's commitment to providing fundamental knowledge and skills for sustainable resilience of its future. Disaster education is tasked with meeting challenges that many times exceed system and societal capabilities in an effort to protect the public. The responsibility attributed to providing the educational and training needs associated with preparing for oncoming hazards is a daunting task. Very few components impacted by disaster are simple, straightforward or easy to overcome and control. As the emergency managers interviewed in this study often expressed, they view their role as disaster educators as a fundamental responsibility.

The complexity of preparing, responding and recovering from a disaster event tax even the most developed and resourceful of nations. Disaster education and the integration of preparedness and operational functions requires more than just verbal commitments, generalised programming and tacit support from those responsible for governance of our societal organisations and framework. This study revealed that emergency managers and the public look toward local emergency management agencies, schools and the National Weather Service as a major distributor of disaster education information.

Intertwining sound educational principles with disaster system needs is difficult and complex. The efficacy of current disaster education and training programmes continues to challenge and perplex disaster researchers and professional practitioners. Defining who is responsible, identifying content, determining which approaches work best under varying circumstances and conditions, and selecting appropriate measures for effectiveness related to disaster education, require continued assessment and analysis.

Defining educational goals and objectives for International and national strategies is a continuing process. The design, development and implementation of processes and programmes that not only meet but effectively demonstrate the success of those strategies is most difficult and challenging. Often the focus of disaster education encompasses broad policy directives designed to direct a systemic effort for instigating practices, behaviours and plans for safer communities. Those broadly produced education policy targets generally do not incorporate the detailed needs encountered by local or regional disaster planners, administers and specialists. Nor are they designed to do so. What occurs is a gap between policy and effective implementation of programme goals. This is not however a unique occurrence and certainly is not specific to disaster policy design and programme effectiveness. It is the result of the development of complex adaptive systems reflective of societal integration and interaction. Complex adaptive systems are dynamic systems able to adapt in and evolve with a changing environment. There is no separation between a system and its environment; a system continuously adapts to a changing environment. As such, change is seen in terms of interactive evolution with all other related systems, rather than as adaptation to a separate and distinct environment.

Within the U.S. warning system, emergency managers function as system integrators and coordinators, responsible for implementation of disaster policy and operational oversight within the four components (preparedness, response, recovery and mitigation) of the disaster response framework. The Deaf and hard of hearing community is a recipient of those services and a particular group requiring special attention with special needs. How and if those needs are met requires an understanding of the challenges that exist within a hearing environment for those with hearing loss. Although often overlooked and marginalised within the perspective of disaster management of hazard events, the Deaf and hard of hearing population is growing substantially in an aging society. As a growing segment of the population, increased attention from emergency managers to their special needs brings further inclusion and input from a much overlooked community. This is not a new discovery or identified gap within the disaster field. Higher emphasis requires a specific strategy of intervention for addressing this growing need. Inclusion of the Deaf and hard of hearing population, and all special needs populations into the direct line of disaster planning activities is the initial approach of adapting a people-centred strategy to disaster management.

Disaster education and training programmes therefore must include an adaptable design capable of meeting a variety of hazards within the complex environment of human diversity and individualised context. The success of disaster education depends on multiple factors, establishing clear, measureable objectives that are practicable and achievable. These education outcomes may be varied depending on the local needs, cultures and social arrangements of each community or social group. Understanding needs, parameters, organisational capabilities, and resources provides a framework for addressing education and training pathways designed to provide safer environments and individual options for action.

9.6 Institutionalisation of Emergency Management Roles

The changing institutionalisation of emergency management roles has created a certain dysfunction as it relates to its position within the early warning paradigm. Instead of viewing this as a systemic flaw, in reality it is a natural progression for defining a legitimate foothold within the integration process of merging responsibilities. Emergency managers are becoming a critical linkage between government warning mechanism, namely the National Weather Service, and the public which they serve. As this study discovered, emergency managers' perspective of their professional responsibilities to their local communities is expanding and developing. Those responsibilities defined encompass an assortment of fundamental activities associated with policy formulation, policy implementation, preparedness and response coordination and public disaster education.

These functionary components within the early warning system vary considerably depending on jurisdiction and are predicated on local political structure, economics and social makeup of each community unit. The key emphasis is that emergency managers play a pivotal role in each, and as emergency management evolves, their impact can be considerable. Those emergency managers interviewed in this study readily acknowledge the difficulties they face but continue to expound on the willingness to develop professionally. The fragmented development of the U.S. early warning system, and in particular the severe weather and tornado warning system, is a creation of years of scientific hazard research and social/behaviour science related to disaster; the latter being relatively new in comparison, albeit somewhat parallel in its specific application. This co-mingling of disciplines brings an institutionalisation of the technical elements within the social aspects of disaster science resulting in an interdisciplinary collaboration and approach. This cooperative design is beginning to show signs of expanding and even redirecting the knowledge applications associated with severe weather and tornado warning research (NWS Joplin Assessment, 2011).

The catastrophic destruction resulting in the 2011 Joplin, Missouri tornado is an example of the reassessment of tornado warning protocols and the rethinking of the social/behavioural factors affecting individual protective actions. It is impractical to expect 100 percent compliance to alerts and warnings, however further understanding of risk assessment, disaster management practices, and comprehension of better preparedness knowledge is slowly re-shifting the emphasis of former approaches to disaster research, lessons learned, and applied science applications. Emergency managers involved in this study desire more and better interaction between practitioners and academic researchers. This is further demonstrated by occurrences in the recent 2013 Moore, Oklahoma EF-5 tornado in which “optimal” warning timeframes are being re-evaluated as to what may be considered as being too-long or too-short (Murphy 2012). Although this issue is currently being discussed and evaluated, timeliness of warnings is not a new topic of disaster research (Handmer 1992). At issue is how warning information is received, synthesised, analysed and acted upon.

Emergency management, and in particular emergency managers, continues to maintain a positive commitment as integrators of public policy, disaster education and proponents of applied research involving disaster operations. Although not the only component for carrying these issues forward, the maturation of emergency management into a truly professional level of responsibility is showing a higher commitment to the development of evidenced-based processes for public application. Their continued input and focus emphasises the enhancement of professional stature, applied objectives which make use of scientific knowledge, more sophisticated management practices and greater concentration on public interaction involving education, training and community needs (Nielsen and Lidstone 1998).

The need for public input within the early warning paradigm remains a focus that is often clouded by bureaucracy, government procedures, and confusion over disaster approaches and applications. The findings from this study which involved the Deaf and hard of hearing community, heavily support the need for public input and involvement in developing disaster policy and preparedness and response protocols. Overlooking the contribution that the public can provide in developing understanding how things can be done differently for improving warning protocols and individual reception of warnings is a major mistake that often occurs. In response to the 9/11 Commission Report addressing the findings of the attack on the World Trade Towers, Kathleen Tierney, Director of the Natural Hazards Center at the University of Colorado, expressed her concerns with the Commission’s failure to “engage the public in preparedness and response effort.” The failure to include input from those who worked in the Towers and had to evacuate themselves was illustrative of the bureaucratic mind-set which was prevalent at the time. She summed it up stating, “On the contrary, the Commission report is consistent with current trends that frame disaster management as a problem best addressed by people in uniform – law enforcement and the military.” (Knowles 2013, p. 255).

Hopefully this oversight is slowly receding both in disaster research findings and operational approaches by emergency managers. This important aspect should add significantly as more applied research methodology focus is directed toward learning what public perspectives bring to solutions addressing disaster issues. This thesis has shown that this is especially applicable to special needs groups, particularly those who are Deaf or hard of hearing.

9.7 The Deaf and Hard of Hearing Perspective

The paucity of research attributed to needs of individuals requiring special attention, especially related to hazard or disaster events is unfortunate but reflective of profound gaps in disaster research and operational attention. As this study has shown with respect to the Deaf and hard of hearing community, the lack of substantive information and data associated with this is woefully deficient. The solution for addressing this is one directed toward renewed emphasis by committed policy focused on academic research, funding and concerted effort to include the Deaf and hard of hearing community into the formulation for defining its relevant operational needs (Twigg 2014). This study was one initial attempt to move that agenda forward. Of equal importance is the relationship and integrated emergency management policy for addressing the needs of the Deaf and hard of hearing community within the framework of preparedness and response activities.

The at-risk, in both spatial context and population demographics related to tornado hazard, make up a considerable potentially affected proportion of the U.S. The increase of affected aging population and the increased cluster of recent tornadic activity require review and assessment of how we deal with and can better serve the Deaf and hard of hearing community relevant to severe weather and tornado warning events. As emergency management professionals tasked with coordinating preparedness and response activities for their communities, emergency managers are keenly positioned to undertake a substantive role in preparing the Deaf and hard of hearing community to understand alert and warning terminology, take pertinent protective action, and to provide training and education designed specifically to this community of individuals.

9.8 Strategy Development Requirements

As the findings from this study have shown, an individual with hearing loss viewing television with closed caption capabilities, often the problems associated with placement, overlapping, and interpretation gaps create considerable disruption related to understanding, comprehension and confusion. With fast on-set hazards such as severe weather and tornadoes, the inability to receive clear, directed alert messages is a major concern. The National Weather Service, the broadcast media and emergency management are working toward adopting corrective strategies for allowing those with hearing loss to effectively receive, understand and be able to respond appropriately when protective actions are needed.

Through conversations and discussions as part of this study, the broadcast media is also aware of the need to make a more concerted effort to bring closed captioning technology to a wider audience and develop a standardised set of protocols designed to address the existing problems associated with severe weather and tornado reporting. Deaf and hard of hearing individuals are especially vulnerable in their inability to properly and effectively obtain and receive severe weather alerts and warnings. As a growing segment of our society, failure to correctly perceive and understand their needs must be addressed. This requires a committed collaborative effort between applied academic research, emergency management, NWS and the broadcast media with the goal of providing workable, effective solutions for the Deaf and hard of hearing community.

9.9 Holistic Approach for Institutionalisation

System complexity is the overarching reality regarding the severe weather alert and tornado early warning system. Its evolution and structural makeup is the result of decades of dedicated work by academic researchers, hazard scientists, committed practitioners and government professionals whose goal has been to develop an alert and warning system that is effective and safety driven. Its components are characterised through a process consisting of prediction, forecasting, detection, message formulation, information dissemination, and education of protective actions to be taken of impending weather related hazards. It is a collaborative process between public/private partnerships and shared integration of roles and responsibilities of various professionals who maintain the commitment for making our communities better prepared, safe, resilient and responsive when needed.

It is a system that constantly strives to optimise its impacts whilst providing a safety net over the individuals its duty is to protect. The over-reach requirements involving its multi-jurisdictional environment coupled with the context of individual diversity of the population it serves, creates significant challenges and complexities. As we have seen through this research study there is no "one size fits all" approach to the alert and warning process, although certain commonalities exist and often protocols are shared on a regional and even national basis. The challenges produced are reflective of the population needs of the diverse public. The inclusion of special needs groups also adds to the complexities of human factors impacting warning science. The combination of all these elements results in the need for holistic solutions that fit with the institutionalisation process for alerting and warning the public of severe weather conditions.

Trying to attain a consistency of effectiveness in light of population variances, built and natural environmental conditions, and the enormity of governmental structure is a considerable challenge. Discussion therefore must begin to look at better ways in our attempt to encourage individuals to respond more appropriately to severe weather alerts and warnings. Shifting a focus emphasis from macro to micro within those areas specific to community needs may in effect individualise the solutions for attaining better individual response to alert and warning messages.

9.10 Further Integration of Emergency Management into the Alert and Warning Paradigm

Very little empirical data exists into understanding the complex role of local emergency managers and their impact and contribution to their communities regarding issuance and responses to severe weather alerts and tornado warnings. Studies indicate that community residents trust their local emergency management officials and as the research data from this study have shown, belief in the source of the warning message is critical for instilling appropriate protective action. Disaster research can enhance and solidify further the understanding how local emergency managers interact and affect the response actions of their communities. Local community participation is important to developing strong individual preparedness skills.

The ability of emergency managers to strengthen their working partnership with their community will impact overall responsiveness, resilience building and survivability of their constituents when a hazard event occurs. The study findings indicate both the willingness of emergency managers and the public's desire for greater collaboration and interaction. In areas that experience potential for severe weather and tornadic impacts, determining how emergency managers can take a more direct role in the alerting and warning process is an important objective. Whether this requires changes in training curriculum for emergency managers, programmes for assisting in the building of closer partnerships, or creating mechanisms for allowing emergency managers better access to applied research, all deserve consideration for on-going programming and research.

9.11 Disaster Research Focus for the Deaf and Hard of Hearing Community

The researcher's experience in emergency preparedness and operational response related to disasters, and in particular the findings from this study, leads to a belief that a major gap exists in our preparedness efforts directed toward our special needs populations. The attention to and understanding of those needs is woefully lacking. The paucity of disaster research focusing on special needs individuals makes it difficult to develop reasonable conclusions based on empirical evidence. With respect to the Deaf and hard of hearing population, the data derived from this study show that disaster research devoted to this area of study is almost non-existent. One exception to this is the recent focus on research involving mobile technology applications for receiving alerts and warnings for those with hearing loss. However, this research is in its infancy and requires greater study.

This study found that specialised alerting equipment for the Deaf and hard of hearing is costly and difficult to obtain. Available severe weather and tornado preparedness programmes are scarce, and of those that do exist, most are not applicable to the hard of hearing community. Disaster preparedness training programmes in general can only be found in select locations in the U.S. As attention to disaster education continues to expand and develop descriptive investigation of basic demographic information, increase in the availability of disaster education/training programmes, and the collection and analysis of disaster materials used currently for public education purposes will further enhance this area of study. The ongoing research and programming however must develop evidence-based methodologies and measurements to determine what approaches, tools and applications are needed. Also needed is a thorough assessment of the processes and protocols regarding alerts and warning for severe weather and tornadic activity for determining what will work for those with hearing loss.

9.12 The Future of Disaster Education

The thesis has brought to the forefront a number of disaster education related issues and expressed belief that although emphasis on both the international, as well as many individual nation levels, disaster education is viewed as a principle of disaster reduction strategies. It is a concept broadly defined in traditional terms but is less understood from a learning science perspective. Mostly identified in a descriptive form, until the past few years it was difficult to define and has been the subject of few substantive research studies. However, disaster education is now being discussed at academic and professional conferences in a more critical and scientifically focused manner. The discussion now focuses on how disaster education must therefore include identified outcomes consisting of quality indicators that are scientifically evidence-based. This is not to say that all disaster education programmes be rigorously controlled and evaluated but strategic policy focused programmes should require outcomes based on theoretical framework. The establishment of interventional disaster research as opposed to purely descriptive research is one approach. The utilisation of idea mapping and literature analysis are other innovative concepts that would lend themselves to opening up creative cognitive processes for moving disaster education to a higher level of thought and applied usage.

Disaster education must continue to expand as a people-centred focus in both design and development. Current research findings indicate that community directed approaches result in better received programmes, are more effective and help to increase community awareness and preparedness levels (Paton and Johnston 2001, Shiwaku et al 2007, Dufty 2008, Zach and McKnight 2010). Disaster education thinking should include a micro/macro approach however, a concerted shift to a more community-based direction will result in better community response and a safer hazard environment, as evidenced by this study data.

9.13 Policy Implications

Much has been studied and written regarding the best avenue for preparing for and recovering from disasters. Such discussion is fundamental to theory building, concept formulation and applied implementation associated with the cognitive processes and syntheses of research data derived from the intellectual efforts of disaster science. All this results in the development of governance policies designed to make us more effective, efficient and hopefully more safe. It is easy to criticise efforts from seemingly poorly managed disaster events or find fault with disaster operations that do not live up to public expectations or after-the-fact scrutiny. The challenge is how to design and develop a system that meets all the public demands for the "perfect" system. Disaster policy development is a complex process consisting of politics, economics, and social and cultural context.

Disaster policy in the U.S. for all practical purposes is a top-down process. With a system designed as a bottom-up operational process, complications are inevitable. This structural conflict must be addressed to include more focus and input at the local level. This includes greater input from the local community related to programmes based on prioritisation of "their" determined needs. This approach has been consistently repeated by those interviewed with hearing loss in this study and reflected in the responses by the emergency managers surveyed. Additional financial resources allocated to local emergency management should address factors affecting emergency management professionalism such as education, standardisation, leadership and development of managerial skills. One major consideration is the integration of emergency managers as a component into the academic research and scientific research complex of disaster science.

As academic and scientific circles become more involved with disaster professionals, policy makers and emergency managers are expressing the desire of becoming more familiar with disaster research and applying that knowledge for better policy formulation. Too often pertinent research findings that provide workable solutions or beneficial input to real disaster related problems are either overlooked, ignored or are unknown. Drabek (2007) recognized this as a fundamental problem emanating at the highest levels of government stating:

> "The White House Report (2006) which emphasized "lessons learned" also ignored most of the social science literature on disasters. Yet, seventeen ". . . most critical challenges that were problematic . . ." (p. 2) were identified to serve as a backdrop for a new vision. That is, a "National Preparedness System" is to be implemented along with a "culture of preparedness." I'll return to these matters in the fourth section of this paper, and here only note that the 689 endnotes cited throughout the six chapters of the White House report include very few references to what most of us would consider the "standard" sociological disaster research literature, although a few historical (e.g., Vale and Campanella 2005), policy oriented (e.g., Platt 1999) and popularized works (e.g., Larson 1999) were included." (p.31)

He goes on to state:

> "While lots of different types of other evidence could be cited, my first theme reflects two basic conclusions: 1) a significant scientifically based core of knowledge has been created by disaster and hazards researchers, and 2) during the last six years especially, this knowledge has too frequently been ignored by high level policy makers." (p.32)

As an element of disaster policy, focus on disaster research pertaining to special needs becoming a priority is evidenced through this study's findings. This overlooked segment of the population must become a point of emphasis in all preparedness planning processes at the federal, State and local levels of government.

Chapter 10. Conclusion

"It should be appreciated that the loss of just one individual or 10,000 may be equally grave a disaster experience to a bereaved individual."
Andrew E. Collins, 2009, *Disaster and Development* p.91.

10.1 Introduction

The thematic aim of the thesis was to investigate tornado early warning system impacts and influences on protective behaviours to determine if, and/or how disaster education endeavours affect those responses. The focus was to explore the U.S. early warning system in the context of three separate but interlocking components: emergency management, special needs populations, represented by the Deaf and hard of hearing community, and disaster education. The study findings provided some unexpected as well as enlightening data regarding the inner workings of the severe weather and tornado early warning system currently utilised within the U.S. As weather events continued to occur throughout the course of this study, topics specifically relevant to this research were developing in a real-time framework. Tornadic activity increased both in occurrences and severity in many parts of the U.S. causing record deaths, injuries and damage. The same issues related to warning protocols being studied were coming into question as the result of these devastating storms. Emergency managers and representatives of the hearing loss community were able to relay their thoughts, concerns and frustrations in a timeframe relevant to actual events. Those findings help illustrate the need for further study and the continued search for different approaches in an effort to strengthen the early warning system.

10.2 Pathways for Integrating Emergency Management, Policy Development and Policy Implementation

The 1970s in the U.S. saw a dramatic increase in the development and utilisation of emergency management and emergency management personnel, both as a profession and integrator of policy. The formation of the Federal Emergency Management Agency into a Presidential Cabinet level position provided the impetus for establishing emergency management as a core component for coordination of disaster operations. The evolution of bureaucracy, governance, and political manoeuvring of the emergency management system is neither unexpected nor disappointing. In fact, it has taken a normal progression of organisation development within the framework of institutionalisation. Its brief history of development is illustrative of growing pains, maturation, and political influences that represent the natural emphasis of "local control" seen at all levels of government. Local and county units of government number over 89,000 within the U.S. Although not all of those maintain operational emergency management components in their organizational structures, many incorporate an emergency management presence relative to planning and preparedness functions.

The task of organising and coordinating disaster operations is often complicated by both the developing and the mixing of policy within the operational requirements of managing a disaster event. This theoretical, conceptual, and practical approach creates at times a process seemingly disjointed and dysfunctional in outward appearance. In reality, and much to be attributed to the professionalism of emergency management personnel, actual disaster events many times are minimised and mitigated resulting in little loss of life and unnecessary injuries.

The integration of emergency management in the disaster paradigm as it has evolved over the years continues to sort out the philosophical differences between opposing groups focusing on the all-hazard approach and mitigation and those supporting the command and control position. Scott Knowles in his book, *The Disaster Experts* explains, "In the post-September 11 United States, and particularly since Hurricane Katrina, a new uncertainty defines the always tenuous relationship between disaster experts and policy makers. In the midst of this uncertainty, a new era of "hazards realists" are working to get past the stale arguments over what "should have never been built," or "why people don't protect themselves against disaster." These disaster experts- drawing (as is familiar) from many disciplines and acting at different levels of government, and outside of government, are facing the nation's hazards with innovative solutions that might redefine the American disaster landscape for the twenty-first century." (p. 255)

10.3 Tornado Preparedness Adapted to the Deaf and Hard of Hearing Needs

As with all special needs groups, the Deaf and hard of hearing require specific adaptations when addressing disaster preparedness applications. In the case of preparing for severe weather and tornadoes, hearing difficulty places these individuals at a particular disadvantage.

Most of the NWS tornado notification protocols rely heavily on sound and the ability to be audibly stimulated to the alerting signal. This is especially applicable when sirens, weather alert radio, or television and radio broadcasts are utilised. The inability to hear either requires some type of lighting or vibration device to signify the existence of a weather alert notification in progress. With the exception of the weather alert radio, the other notification sources do not provide this capability without special adaptation equipment. The result is missed alerts and warnings. As we have discovered in this research the cost for obtaining these accessories for weather alert radios can be expensive and therefore, prohibitive.

10.4 Disaster Education

As we have experienced, the concept of disaster education is seen as a fundamental component of preparedness, resilience building and sustainable development. By its very definition it is perceived as an essential element for the establishment of a long-term disaster strategy (Yokohama 1994, HFA 2005, WCDR 2005, OECD 2008). It remains a fundamental principal of international disaster risk reduction structure and strategy. As a pedagogical approach disaster education is presented in various training media formats from videos, pamphlets, brochures, instructional courses, and more recently in numerous on-line and Internet communications. What lacks however is clear evidence of outcome-based designs having undergone substantial rigorous analysis and review. Many of the instructional materials remain anecdotal and descriptive in nature; missing an interventional dimension validating their effectiveness and legitimacy of purpose. Their design is often broad based for mass consumption and fail to incorporate a people-centred approach directed toward specific community needs (Glik 2007). Disaster education therefore must be more directed towards a humanistic design and less to an institutional framework developed from top down oversight. Individualised and community input are the keys for constructing and implementing a disaster education system responsive to human conditions.

10.4.1 *The Need for Applied Evidence-Based Evaluation and Outcomes Regarding Disaster Education*

The effectiveness measure of disaster education programs and materials is not necessarily an easy task to perform. Identification of valid predictors remains an open discussion although some measures of effectiveness are indicated through characteristics attributed to evaluating awareness, personal preparedness, and in school programs and the transfer of learning to families (Dufty 2009). As disaster education approaches become more scrutinised by both the research community and disaster professionals, changes in the development of programmes and materials will likely incorporate outcomes which are based on learning theory principles and concepts which can be applied to community settings. This applied approach to development of disaster education and training programs and materials will become a part of any strategy for furthering the inclusion of disaster education within the framework of disaster reduction and sustainable development programs.

As has been the case both on the national and international levels, establishing the goal of disaster education outcomes inclusive of evidence-based measures has been difficult to accomplish. The dearth of research studies devoted to this educational focus is evidenced by both the lack of attention and the difficulty in retrieving valid data for addressing the problem. The solution calls for an interdisciplinary approach from researchers, learning specialists, and disaster practitioners to begin investigating the integration of learning and cognitive theory into disaster education and training development. Established knowledge from within the fields of learning sciences and cognitive behavioural research can be adapted to the disaster setting. This approach will certainly require adjustment relative to hazard and individual context, but nonetheless should be seriously considered as an overall goal of disaster education focus.

10.5 Future Research Direction

The information gathered from this study provides potential research pathways for other ancillary and adjoining areas of interest related to alert and warning science, emergency management and specifically, disaster issues directly affecting special needs such as the Deaf and hard of hearing community. The literature provides extensive research addressing early warning of natural, man-made and technological disasters and the factors impacted by numerous demographic and spatial parameters (Perry et al 1982a, Gladwin and Peacock 1997, Golden and Adams 2000, Mileti and Peak 2000, Lindell and Perry 2004, Hall 2007).

Research into disasters has led to over six decades of hazard specific and sociological introspection related to disaster dynamics, human response, and technological advances in the prediction and detection of hazards (Doswell 1998, Hamilton 2000, Lindell and Whitney

2000, Spittal et al. 2008). Advances in risk reduction, resilience building and mitigation of hazards have also shown considerable improvement over the years (ISDR 2004, 2007; Peguero 2006; Drabek 2010; Kuhlicke 2013; Lorenz 2013). Studies related to disaster education have grown and continue to be a topic of interest contributing to the goal of providing better knowledge and directed response to potential hazards (Ronan and Johnston 2003, Mileti et al. 2004, Shaw 2004, Shiwaku et al. 2007, Fuhrmann 2008, Soffer 2011).

The body of disaster research has grown considerably over the years, however this expansion has identified a need for shifting of focus and some redirection of efforts as has been shown by the results and findings of this study into alert and warning applications. Gaps continue to remain regarding the role development of emergency management and the emergency manager, validation of measuring effective disaster education and designing preparedness and response programmes tailored to meeting the specific needs of the Deaf and hard of hearing community.

10.6 Strengths and Limitations of the Study

This thesis approached the severe weather and tornado early warning system and disaster education from two perspectives, emergency management and the special needs group comprised of the Deaf and hard of hearing community. Both are subject to limited study as evidenced by the findings derived from this research. Both groups are important components of the early warning system although for very different reasons. The emergency managers surveyed and contacted expressed satisfaction with being able to contribute their views and opinions related to alert and warning processes which are an important and frequent part of their duties and responsibilities. Their role as integrators, coordinators and managers of disaster operations in their local communities must be expanded to incorporate them as essential team builders and trusted leaders (Drabek 2007). The findings from this study lend credence to that assessment. Work in redefining and enhancing the role of emergency managers into the early warning paradigm is greatly needed. This initial research has determined the importance for further study in this area to add to the knowledge and strengthen delivery and response mechanisms that are essential to alerting the public and providing pertinent information during severe weather and tornado activity. The thesis supports the need for expanding emergency management to be less bureaucratic and organisational and more community centric incorporating holistic and social learning processes (O'Brien 2008, O'Brien et al 2010).

A major accomplishment of the thesis has been the contribution of research data regarding disaster preparedness directed toward the Deaf and hard of hearing community. The information gathered, provides a platform for further study into the needs, requirements and specific vulnerabilities affecting this growing population. It is a special needs area of disaster research that is lacking in focus and requires greater attention and commitment to developing a safer environment for those with hearing loss in order to navigate the alert and warning challenges.

As with most research studies, limitations exist and present challenges and obstacles that must be overcome throughout the course of investigation and exploration. This study was no different. As for the emergency mangers, it took a concerted effort to develop a rapport of trust to be allowed to navigate within their environment. Introductions often required trusted third-party involvement (White et al. 2007). As a group, they were relatively unfamiliar with scholarly field research but were exceptionally interested in how they could contribute and interact. Information regarding emergency management procedural operations is relatively sparse and is usually found in standardised government documents which at times may differ substantially from actual protocols and practices conducted in the field. Survey responses were limited to the emergency managers from the State of Tennessee and therefore caution should be used in generalising these findings to all emergency managers within the U.S. early warning system.

Accessing the Deaf and hard of hearing community posed similar challenges as those encountered from the emergency managers. There exist some cultural trust issues with this population that required special cultivation. Support from professionals who work within the Deaf and hard of hearing community was invaluable in this regard. Survey responses were limited to approximate 200 respondents and challenges in taking part in a survey of this type were difficult for some. A signed version of the video however was produced and did help to minimise confusion and misinterpretation of survey questions asked. Demographic information was somewhat skewed with regard to race and primary mode of communication. With the small number of respondents taking the survey, interpretation of the results is reflective of those who responded and caution should be used in attributing the findings to the general Deaf and hard of hearing population.

10.7 Concluding Remarks

The contents of this chapter have explored a number of aspects specific to this thesis and to the body of knowledge derived from past research studies addressing the early warning system paradigm. This study adds to that knowledge in three ways. First, the research identified the limited focus of information pertaining to the understanding of the emergency management role as it relates to alerting and warning processes. A broader discovery was the narrow direction of the emergency management role limited to mostly bureaucratic and organisational functionality. Second, the research re-enforced the need for further study of specific needs populations related to disaster preparedness and response, in this case study, identified as the Deaf and hard of hearing community. The findings highlighted the gaps in early warning dissemination pertaining to broadcast messaging and modes of distribution; equipment needs; the lack of preparedness education opportunities; and identified special challenges faced by those with hearing loss in receiving alerts and warning information. Third, the research centred on disaster education as a principle of strategic disaster planning and identified the need for local community and in individual emphasis in developing disaster education programmes. The findings also gave credence to the need for disaster education to include measureable outcomes derived from scientifically evidence-based theory.

The thesis contributed to the limited research devoted to disaster education (Ronan and Johnston 2003, Mileti et al 2004, Shaw 2004) and the call for more community directed disaster education (Paton and Johnston 2001, Shiwaku et al 2007, Dufty 2008, Zach and McKnight 2010). The findings helped to confirm the lack of research and specific policy implementations facing the plight of special needs populations as they continue to struggle and find ways to protect themselves in a system that fails to adequately integrate them into the disaster preparedness and response framework. The thesis provided further evidence that proactive approaches to emergency management focused toward holistic concepts would begin to address those individualised community needs at a level where less bureaucracy and more humanistic solutions can be actualised.

In essence, the thesis presented an in-depth observation of the dimensions of the U.S. early warning system and how alerts and warnings impact organisations, society and individuals. It is an institutional organism that continues to evolve as do most social structures. Its limitations are a function of our political, economic and culture framework. However, what is most apparent is that it is a system steeped in hard work by professionals who have dedicated their lives to making the world better and safer. The challenges will continue for those interested and concerned with disaster research. Their efforts must incorporate past knowledge and provide an expansion of thought to meet the complexities produced by a future technological and risky world.

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Appendix 1: Emergency Manager Survey Questionnaire

Emergency Manager Survey Questionnaire

Question 1.

The following is a list of methods/tools used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 10 being the least important.

a. ❑ Alert FM
b. ❑ Cellular phone / Text messaging
c. ❑ Emergency Alert System
d. ❑ HAM radio
e. ❑ Mass telephone notification (Reverse 911)
f. ❑ NOAA Weather Radio
g. ❑ Social media (Facebook, Twitter, other similar media)
h. ❑ SMS text via cell phone
i. ❑ Tornado siren
j. ❑ Web / Internet
k. ❑ Other (Please specify): ____

Question 2.

The following is a list of sources used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 9 being the least important.

a. ❑ 911 Dispatch
b. ❑ Contract weather service
c. ❑ Live radio broadcast
d. ❑ Live television broadcast
e. ❑ Local Emergency Management Agency
f. ❑ National Weather Service
g. ❑ State Emergency Management Agency
h. ❑ Storm Spotters
i. ❑ The Weather Channel
j. ❑ Other (Please specify): ____

Question 3.

Please indicate the level of your agreement on a scale of 0 to 4 with 0 being "Completely disagree" and 4 being "Completely agree."

(4) Completely Agree (3) Generally Agree (2) No Opinion (1) Generally Disagree (0) Completely Disagree

a.	*Emergency management should take a more active role in public education campaigns directed toward tornado preparedness.*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
b.	*Existing tornado education/training materials (provided by FEMA, NWS, ARC, etc.) being used are effective for preparing the public.*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
c.	*Local broadcast TV/radio does an effective job in informing the public of tornado preparedness actions to take during a tornado occurrence.*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
d.	*More emphasis on tornado preparedness education should be conducted in our schools.*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
e.	*Current severe weather alerts such as tornado warnings issued by the National Weather Service are adequate in notifying citizens to take protective actions during a tornado occurrence.*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
f.	*The public needs to understand the differences between warning terminology, specifically "tornado watch" versus "tornado warning."*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**

Question 4.

In those situations where an individual does not heed a tornado warning in a timely manner, rank the following factors you think contribute to their non-responsiveness? Please indicate the level of your agreement on a scale of 0 to 4, with 0 being "Completely disagree" and 4 being "Completely agree."

(4) Completely Agree (3) Generally Agree (2) No Opinion (1) Generally Disagree (0) Completely Disagree

a.	*Confusion over the severe weather alerts such as tornado watches/warnings*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
b.	*Ignore the alerts and warnings due to receiving too many notifications*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
c.	*Ignore the siren due to the frequency of siren activations (where used)*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
d.	*Do not understand the protective steps to take regarding tornado precautions*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
e.	*Familiarity with seasonal weather patterns in their locale*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
f.	*Lack of understanding of the threat*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
g.	*Media over reporting*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**
h.	*Public complacency*	❑ **4**	❑ **3**	❑ **2**	❑ **1**	❑ **0**

Question 5.

In thinking about who should be responsible for educating the public in tornado preparedness, how would you rate the following sources' level of responsibility for preparedness education? Please indicate their level of responsibility on a scale of 1 to 4, with 1 indicating "Not responsible" to 4 indicating "Very responsible." Selecting 0 will indicate "No opinion."

4 Very Responsible	3 Somewhat Responsible	2 Less Responsible	1 Not Responsible	0 No Opinion

a. FEMA (Federal Emergency Management Agency)

4 **3** **2** **1** **0**

b. Local Broadcast Radio

4 **3** **2** **1** **0**

c. Local Broadcast Television

4 **3** **2** **1** **0**

d. Local Emergency Management Agency

4 **3** **2** **1** **0**

e. Local Government

4 **3** **2** **1** **0**

f. Non-governmental Organizations (Red Cross, VOAD, faith-based)

4 **3** **2** **1** **0**

g. National Weather Service (NWS)

4 **3** **2** **1** **0**

h. Private Industry

4 **3** **2** **1** **0**

i. Schools

4 **3** **2** **1** **0**

j. State Emergency Management Agency

4 **3** **2** **1** **0**

Question 6.

Several of the past tornado seasons produced a significant number of tornadic events that resulted in a high occurrence of deaths and injuries in parts of the U.S. As an emergency management specialist, how would you improve the system to provide effective notification leading to better public response to severe weather alerts such as tornado warnings?

Appendix 2: Deaf and Hard of Hearing Survey Questionnaire

Question 1.

What source do you prefer to receive severe weather alerts, such as tornado warnings? (Check all that apply)

a. ☐ Computer Applications
b. ☐ Highway Message Boards
c. ☐ Internet
d. ☐ Mass Telephone Calls
e. ☐ Mobile Device (cell phone, tablet, laptop)
f. ☐ Television Station
g. ☐ Weather Alert Radio
h. ☐ Other: ______________________________

Question 2.

What actions do you take when there is a severe weather alert, such as a tornado warning in your area?

		YES	NO
a.	Communicate with family members	☐	☐
b.	Don't do anything	☐	☐
c.	Go to another location that is safe	☐	☐
d.	Stay inside a safe place	☐	☐
e.	Turn on local television station	☐	☐
f.	Other: (Please Specify): ____________________	☐	☐

Question 3.

If you watch television weather broadcast as a source for receiving severe weather alerts, such as tornado warnings, is the closed captioning.....

		YES	NO
a.	Could be more detailed as to what to do	☐	☐
b.	Easy to understand	☐	☐
c.	Helpful in what actions to take	☐	☐

Question 4.

Where do you prefer closed captioning to be placed on your television screen?

a ☐ Bottom
b. ☐ Left Side
c. ☐ Right Side
d. ☐ Top

Question 5.

How would you rate the quality of the captioning during a live weather broadcast?

a. ☐ Good b. ☐ Fair c. ☐ Poor

Question 6.

Below is a list of emergency alert/warning devices. Please check any that you have.

a. ☐ Smoke Alarm only
b. ☐ Smoke Alarm with Strobe Light
c. ☐ Smoke Alarm with Vibration
d. ☐ Weather Alert Radio only
e. ☐ Weather Alert Radio with Strobe Light
f. ☐ Weather Alert Radio with Vibration
g. ☐ Other (please specify):___________________

Question 7.

Please indicate reasons for NOT using the emergency alert/warning devices.

DEVICE	**Too Expensive**	**Do Not Know Where To Buy**	**Did Not Know About Device**	**Do Not Need This Device**
Smoke Alarm with Strobe Light	☐	☐	☐	☐
Smoke Alarm with Vibration	☐	☐	☐	☐
Weather Alert Radio with Strobe Light	☐	☐	☐	☐
Weather Alert with Vibration	☐	☐	☐	☐

Question 8.

Please check the alert/warning device you would like help setting up.

a. ☐ Do not need help setting up alert/warning device
b. ☐ Smoke Alarm
c. ☐ Weather Alert Radio

Question 9.

Please check any of the emergency preparedness classes you have completed.

a. ☐ Community Emergency Response Team (CERT)
b. ☐ CPR
c. ☐ First Aid
d. ☐ Have not completed any emergency preparedness classes
e. ☐ Personal Preparedness Training/Education (FEMA, Red Cross, etc.
f. ☐ Severe Weather / Storm Spotter
g. ☐ Other (please specify):___________________________________

Question 10.

Please check any of the emergency preparedness classes you are interested in taking.

a. ☐ Community Emergency Response Team (CERT)
b. ☐ CPR
c. ☐ First Aid
d. ☐ Not interested in taking any emergency preparedness classes
e. ☐ Personal Preparedness Training/Education (FEMA, Red Cross, etc.
f. ☐ Severe Weather / Storm Spotter
g. ☐ Other (please specify):___________________________________

Question 11.

In the past 30 days, have you seen any messages or announcements telling people how to prepare if an emergency occurs in your community?

a. ___No

b. ___Yes

If you answered Yes, where did you see it? ______________________________________

Question 12.

If you have an emergency/disaster supply kit at your home, which of the following items are in your kit?

a. ☐ I do not have an Emergency/Disaster Supply Kit
b. ☐ 3 day supply of food
c. ☐ 3 day supply of medicine
d. ☐ 3 day supply of water
e. ☐ Extra batteries
f. ☐ First Aid Kit
g. ☐ Flashlight

Question 13.

Do you have a Family Emergency Response Plan?

a. ___No

b. ___Yes

Question 14.

How do you identify yourself?

a. ☐ Deaf
b. ☐ Deaf Blind
c. ☐ Hard of Hearing
d. ☐ Late Deafened
e. ☐ I do not have hearing loss
f. ☐ Other (please specify): ____________________________________

Question 15.

What is your primary mode of communication?

a. ☐ Cued Speech
b. ☐ Sign Language
c. ☐ Writing
d. ☐ Other
e. ☐ Other (please specify): ____________________________________

Question 16.

What is your primary language?

a. ☐ American Sign language (ASL)
b. ☐ English
c. ☐ Spanish
d. ☐ Other (please specify): ___________________________________

Question 17.

What is your age? __________

Question 18.

What is your gender? ___Female ___Male

Question 19.

What is your race?

a. ☐ American Indian
b. ☐ Asian or Pacific Islander
c. ☐ Black
d. ☐ Eskimo or Aleut
e. ☐ Hispanic / Latino
f. ☐ White
g. ☐ Other (please specify): ___________________________________

Question 20.

What is your zip code? __________________

Appendix 3: Northumbria University Research Project: Ethics Registration and Approval Form

northumbria UNIVERSITY School of the Built Environment

RESEARCH PROJECT: ETHICS REGISTRATION AND APPROVAL FORM

Section One: Registration *To be completed by researcher*

Project Title	Efficacy of Community Education Programmes Influencing Public Reception and Response Behaviour Factors Related to Tornado Warning Systems
Researcher's name	John Walsh......
Programme of study	- PhD................(if researcher is a student)
Supervisor's name	- Dr. Andrew Collins.......(if researcher is a student)
Short description of research project and methods	

The main aim of this thesis is to analyse the impact of disaster risk education programmes on community preparedness levels and response behaviours relative to tornado early warning systems (EWS). This involves understanding the relationship between the tornado EWS, emergency management, the community and an educational programme. These aspects form parts of the design of implementation approaches that are to impact on citizen response to reduce injury and death from tornado hazard. The practical rationale behind this research is that beyond warning and informing, better understanding of the needs and requirements for alerting, preparing and protecting the community will further the development of improving wellbeing, including through the encouragement of more participatory community-based strategies from governing bodies.

The methodology for the research will use a mixed method and triangulated approach in an effort to expand on quantitative and qualitative data. The research will include two separate sampling populations, 1) a sample selected from emergency manager professionals, and 2) a sampling selected from the general population. The emergency manager group will be selected from a systematic random sampling drawn from local metropolitan and county emergency managers within the state of Tennessee. The general population sampling will be selected using a random sampling drawn from individuals residing within the Metropolitan Statistical Area of Nashville, Tennessee, USA. The research design will include development of a survey questionnaire for distribution to both populations. Focus groups made up of participants from each sampling category will be used to develop and test question design and structure for inclusion in the survey questionnaires. Following collection of data from the questionnaire, follow up focus groups from one or both sample populations may be conducted to confirm or compare data analyses.

Ethical considerations in the research project

1. Does your research involve human participants? Yes

If yes

2. Will you inform the participants about the research? Yes

3. Will you obtain their consent using the standard consent form? Yes

4. Is any deception involved? No

5. Do any participants constitute a 'vulnerable group' (e.g. under 18 years of age?) No

6. Will the research involve commercially/personally/ politically sensitive information? No

7. Are there likely to be any risks for you or for the participants in your research? No

8. If yes [to 3, 4, 5, 6 or 7 above] have you identified steps to address the issues? Yes

Statement by researcher

This statement should explain how any issues identified in the answers to the above questions will be addressed

Prior to subjecting any potential participant in either a focus group or as a recipient of the survey questionnaire, each participant will receive a standardised Informed Consent Form giving consent to participation in the research. Consent forms will be distributed to all potential participants of any interview, observation or any other form of participation that may be used within the research study. In addition, each participant will be given an Information Sheet describing the aim of the study, how the information gathered will be used, what the anticipated distribution of the information will be, and that their participation is voluntary and that they may withdraw from participating at any time. The information sheet will also include the name and contact information of the researcher.

I have read the University and the School Ethics Policy and Procedures and confirm that the answers I have given above are correct. Where further issues arise under items 3, 4, 5, 6 or 7 [above] I have described in writing how I intend to approach these issues in the research.

Researcher's signature **Date 10/5/11**

northumbria UNIVERSITY School of the Built Environment

RESEARCH PROJECT: ETHICS REGISTRATION AND APPROVAL FORM

Section Two: Approval

To be completed by the following academic staff:

- *Research by academic staff and Postgraduate Research students: Dean, Associate Dean, Professor or Reader*
- *Research by students on taught undergraduate and postgraduate programmes: Module tutor or dissertation/project supervisor*

Project title **Efficacy of Community Education Programmes Influencing Public Reception and Response Behaviour Factors Related to Tornado Warning Systems**

Researcher's name **John Walsh**

Programme of study **PhD** .... (if researcher is a student)

Supervisor's name **Dr. Andrew Collins** .... (if researcher is a student)

Ethical category of research project

Red ☐ **Amber** ■ **Green** ☐ (please tick)

[Red: Vulnerable participants, sensitive data, risks to participants or researchers, NHS, clinical trials etc

Amber: Human participants, personal data, environmental issues, commercially sensitive information

Green: Other projects

for full definitions see University Research and Ethics Governance Handbook]

Ethical approval

(please tick appropriate boxes)

☐ 1. Ethical approval is given without conditions NO

☐ 2. Ethical approval is given with the following conditions YES

☐

I. Information provided to participants YES

☐ II. Participant consent to be obtained using the standard Research Participant Consent

☐ Form or otherwise in accordance with School procedures YES

☐ III. Data is stored securely in accordance with University guidelines YES

IV. Other (please state) NO

☐

3. Project is referred to SREC for approval NO

Name (of member of staff)…Andrew Collins…………………………………….   Signature Andrew Collins ……………Date ………………………………16th May 2011
Outcome of SREC referral – Decision, minute and date of meeting

Appendix 4: Vanderbilt University IRB Approval Letter

Vanderbilt University

Institutional Review Board

504 Oxford House
Nashville, Tennessee 37232-4315
(615) 322-2918 Fax: (615) 343-2648
www.mc.vanderbilt.edu/irb

October 3, 2012

John Walsh, MS
106021 - SON Executive
106021 - SON Executive
Michael L. Freeman
Radiology -
Radiation Oncology
B-902 TVC 37232

RE: IRB# 121427 "Efficacy of Community Education Programs Influencing Public Reception and Response Behavior Factors Related to Tornado Warning Systems"

Dear John Walsh, MS:

A designee of the Institutional Review Board reviewed the Request for Exemption application identified above. It was determined the study poses minimal risk to participants. This study meets 45 CFR 46.101 (b) category (2) for Exempt Review. Approval is extended for the Request for Exemption application dated 10/01/2012 for Principal Investigator John Walsh, MS.

Any changes to this proposal that may alter its exempt status should be presented to the IRB for approval prior to implementation of the changes. In accordance with IRB Policy III.C, amendments will be accepted up to one year from the date of approval. If such changes are requested beyond this time frame, submission of a new proposal is required.

DATE OF IRB APPROVAL: 10/03/2012

Sincerely,

Ashley Grooms

Ashley Grooms, MA
Behavioral Sciences Committee

ABG

Electronic Signature: Ashley Grooms/VUMC/Vanderbilt : (14808CF54FE937035A1862D07DF2A917)

Signed On: 10/04/2012 10:54:15 AM CDT

Walsh, John IRB # 121427 10/04/2012

Appendix 5: Emergency Management Survey Description

Emergency Management Survey Description

Studies devoted to the social science aspects of disaster research have shown an important correlation between the perception of risk, reception and understanding of the warning message, and an individual's informed decision to take appropriate responsive action based on receiving information. As an emergency management professional, you are being asked the following questions in order to determine how we can better inform the public of threats involving tornadic activity, and identify better ways we can assist in making it clearer for the public to understand and interpret the information they receive.

Question 1.

The following is a list of methods/tools used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 10 being the least important.

a. ___Alert FM
b. ___Cellular phone/text messaging
c. ___Emergency Alert System
d. ___HAM radio
e. ___Mass telephone notification (Reverse 911)
f. ___NOAA Weather Radio
g. ___Social media (Facebook, Twitter, other similar media)
h. ___SMS text via cell phone
i. ___Tornado siren
j. ___Web/Internet
k. ___Other (check)
If other, please specify: ____

Question Rationale:

The U.S. weather enterprise is comprised of multiple dissemination methods when severe weather alerts such as Tornado Warnings are issued by the National Weather Service. However, knowing which sources emergency managers consider as important and effective as alert and warning disseminators provides information that help determine what the specialists in the field perceive as better methods to be used. The distinction between what government perceives as effective methods of warning dissemination and what specialists in the field deem important may be significant. The design of the question is looking at effective message dissemination as opposed to accepting what has evolved from influences that may or may not indicate what is working or needed from a local perspective.

Supporting References:
Research related to communication methods addressing alerting and warning message dissemination.

Expected Responses:
This question should provide an indication of what methods being used to disseminate alerting and warning messages are considered more effective or more utilized in the field. The list of choices is common but the ranking of importance should remain consistent for the top five and then will more likely be dispersed for the remainder. Obviously variation may occur depending on the locale but some patterning should surface related to certain methods as being viewed as more effective than others. Those methods least selected in the higher rankings may indicate the lack of usefulness of the method or is a less evolved method for dissemination.

Question 2.

The following is a list of sources used to communicate severe weather alerts such as tornado warning information to the public. In your opinion, rank them in order of importance, with 1 being the most important and 9 being the least important.

a. ___911 Dispatch
b. ___Contract weather service
c. ___Live radio broadcast
d. ___Live TV broadcast
e. ___Local Emergency Management Agency
f. ___National Weather Service
g. ___State Emergency Management Agency
h. ___Storm spotters
i. ___The Weather Channel
j. ___Other

If other, please specify: ____

Question Rationale:

This question is similar to question #1 but is asking for information related to sources of alerting and warning message dissemination as opposed to methods. One identified problem with message dissemination within the U.S. weather enterprise is the coordination of sources. This private/public partnership often creates conflicts and over sensationalising, such as market share issues affecting TV and radio broadcast competition. The public is often left confused as to how severe the situation actually is, desensitized to the frequently of the alerts and warnings, and inundated with the issuance of false-positive alerting information. Gaining a clearer perception of what is considered an important source for local emergency managers may provide identification of further research focus to address the sourcing problems related to alerting and warning protocols.

Supporting References:

Research related to communication sources addressing alerting and warning message dissemination.

Expected Responses:

The top 2 or 3 selection will probably remain consistent for most respondents. The variances that develop may be interesting. Identification of what sources emergency managers rely on for receiving their alerting information as important will shed light on what aspects of the system are seen as effective sources. Those of lower ranking may either indicate problem areas or identify sources that are viewed as least effective or lower performing alerting sources.

Question 3.

Please indicate the level of your agreement on a scale of 0 to 4 with 0 being "Completely disagree" and 4 being "Completely agree."

4	3	2	1	0
Completely Agree	**Generally Agree**	**No Opinion**	**Generally Disagree**	**Completely Disagree**

a. Emergency management should take a more active role in public education campaigns directed toward tornado preparedness.

4 3 2 1 0

b. Existing tornado education/training materials (***provided by*** FEMA, NWS, ARC, etc.) being used are effective for preparing the public.

4 3 2 1 0

c. Local broadcast TV/radio does an effective job in informing the public of tornado preparedness actions to take during a tornado occurrence.

4 3 2 1 0

d. More emphasis on tornado preparedness education should be conducted in our schools.

4 3 2 1 0

e. Current severe weather alerts such as tornado warnings are adequate in preparing citizens to take protective actions during a tornado occurrence.

4 3 2 1 0

f. The public needs to understand the differences between warning terminology, specifically "tornado watch" versus "tornado warning."

4 3 2 1 0

Question Rationale:

This is a multi-focused question that covers several different alerting topics addressing disaster education, training materials, effectiveness of TV and radio alerting, understanding of terminology, and protective action. The purpose is to gather data on several different areas that are relevant to alerting protocols and system construction. Receiving feedback from local emergency management specialists provides perspective regarding perceived roles, warning system functionality, some insight as to the effectiveness from the emergency management viewpoint regarding disaster education.

Supporting References:

Disaster research related to warning terminology, education emphasis and alerting and warning message dissemination and reception.

Expected Responses:

Question “a” will probably have mixed results. In emergency management circles, the role of emergency managers in training the public is under debate. Some local managers are heavily involved in public education programs and other feel it is the responsibility of other segments of the responder community. However, most will answer in the affirmative. Question “b” responses will lean to the affirmative side. Managers generally are not familiar with educational development and may leave the “effectiveness” issue regarding the instructional materials to learning specialists. The reputation of the agency will stand on its own. Empirically, whether the materials are educationally beneficial will remain a substantive question to answer. It is anticipated that Question “c” will be widely disputed. This is an area of considerable discussion. The competitive nature of the market share for audience attention is considerable and according to TV and radio weather meteorologists, weather related production plays a big factor in market share. It will be interesting to explore the emergency management perspective of this question. Question “d” will most likely be in the affirmative. The perception of the general public is that schools play an overall and significant role is forming personal behaviour related to school age children, emergency managers will likely agree. The limited disaster education research tends to follow this belief. Question “e” will likely fall in the negative category. The numbers of deaths and injuries resulting from tornadic activities over the past years have raised an increase concern regarding the lack of, or perceived lack of, protective response to tornado hazards. Recent research regarding this is identifying data that indicate current alerting is having marginal impact. The lack of comparative studies has led to a gap in this research area but earlier studies on alerting and warning processes and risk awareness seems to validate some accepted conclusions. Question “f” is attempting to study the belief that the general public is still unclear concerning some fundamental weather alerting and warning terminology, specifically related to tornado activity. The sentiment is that emergency managers believe this to be true as well.

Question 4.

In those situations where an individual does not heed a tornado warning in a timely manner, rank the following factors you think contribute to their non-responsiveness? Please indicate the level of your agreement on a scale of 0 to 4, with 0 being "Completely disagree" and 4 being "Completely agree."

4 Completely Agree	3 Generally Agree	2 No Opinion	1 Generally Disagree	0 Completely Disagree

a. Confusion over the severe weather alerts such as tornado watches/warnings

4 3 2 1 0

b. Desensitization due to the frequency of Alert

4 3 2 1 0

c. Desensitization to the perceived frequency of siren activation (where used)

4 3 2 1 0

d. Do not understand the protective steps to take regarding tornado precautions

4 3 2 1 0

e. Familiarity with seasonal weather patterns in their locale

4 3 2 1 0

f. Lack of understanding of the threat

4 3 2 1 0

g. Media sensationalizing

4 3 2 1 0

h. Public complacency

4 3 2 1 0

i. Warning notification redundancy

4 3 2 1 0

Question Rationale:

A major issue continues regarding why or why not individuals respond in a timely manner to hazard alerts and warnings. Considerable research over the last 60 years has attempted to understand this phenomenon of human behaviour and risk perception. This question attempts to further that understanding by asking emergency management professionals their perception of the causes for responding or not responding. As the U.S. weather warning system evolves there is still much debate to the solution for having individuals respond more appropriately. Although this questionnaire addresses only the emergency management perspective, it's a question focus that has been researched from a limited standpoint. Over alerting and desensitisation, confusion of terminology use, complacency and redundancy are on-going issues that seem to be at the forefront of the issue currently. Better understanding of the causal factors and relationships between each of these variables need further exploration and is the purpose of this line of questioning.

Supporting References:
Alerting and warning research, communication factors related to alerting and warning studies, and risk awareness/perception research. (Example, NWS May 2011 Joplin Tornado report)

Expected Responses:
Because much of the dissemination methods include use of private sector competitive enterprises it is anticipated that overexposure and desensitisation to alert messages will be highly selected. The need for further verification of the threat, in addition to the primary alerting message, seems to be a general trend. One cause for this may be overexposure caused from redundancy by commercial weather reporting, which lead to human desensitisation and complacency to hazard risk.

Question 5.

In thinking about who should be responsible for educating the public in tornado preparedness, how would you rate the following sources' level of responsibility for preparedness education? Please indicate their level of responsibility on a scale of 1 to 4, with 1 indicating "Not responsible" to 4 indicating "Very responsible." Selecting 0 will indicate "No opinion."

4 Very Responsible	3 Somewhat Responsible	2 Less Responsible	1 Not Responsible	0 No Opinion

a FEMA (Federal Emergency Management Agency)

4 3 2 1 0

b. Local Broadcast Radio

4 3 2 1 0

c. Local Broadcast Television

4 3 2 1 0

d. Local Emergency Management Agency

4 3 2 1 0

e. Local Government

4 3 2 1 0

f. Non-governmental Organizations (Red Cross, VOAD, faith-based)

4 3 2 1 0

g. National Weather Service (NWS)

4 3 2 1 0

h. Private Industry

4 3 2 1 0

i. Schools

4 3 2 1 0

j. State Emergency Management Agency

4 3 2 1 0

Question Rationale:

Disaster education is a concept that continues to elude substantive, evidence-based research. This leads to general conclusions that disaster education is relevant to preparedness and response solutions for making a more safe environment. However, just how effective current education approaches are is for the most part speculative. This question is designed to explore the functional aspects of what disaster education really is and who should take more responsibility in educational approaches. Each of the question items addresses an organizational entity that plays a particular role within the current system in providing disaster education to the public in some manner. Whether this evolutionary configuration satisfactorily contributes to the safety of the public is, at best, open for discussion. Determining how disaster education relates to severe weather should be further studied. This is an important continuation of the development of the weather enterprise/alerting and warning paradigm.

Supporting References:
Disaster education research, resiliency and sustainable development

Expected Responses:
The question should raise an interesting aspect to disaster education. Local emergency management may look at this as a primary responsibility of the federal government, namely the National Weather Service (NWS) or the Federal Emergency Management Agency (FEMA), while their local role in educating as secondary. The current system is a mix of public/private sector sharing with development of the educational materials related to severe weather, a federal government and/or non-governmental organization product. Local TV and radio media provide some lead in this as well. Emergency managers may determine that schools should play an important role; not necessarily as a responsibility shift but as a positive extension of schools viewed as important to the development of community resilience.

Question 6.

Several of the past tornado seasons produced a significant number of tornadic events that resulted in a high occurrence of tornado related deaths and injuries in parts of the U.S. As an emergency management specialist, how would you improve the system to obtain more effective notification and greater public response to server weather alerts such as tornado warnings?

Question Rationale:

This question is designed to provide an opportunity to capture the emergency manager's perception and thoughts for improving the severe weather alerting and warning process. During some of the design and testing feedback, emergency managers liked the idea of being asked for their opinion. As in Question 3 the concern will be on response rates requiring written response as opposed to an oral response. Depending on the results, it may be a question for a subsequent focus group. Emergency managers as a group can be quite opinionated. This question hopefully will provide an opportunity gather a local perspective on how we can evolve the weather enterprise differently to operate more efficiently and enhance the protective behaviours of individuals to take action quicker and more appropriately. The data gathered should provide insightful information regarding system functionality but and identify human factors that fall outside of conclusions drawn from earlier studies.

Supporting References:

N/A

Expected Responses:

This is an important question that should generate relevant information as to the emergency management perspective into the workings of the current severe weather enterprise as it affects local operations. Problematic areas will be readily highlighted; areas that are working fairly effectively will be less noted. Over alerting and problems of geo-targeting of alerts will probably be addressed. The National Weather Service will be viewed as a positive aspect of the system but completion interests from local TV and radio media may be identified as a contributor to public confusion and compliancy.

Appendix 6: Deaf and Hard of Hearing Survey Description

Deaf and Hard of Hearing Survey Description

Question 1.

What source do you prefer to receive severe weather alerts, such as tornado warnings? (Check all that apply)

a. ☐ Computer Applications
b. ☐ Highway Message Boards
c. ☐ Internet
d. ☐ Mass Telephone Calls
e. ☐ Mobile Device (cell phone, tablet, laptop)
f. ☐ Television Station
g. ☐ Weather Alert Radio
h. ☐ Other: ____

Question Rationale:

A number of authors have suggested that the mode of communication be improved. This question is designed to capture the methods the HOH population most frequently uses to receive alerts and warnings. The answers will help identify those modes most utilized and provide comparative data whether this population is following the same trends as the general population with respect to age and the communication modes they prefer. Of interest is knowing what transmission modes serve and are used by the HOH community. Usage may give some insight what they are comfortable with and what may be the most effective for them.

Supporting References:

Alert and warning message reception research; disaster communication research

Expected Responses:

TV, mobile devices, and internet will probably be the order of preference; however, age may be an important factor. I suspect that older individuals are going to rely of TV whereas the younger population may rely more on mobile devices and the internet. Weather alert radio may be utilized less frequently because the technology does not lend itself currently to the HOH community.

Question 2.

What actions do you take when there is a severe weather alert, such as a tornado warning in your area?

	YES	NO
a. Communicate with family members	_____	____
b. Don't do anything	_____	_____
c. Go to another location the is safe	_____	_____
d. Stay inside a safe place	_____	_____
e. Turn on Local Television Station	_____	_____

f. Other (please specify)

____

Question Rationale:

The problem with messaging is what is the individual going to do when they receive it? This question may give us some indication whether they understand their options or if there may be a gap or a need for better understanding the alert or warning itself. Perception of risk is important so the intent of the question is to find out what protective action, if any, are they taking. This opens a whole host of questions related to message design and content, effectiveness of dissemination modes, training/education gaps, etc.

Supporting References:

Disaster communication mode research, perception of risk research

Expected Responses:

Answering this question may be based primarily on their personal environment and circumstance. Stay inside in a safe place and evacuation will be the most likely choices. Those of non-English speaking ethnicity may be more prone to communicate with family members. Age again may be a contributing factor in their choice as well. I'm particularly interested to see what the “Other” category may provide. What would be interesting as well is why they took that action. That really is the essential question, but this type of survey format is not conducive to gathering that information. The “Other” category provides an opportunity for some additional information.

Question 3.

If you watch television weather broadcast as a source for receiving severe weather alerts, such as tornado warnings, is the closed captioning....

	YES	NO
a. Could be more detailed as what to do?	_____	_____
b. Easy to understand?	_____	_____
c. Helpful in what actions to take?	_____	_____

Question Rationale:

A major problem area for the hard of hearing involves closed captioning which is provided by some of the television broadcast media during severe weather and tornado coverage. As in most alerting and warning messaging, the content is sometimes confusing, non-instructional (protection), or poorly written for comprehension of the hard of hearing population. This question attempts to identify the types of challenges encountered relative to captioning. In some TV markets, captioning is unavailable.

Supporting References:

Alert and Warning message design and dissemination research; protective behaviour research

Expected Responses:

There mostly likely will be a wide disparity in answers due to the fact that messaging design will generally occur at the local broadcast level. Message content may be limited containing only the alert, providing no additional information relative to the exact location of the alert/warning hazard or containing no protective action information within the message. Most of the discussions in the survey drafting meetings indicate that captioning is not very helpful and requires a lot of rethinking regarding how and why they are utilized.

Question 4.

Where do you prefer closed captioning to be placed on your television screen?

a. Bottom

b. Left side

c. Right side

d. Top

Question Rationale:

Placement of the captioning is an apparent problem area for the hard of hearing population. At times it covers up other important graphic information and there is not any industry standardization relative to placement on the screen. When multiple layers of scrolls, crawls, overlays and captioning occur at the same time the effectiveness of HOH captioning is significantly degraded. Most TV media provide captioning under pressure by advocacy groups. There is very little incentive to provide the service otherwise. If the market share of the HOH community was significant, media outlets may be more attuned to the problem. This may apply to the relationship between communication and protection.

Supporting References:

Message design, dissemination, and reception research; protective behaviour research

Expected Responses:

The expected response will most likely be varied as placement may be an individual preference. The question is intended to provide data that caption placement in its current framework is ineffective without specific industry testing and standardization. In the drafting discussion several solutions to the problem were suggested. Some were quite good but would the costs be justified serving such a small population? Maybe the population numbers would disprove that.

Question 5.

How would you rate the quality of the captioning during a live weather broadcast?

a.___Good   b. ___Fair   c. ___Poor

Question Rationale:

Upon designing and refining the questionnaire a great deal of discussion from the Deaf and hard of hearing community centred on the quality of the captioning of severe weather broadcasting. This is obviously an important issue and needs to be a focus of addition research.

Supporting References:

Message design, dissemination, and reception research; media/communication of warning information; protective behaviour research

Expected Responses:

During the design process of the Deaf and hard of hearing survey questionnaire, much discussion involved relaying of stories on the difficulty in available closed captioning messaging for the hearing loss. Very few positive comments were received so it is anticipated that the majority of the responses will be in the Fair and Poor categories.

Question 6.

Below is a list of emergency alert/warning devices. Please check any that you have.

a. ___Smoke Alarm only

b. ___Smoke Alarm with Strobe Light

c. ___Smoke Alarm with Vibration Device

d. ___Weather Alert Radio Only

e. ___Weather Alert Radio with Strobe Light

f. ___Weather Alert Radio with Vibration Device
g. ___Other (please specify) ____

Question Rationale:
The question is designed to determine 1) what types of alerting and warning devices do the hard of hearing population have and 2) are those devices being used. There doesn't appear to be much statistical data on the types and numbers of devices utilized. The question is important for the HOH community because they want some data justification for acquiring grant funds for purchasing these types of devices.

Supporting References:
Alert and warning message reception research; technology solutions for protection actions; disaster training/education

Expected Responses:
The consensus of the drafting group is that numbers will be low because of the cost constraints associated with purchasing the devices. They feel the unit pricing is somewhere in $100+ range and is prohibitive for the target population. The answers are actually multi-facetted. Accessibility is an issue, as is understanding the purpose and use of the devices. To the hearing population both of these devices are fairly common, at least with smoke alarms.

Possession and use of smoke alarms will probably exceed that of weather alert radios. Low numbers from either may indicate a training/education gap issue.

Question 7.

Please indicate reasons for NOT using the emergency alert/warning devices.

	Too expensive	Don't know where to buy	Did not know about this device	Do not need this device
Smoke Alarm with Strobe Light	___	___	___	___
Smoke Alarm with Vibration Device	___	___	___	___
Weather Alert Radio With Strobe Light	___	___	___	___
Weather Alert Radio With Vibration Device	___	___	___	___

Question Rationale:

This question is searching for the reason why alerting and warning devices are not being used by the HOH population. These data will hopefully assist in obtaining grant funds (HOH group purpose) for purchasing these devices for the HOH community. For my research interest this provides an indication that protection gaps may exist within this population subgroup. Comparing this with data from the general population (if it exists) may lead to some informative conclusions related to significant relational gaps affecting some of the interventions available to the general population and not available to the HOH sub-group population. A number of factors could play a role in addressing this question – economics, lack of political influence, market isolation, etc. This may be stretching it a bit but some of these relationships and intervention possibilities could produce impacts.

Supporting References:

Alert and warning message reception research; technology solutions for protection actions; risk perception; disaster education, preparedness training

Expected Responses:

The reasons why protection devices are or are not utilized is an important source of information that may provide significant ancillary data. The drafting group thinks expense will be major contributor for not acquiring the devices. Answers associated with not knowing about these devices or where to purchase these devices may indicate a training or education gap. Likewise, not feeling a need to be alerted could indicate a training/education gap or a perception of risk issue. Obtaining alerts and warnings in other ways opens up other questions. If they understand the risks, how are they receiving their alerts? Are they doing things that could be used as lessons-learned, best practices, etc.? Do we need to completely change the way we are addressing the needs of this and other special needs populations with regard to alerts and warning; protective response protocols, training/education materials and pedagogy, or create new idea development based on existing research?

Question 8.

Please check the alert/warning device you would like help setting up.

a. ___Do no need help setting up alert/warning device

b. ___Smoke Alarm

c. ___Weather Alert Radio

Question Rationale:

There is a belief in the HOH community that education and training in the use and operation of these devices is significantly lacking. Verifying whether or not this gap exists is important. The inability to use these devices properly, or even at all, may be a greater indication of needs related to hazard education, protection, and/or individual survival skills. The establishment of programs addressing the proper use of alerting devices could greatly enhance the preparedness and response levels of this population.

Supporting References:

Disaster preparedness education/training

Expected Responses:

I suspect there is a high interest from the HOH population for instruction in using these devices for those who have them. The correlation between the number of responses and the number of NO responses against the number of YES responses will be interesting. Comparing those numbers with the HAVE, USE or DON'T USE responses in Question 5 should present some interesting results. Training /education gaps should be identified by the responses to this question as well.

Question 9.

Please check any of the emergency preparedness classes you have completed.

a. ___Community Emergency Response Team (CERT)

b. ___CPR

c. ___First Aid

d. ___Have no completed any emergency preparedness classes

e. ___Personal Preparedness Training/Education (FEMA, Red Cross, etc.)

f. ___Severe Weather / Storm Spotter

g. ___Other (please specify)
If other (please specify) ____

Question Rationale:
There are two objectives to this question, 1) focus on the identification of the types of emergency and preparedness training/education the hard of hearing population is or has attended, and 2) determine if training/education gaps exist.

Supporting References:
Disaster preparedness education/training; preparedness levels

Expected Responses:
There is very little formalized training that is specific to the hard of hearing population, especially addressing preparedness and response training. Even less prevalent is training directed toward weather related hazard. More favourable responses to this question may be in the areas of CPR and first aid training. It would be interesting to compare the general population with the hard of hearing community regarding preparedness and response training. Some secondary data associated with the general population may be available but this not an area that is heavily studied.

Question 10.

Please check any of the emergency preparedness classes you are interested in taking.

a. ___Community Emergency Response Team (CERT)

b. ___CPR

c. ___First Aid

d. ___Not interested in taking any emergency preparedness classes

e. ___Personal Preparedness Training/Education (FEMA, Red Cross, etc.)

f. ___Severe Weather / Storm Spotter

g. ___Other (please specify)

If other (please specify) ____

Question Rationale:

This question is complimentary to Question 9 and seeks to clarify what types of education/training opportunities the Deaf and hard of hearing population would like to have available to them and what specific areas of preparedness they would prefer to participate in. Very little research has been conducted focusing on what the special needs population is wanting. Most of the disaster preparedness materials are driven by top down policy with little true input from the population they are developed for.

Supporting References:

Disaster preparedness education/training; disaster training materials; preparedness levels of special needs populations

Expected Responses:

It is anticipated that the responses will vary widely. The Deaf and hard of hearing community receives very little attention related to disaster preparedness. Their culture (for a variety of reasons) often places them in a position to be hesitant in responding to outside inquiries. They often can be withdrawn in giving their opinions or in addressing their needs. However, they are stimulated when presented the opportunity to participate in disaster drills and the few disaster training opportunities that exist. The areas they identify as becoming important disaster education and training topics will result in new knowledge and data development for better understanding the emergency response and preparedness needs of the hearing loss community.

Question 11.

In the past 30 days, have you seen any messages or announcements telling people how to prepare if an emergency occurs in your community?

c. ___No

d. ___Yes

If you answered Yes, where did you see it? ____

Question Rationale:

This question is designed to capture data regarding if the hearing loss community is interacting with existing emergency messaging modes of communication targeted for the general population.

Supporting References:

Disaster preparedness education/training; communication modes of disaster messaging; preparedness levels of special needs populations; alert and warning message reception research; technology solutions for protection actions; risk perception

Expected Responses:

There is a significant lack of data on how the Deaf and hard of hearing population receives and processes existing emergency messaging information. The data results from this question may be limited but should provide pertinent information as to the effectiveness of this mode of communication is for the hearing loss community.

Question 12.

If you have an emergency/disaster supply kit at your home, which of the following items are in your kit?

a. ___I do not have an emergency/disaster supply kit

b. ___3 day supply of food

c. ___3 day supply of medicines

d. ___3 day supply of water

e. ___Extra batteries

f. ___First Aid kit

g. ___Flashlight

Question Rationale:

Virtually no research data exists regarding preparedness levels of the Deaf and hard of hearing population. The question is designed to begin collection of the data as they relate to preparedness levels and identification of gaps.

Supporting References:

Disaster preparedness education/training; disaster training materials; preparedness levels of special needs populations

Expected Responses:

In the general population preparedness levels for individuals and families who maintain emergency supplies ranges roughly between 30-35 percent depending on the research data available. Because the hearing loss community is even less included in emergency planning functions most likely the responses from the survey will fall below the percentage numbers of the general population.

Question 13.

Do you have a Family Emergency Response Plan?

a. ___No

b. ___Yes

Question Rationale:

This question purpose mirrors that of Question 12. Data is does not exist and will add to the knowledge of existing preparedness levels of the Deaf and hard of hearing population.

Supporting References:

Preparedness levels of special needs populations

Expected Responses:

Responses will most likely reflect those in Question 12 and be less of a percentage than that of the general population having a Family Emergency Response Plan.

Question 14.

How do you identify yourself?

a. ___Deaf

b. ___Deaf Blind

c. ___Hard of Hearing

d. ___Late Deafened

e. ___I do not have hearing loss

f. ___Other (please specify ____

Question Rationale:

This the initial question associated with the target population. There are several categories which define the hard of hearing population. Although the distinctions are clearly characterized from a clinical perspective, individuals may categorize themselves differently depending on age, perceived sense of hearing loss or other individualistic factors and environments. The answers listed cover the recognized categories within the hard of hearing community. From a clinical standpoint the categories of hearing loss may impact the comprehension of the question and the response given.

Supporting References:

Schow RL, Tannahill JC. Hearing handicap scores and categories for subjects with normal and impaired hearing sensitivity. Hearing handicap scores and categories for subjects with normal and impaired hearing sensitivity. J Am Audiol Soc. 1977 Nov-Dec;3(3):134-9. PMID: 149100

http://www.open.ac.uk/inclusiveteaching/pages/understanding-and-awareness/types-of-deafness.php

http://webaim.org/articles/auditory/auditorydisabilities#types

Expected Responses:

Responses will depend on the individual respondent and their hearing loss type.

Question 15.

What is your primary mode of communication?

a. ___Cued speech

b. ___Sign Language

c. ___Speech reading

d. ___Writing

e. ___Other (please specify) ____

Question Rationale:

An individual may use several modes of communication depending on the circumstances they are in and the other individuals they are communicating with. Understanding what mode they use or the frequency of the mode used may provide information on what gaps exists or what modes disaster specialists should consider using more consistently in communicating with the hard of hearing community. Obviously, the one mode fits all concept is not feasible when communicating with this population.

Supporting References:

Unknown

Expected Responses:

Responses will depend on the individual respondent however sign language appears to be the favoured and most prevalent mode of communication. Speech reading is difficult and prone to miscommunications related to a number of factors. The four listed answers are considered the most frequently utilized modes.

Question 16.

What is your primary language?

a. ___American Sign Language (ASL)

b. ___English

c. ___Spanish

d. ___Other (please specify) ____

Question Rationale:

This question is designed to identify the primary language used by respondents in the hard of hearing population. The choices are limited due to the population demographics of the survey region (State of Tennessee). The "other" category should capture data involving other languages. It is anticipated that the survey may be printed in Spanish due to the population numbers. Very little data exist related to the Hispanic hard of hearing population and this is one area where statistics may be valuable for a number of reasons.

Supporting References:

Unknown

Expected Responses:

ALS will probably rank first followed by English and Spanish. However, since there is relatively little known about the Spanish speaking HOH community the data gathering from this category will be interesting depending on the number retrieved. This sub-group within the HOH population is expected to have significant needs in general and specifically when related to emergency preparedness and severe weather alerting challenges.

Question 17.

What is your age? __________

Question Rationale:

The age covariate will be used to look at influences age may play with any of the multiple variables or factors derived from the essential and corollary questions asked in the survey. Depending on the specific data gathered, the influence of age may or may not be viewed as important. Age may have an impact on the method preferred for receiving alerts and warnings or it may influence what actions one takes during a severe weather alert or tornado warning. The results of the statistical tests performed with help determine if relevant and significant data are revealed. This suggests that the continuous number response would be more effective in the analyses.

Supporting References:

Disaster research related to age variables

Expected Responses:

At this point it is difficult to determine what will result in significant discoveries related to age. How age influences certain variables in the HOH community within this study is basically unknown at present. Possibly sources (Q1), actions (Q2), acquisition and use of warning devices (Q6), failure to use alerting and warning devices (Q7), and training/education (Q9, Q10) may be subject to age influences.

Question 18.

What is your gender? ___Female ___Male

Question rationale:

This is similar to question 17 related to age. This may only be pertinent with regards to gathering demographic data associated with the hard of hearing population. The drafting group knows of very little information statistics related to the HOH sub-group.

Supporting References:

Disaster research related to gender variables

Expected Responses:

Clearly demographic in nature. There may be other studies that address gender significance possibility.

Question 19.

What is your race?

a. ___American Indian

b. ___Asian or Pacific Islander

c. ___Black

d. ___Eskimo or Aleut

e. ___Hispanic / Latino

f. ___White

g. ___Other (specify)_______________________________________

Question Rationale:

Again, data appears to be sketchy with regards to data collected regarding the ethnicity demographics of the hard of hearing population, especially making up the Tennessee sub-group. The answers follow the selection classifications established by the U.S. Census Bureau. Under the Census criteria Hispanic/Latino is technically classified as "Other", however there are several specific classifications of this particular group as Spanish speaking in other additional information collected by the Census Bureau. For my specific needs the listed answers are adequate.

Supporting References:

Disaster research related to race variables

Expected Responses:

It is expected that the answer profile will follow along the lines of the general population.

Question 20.

What is your zip code? _________________

Question Rationale:

This question is designed to capture the location demographics of the hard of hearing population in Tennessee. The use of zip code will provide enough specificity to either attach residency to a city or municipality or to a county depending on the need. The HOH community will use this data for grant purposes and in looking at urban/rural population numbers.

Supporting References:

N/A

Expected Responses:

This will provide new HOH population demographic information. Solely dependent on individual respondents.

Appendix 7: Deaf Population of the United States

Local and regional deaf populations

Holt and Hotto, in *Demographic aspects of hearing impairment: questions and answers*, say that demographic statistics for individual U.S. states and localities are not available, due to deficiencies in current demographic sampling surveys.

However, the Bureau of the Census has made its own estimates for both deaf and hard of hearing populations in each of the 50 U.S. states and the District of Columbia. These estimates shown below have been extracted from the Bureau's many charts posted on the World Wide Web, and compiled here. Note: When using this data, it must be remembered that it is *not* based on any actual counting of deaf people, and could be different from reality.

Some other estimates or "guesstimates" may (or may not) be available from the various state associations of the deaf and/or the state office on deafness, if the state has one. The *American annals of the deaf* annual directory issue (no.2 of each year) lists the addresses of each state association of the deaf under "Organizations and Associations--National Association of the Deaf". In the same *AAD* issue, under "Regional and Local Programs", are listed various agencies, some of which may be able to provide estimates for their areas.

The following figures are model-based **estimates** based on **American Community Survey 1-Year Estimate** data for **2012**, for "non-institutionalized civilians" (e.g., those in the prison system are not counted). This is the latest information available as of February 2014. All of this data is available at Census.gov and the Annual Disability Statistics Compendium for 2013, in Table 1.8, covering working-age civilians, ages 18-64. For a discussion on why this limit is imposed, see page 6 in the NTID Collaboratory report.

Note that the U.S. Census Bureau identifies only "hearing difficulty" in its ACS estimates; as such, the following figures are estimates that include a wide range of hearing loss from deafness to "slight difficulty hearing on the telephone."

State	Population ages 18-64 with hearing disability (est)	Total population ages 18-64 (est)	Deaf pct (est)
Alabama	83,376	2,937,335	2.8
Alaska	16,552	460,946	3.6
Arizona	82,244	3,866,694	2.1
Arkansas	52,197	1,761,365	3.0
California	363,508	23,798,381	1.5
Colorado	67,322	3,270,163	2.1
Connecticut	36,730	2,233,159	1.6
Delaware	9,656	561,217	1.7
District of Columbia	4,412	442,390	1.0
Florida	211,049	11,578,613	1.8
Georgia	118,214	6,117,277	1.9
Hawaii	15,857	833,610	1.9
Idaho	27,539	944,959	2.9
Illinois	126,710	8,006,505	1.6
Indiana	98,209	3,998,258	2.5
Iowa	37,882	1,862,753	2.0
Kansas	42,974	1,729,836	2.5
Kentucky	82,461	2,685,735	3.1
Louisiana	78,451	2,804,831	2.8
Maine	25,705	830,767	3.1
Maryland	55,235	3,708,246	1.5

Massachusetts	70,648	4,246,935	1.7
Michigan	137,702	6,104,749	2.3
Minnesota	63,688	3,344,084	1.9
Mississippi	49,323	1,783,844	2.8
Missouri	99,982	3,661,457	2.7
Montana	16,554	616,796	2.7
Nebraska	24,715	1,121,006	2.2
Nevada	38,405	1,705,729	2.3
New Hampshire	18,443	844,577	2.2
New Jersey	69,426	5,520,629	1.3
New Mexico	38,856	1,246,884	3.1
New York	185,731	12,402,577	1.5
North Carolina	130,610	5,966,410	2.2
North Dakota	9,476	436,041	2.2
Ohio	159,814	7,076,483	2.2
Oklahoma	71,442	2,281,244	3.1
Oregon	160,899	2,428,162	2.8
Pennsylvania	164,601	7,867,912	2.1
Puerto Rico	58,198	2,218,215	2.6
Rhode Island	12,427	666,700	1.9
South Carolina	67,426	2,868,533	2.3
South Dakota	14,074	499,064	2.8
Tennessee	103,809	3,971,009	2.6
Texas	357,574	15,858,474	2.3
Utah	30,716	1,677,068	1.8
Vermont	10,868	401,075	2.7
Virginia	79,940	5,085,461	1.6
Washington	105,878	4,321,655	2.4
West Virginia	47,463	1,140,973	4.2
Wisconsin	70,800	3,542,388	2.0
Wyoming	10,256	358,028	2.9
Total	4,022,334	195,697,202	2.1

Deaf people, as deaf people, have not been counted in the U.S. Census since 1930. The last census of the U.S. deaf population was privately conducted in 1971, sponsored by the National Association of the Deaf. For figures since then, only estimates are available.

Note that the Gallaudet Research Institute conducts demographic surveys only for deaf and hard of hearing children of school age. It does not manage surveys of the adult deaf and hard of hearing population. Nonetheless, because of repeated inquiries, it has developed its own rough estimates based on 1997-2003 data:

	"Have hearing problems" (includes both deaf and hard of hearing)	
Total U.S. population: 294,043,000	38,225,590	13%
>6 years old	691,883	1.81%
Ages 18-34:	2,309,000	3.4%

67,414,000		
Ages 35-44: 38,019,000	2,380,000	6.3%
Ages 45-54: 25,668,000	2,634,000	10.3%
Ages 55-64: 21,217,000	3,275,000	15.4%
Ages 65 and over: 30,043,000	8,729,000	29.1%

How many of the above are specifically deaf and not hard of hearing? Note how the numbers in the Gallaudet Research Institute's figures from an older analysis, below, change depending on which of three different definitions of "deaf" is used:

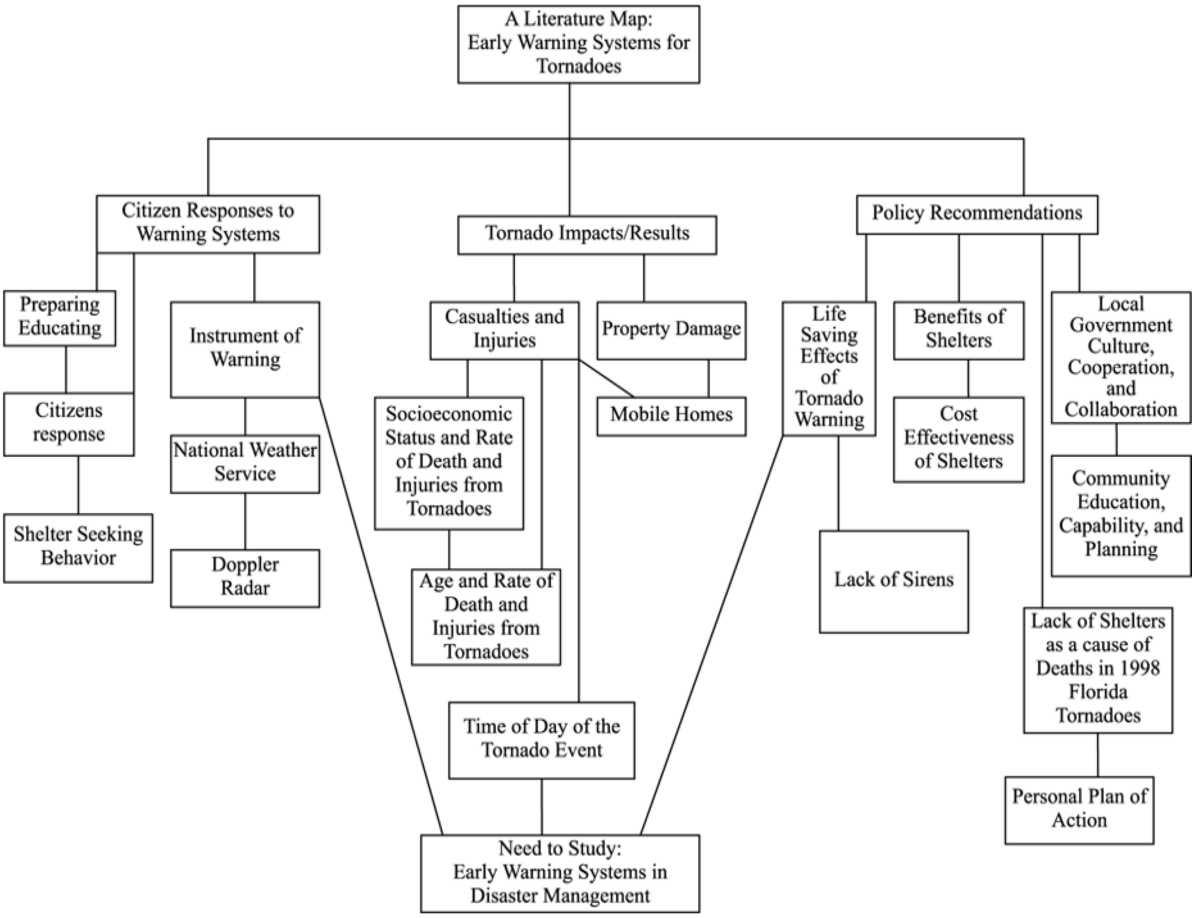
Deaf (definition: "in both ears"	421,000	0.18%
Deaf (definition: "cannot hear and understand any speech"	552,000	0.23%
Deaf (definition: "at best, can hear and understand words shouted into the better ear")	1,152,000	0.49%

The Gallaudet Research Institute offers additional breakdowns of these figures in *Demographic aspect of hearing impairments: questions and answers, third edition*, http://research.gallaudet.edu/Demographics/factsheet.php.

* * * * * * * * * * *

Prepared by Tom Harrington
Reference and Instruction Librarian
July, 2004
Updated: June, 2010
Updated: February 2014

Appendix 8: Literature Map: Early Warning Systems for Tornadoes



Source: Unknown

Appendix 9: Deaf and Hard of Hearing Interview/ Focus Group Release Document

INFORMED CONSENT FORM

As a participant in this interview, you should understand the following:

1. You may decline to participate or withdraw from participation at any time without consequences.
2. Your identity will be kept confidential.
3. John Walsh, the researcher, has thoroughly explained the parameters of the research study and all of your questions and concerns have been addressed.
4. The group interview is recorded; you must grant permission for the researcher, John Walsh, to digitally record the interview. You understand that the information from the recorded interviews may be transcribed; however, the researcher will structure a coding process to assure that anonymity of your name is protected.
5. Data will be stored in a secure and locked area. The data will be held for a period of 3 years and then destroyed.
6. The research results will be used for publication.

"By signing this form you acknowledge that you understand the nature of the study, the potential risks to you as a participant, and the means by which your identity will be kept confidential. Your signature on this form also indicates that you are 18 years old or older and that you give your permission to voluntarily serve as a participant in the study described."

Signature of the interviewee ______________________________ Date _____________

Signature of the researcher _______________________________ Date _____________

Appendix 10: Emergency Manager Survey Introduction Email

Dear Emergency Manager:

My name is John Walsh and I am an Assistant Professor and Assistant Director at the National Center for Emergency Preparedness at Vanderbilt University in Nashville. I am asking for your participation in a research study to better understand the U.S. severe weather/tornado early warning system (EWS). The unusually high number of tornado related deaths and injuries experienced these past few years emphasizes the continued need to study why individuals do or do not respond to tornado warnings in a timely manner. Understanding what we can do differently to improve public warning response is of vital importance and the primary focus of this research.

You were selected to participate in this study specifically because of your expertise within the emergency management field. The importance of your professional knowledge and individual perspective is a vital component for learning what we can do to disseminate better warnings and assist the public in making better-informed decisions in taking proper actions under tornado or severe weather conditions.

Things you should know if you take the survey:

- You may decline to take the survey, participate or withdraw from participation at any time without consequences.
- Data from the survey will be stored in a secure and locked area. The data will be held for a period of 3 years and then destroyed.
- No personal identification information will be asked for or collected.
- The research results will be used for publication.

If you wish to take the survey (or wish to have someone knowledgeable from your agency take the survey), please click this ***LINK*** below.

https://www.surveymonkey.com/s/NRH6HJC

The survey questionnaire consists of only **six (6) questions** and should only take a short time to complete.

As part of the emergency management profession, your input into this research will greatly assist in furthering the development of knowledge for better addressing the impacts related to warning response. If you have any questions, please feel free to contact me at your convenience.

Thank you for your consideration and participation.

John J. Walsh, Jr.

Assistant Professor
Assistant Director
National Center for Emergency Preparedness
Vanderbilt University
461 21st Avenue, South
014 Godchaux Hall
Nashville, TN 37240-1104

Appendix 11: Questions Relevant to Emergency Management Operations Tornado Early Warning System (EWS)

Questions Relevant to Emergency Management Operations

1. What issues should emergency managers focus on regarding the Tornado EWS?

2. Which community related issues are primary concerns for emergency managers?

3. What role do emergency managers play in the development and dissemination of tornado warning messages?

4. From a conceptual standpoint, what aspects or segments of the tornado EWS would you alter or reinforce?

5. What function does the emergency manager play within the tornado EWS?

6. Identify, if any, the challenges which exists for emergency managers in properly educating the general public regarding tornado EWS.

7. Do any major gaps exist in the current system; if so, what are they?

8. What do you believe is the most effective method for getting people to respond to tornado warnings?

Appendix 12: Survey E-mail Contact List for the

Deaf and Hard of Hearing Survey

Email Contact List for

Agencies Serving the Deaf and Hard of Hearing (by County)

Benton County

Hear Now - Starkey Hearing Foundation

Memphis Oral School for the Deaf

Mid South Lions Sight And Hearing Service

Tennessee School for the Deaf

TREDS (TN Deafblind Project)

West Tennessee Hearing and Speech Center

West Tennessee School for the Deaf

Carroll County

Jackson Center for Independent Living

Fayette County

ASL, As a Second Language

DeafConnectMid-South, Inc.

Davidson County

Vanderbilt Bill Wilkerson Hearing & Speech Center

Tennessee Association of the Deaf

Cheatham County

Brentwood Hearing Center

Nashville TN Registry of Interpreters for the Deaf (NTRID)

Cumberland County

Knoxville Center of the Deaf

Anderson County

Hearing & Speech Foundation, The

Hearing Loss Association of America, Knoxville Chapter

Bledsoe County

Audiology Services of Chattanooga

Speech and Hearing Center, Chattanooga

Carter County

Communication Center for the Deaf and Hard of Hearing

Hamilton County

Partnership for Families, Children, & Adults - Services for the Deaf and Hard of Hearing

Hearing Loss Association of America, Chattanooga Chapter

Knoxville County

University of Tennessee, Hearing & Speech Center

Statewide

Bill Rice Ranch Inc

Appendix 13: EM Interview/Focus Group Informed Consent Form

Emergency Manager Interview/Focus Group Release Document

You are being asked to participate in research designed to better understand community preparedness levels and response behaviors related to the U.S. severe weather/tornado early warning system (EWS). The current "weather enterprise" utilized within this system is comprised of a complex set of relationships integrating the tornado EWS, the National Weather Service, local emergency management, the community and various disaster education components that impact citizen responses involving severe weather. The unusually high number of tornado related deaths and injuries experienced these past few years emphasizes the continued need to study why individuals do or do not respond to tornado warnings in a timely manner. Understanding what we can do differently to improve public warning response is of vital importance and the primary focus of this research.

You were selected to participate in this study specifically because of your expertise within the emergency management field. The importance of your professional knowledge and individual perspective is a vital component for learning what we can do to disseminate better warnings and assist the public in making better informed decisions in taking proper actions under tornado or severe weather conditions. You will be asked a few questions designed to add explanation to the results of the survey which was conducted as part of this research. Please understand your participation is completely voluntary. I would like to record your answers but your identity will remain completely anonymous. The results of data derived from this research will be published, however all information collected will be strictly confidential, codified and catalogued with non-traceable identifiers.

If you wish to receive a summary of the survey results, please provide me with your personnel contact information (e-mail or mailing address) and a copy will be sent to you.

If you have any questions or would like additional clarification regarding this research, please contact me at your convenience at: 615-322-1553 or by e-mail at john.walsh@vanderbilt.edu. As part of the emergency management profession, your input into this research will greatly assist in furthering the development of knowledge for better addressing the impacts related to warning response.

Thank you for your participation.

John Walsh

I give my permission to be interviewed and to have my voice recorded as part of this research being conducted.

Signature Date

Appendix 14: Interview and Focus Group Dates and Duration

Legend:

- **Int = Individual Interview** **FGI = Focus Group Interview**
- **EMInt = Emergency Manager Interview** **EMFGI = Emergency Manager Focus Group Interview**
- **D/HInt = Deaf/Hard of Hearing Interview** **D/HFGI = Deaf/Hard of Hearing Focus Group**
- **Age is defined in 5 year increments; example >25 = 25-29 years of age**

EMERGENCY MANAGERS

ID	Date	Location	Age	Sex	Duration
EMInt1	4/10/11	Nashville, TN	>60	M	35 minutes
EMInt2	10/10/11	Franklin, TN	>35	M	45 minutes
EMInt3	18/5/12	Nashville, TN	>50	M	20 minutes
EMInt4	13/7/12	Columbia, TN	>50	F	1.5 hours
EMInt5	30/8/12	Nashville, TN	>45	M	40 minutes
EMInt6	30/8/14	Nashville, TN	>40	M	40 minutes
EMFGI1	20/5/12	Nashville, TN	>30	M	1.5 hours
EMFGI2	20/5/12	Nashville, TN	>50	M	1.5 hours
EMFGI3	20/5/12	Nashville, TN	>35	M	1.5 hours
EMFGI4	20/5/12	Nashville, TN	>45	M	1.5 hours
EMFGI5	20/5/12	Nashville, TN	>45	M	1.5 hours
Total			**Median Age 45**	**F1 M9**	

DEAF AND HARD OF HEARING

ID	Date	Location	Age	Sex	Duration
D/HInt1	17/5/12	Nashville, TN	>40	F	45 minutes
D/HInt2	23/5/12	Franklin, TN	>50	M	35 minutes
D/HInt3	7/6/12	Nashville, TN	>40	M	30 minutes
D/HInt4	7/6/12	Nashville, TN	>30	F	30 minutes
D/HInt5	2/4/14	Nashville, TN	>50	F	1.25 hours
D/HFGI1	10/7/12	Nashville, TN	>30	M	2.25 hours
D/HFGI2	10/7/12	Nashville, TN	<45	F	2.25 hours
D/HFGI3	10/7/12	Nashville, TN	>30	F	2.25 hours
D/HFGI4	10/7/12	Nashville, TN	>55	M	2.25 hours
D/HFGI5	10/7/12	Nashville, TN	>50	F	2.25 hours
D/HFGI6	10/7/12	Nashville, TN	>40	F	2.25 hours
D/HFGI7	10/7/12	Nashville, TN	>20	F	2.25 hours
D/HFGI8	10/7/12	Nashville, TN	>35	F	2.25 hours
D/HFGI9	10/7/12	Nashville, TN	>45	F	2.25 hours
D/HFGI10	10/7/12	Nashville, TN	>25	F	2.25 hours
Total			**Median Age 40**	**F11 M4**	

NATIONAL WEATHER SERVICE

ID	Date	Location	Age	Sex	Duration
NWS1	15/1/13	Nashville, TN	>45	M	I hour

Appendix 15: Interview Example from the Emergency Management Group

(Individual/Professional)

RECORDING WITH EMInt4, F, >50, Emergency Management Professional

JULY 13, 2012 10:05AM – 11:35AM

JW: THANK YOU FOR AGREEING TO BE INTEREVIEWED TODAY AND FOR PROVIDING YOU THOUHGTS REGARDING THE ISSUES RELATED TO THIS RESEARCH. THIS SURVEY THAT HAD TO DO WITH ALERTS AND WARNINGS, THIS PARTICULAR ONE DEALT EMERGENCY MANAGERS. I ALSO HAVE ONE I AM CONDUCTING RELATED TO THE DEAF AND HARD-OF-HEARING COMMUNITY. IT HAS SOME SIMILAR QUESTIONS BUT IT'S A DIFFERENT FOCUS. THERE HAVE BEEN A NUMBER OF RESULTS THAT CAME OUT OF THIS SURVEY AND I'M REALLY LOOKING TO CLARIFY AND GET YOUR PERSPECTIVE ON WHAT YOU THINK THE REASONS EMERGENCY MANAGERS ANSWERED. LET'S JUST START WITH THE FIRST QUESTION – WE LOOKED AT DIFFERENT TYPES, METHODS AND TOOLS THAT EMERGENCY MANAGERS USE TO RECEIVE ALERTS AND WARNINGS. THE RESULTS SHOWED THAT THE NOAA WEATHER RADIO IS THE FIRST CHOICE, THEN AFTER THAT WAS EAS, AND THEN THE THIRD ONE WAS CELLULAR PHONES. INTERESTING, THE VERY LAST ONE WAS WEB AND INTERNET, AND THEN THE SECOND TO LAST WAS HAM RADIO. WHAT DO YOU THINK THE REASONS WERE THAT THEY MADE THEIR SELECTION IN THAT WAY, WHAT IS YOUR PERSPECTIVE?

EMInt4: Number 1 I think is good. I would stick with that and would recommend that myself. Because you can get it two ways; you can get it to where it's a voice, you've can get it with a flashing light and you can also get it towards a phone. That may help your, in some aspects, the hard-of-hearing and stuff like that. That I would agree with. Two – the emergency alert system – and that could be anywhere from a reverse 911 to like what we have which is code red. I kind of agree with that because you can get them at home because not everybody has a cell phone, but at the same time, not everybody has a land line. So just sending it to cell phones, and then you got to have a newer cell phone where it's both, some of these distances, if you get the right ones like we have, will go to the old cell phones; you don't have to have a special thing in your new phone like for the ones to be received from the – they come out automatically from the National Weather Service – that one only goes to certain phones, if: 1) it's pushed out by the phone company if they wish to participate; and 2) it will only go to the newer phones that have the capability of receiving it, where the Emergency Alert System, you can push those out to any cell phone so it doesn't matter how old your phone is.

JW: NOW DO YOU INITIATE THE EAS FROM YOUR AGENCY HERE?

EMInt4: It is automatically initiated through the Weather Service, and it only covers a certain area. The difference between the EAS and the NOAA radio, NOAA weather, you can get it down to where it's in that county, but the EAS you can pinpoint even further, and that usually is if you've got the right program, have the right one, it actually comes out and its where ever their little tone is, those are the only people that will receive it, if you fall within that area. So I do agree with both of those; you could probably swap it, either/or, as long as it actually works. And I don't know what the difference is with cellular phones, just send it to a cellular phone like I said, I wouldn't agree too much with that because not everybody has a cell phone.

JW: WHEN I'M TALKING ABOUT METHODS, USUALLLY THOSE ARE THE MEANS HOW YOU GET YOUR NOTIFICATIONS. QUESTION #2 ADDRESSES THE SOURCES FOR COMMUNICATION.

EMInt4: For us to receive it? Okay. For us receiving it, we have the alert system, I have the NOAH Weather Radio, we do, because of our newer phone, we get the cellular INS from the weather service. We also get – that's the majority of ours, are those same 3 methods. Internet I agree with, but not everybody's on the internet all the time, and so I would pretty much knock that out. Ham radio, if I know that severe weather is coming in, then I will monitor the ham radio. But that's only if I know severe weather is coming in and they are going to set up the net. I don't really monitor it otherwise.

JW: LET ME ASK YOU REGARDING THE HAM RADIO – ARE THERE LIMITATIONS? DO YOU HAVE TO BE LICENSED? I DON'T KNOW IF THEY REQUIRE MORSE CODE ANYMORE, IF THAT'S A REQUIREMENT OR NOT.

EMInt4: No, it's not necessarily a requirement, but the one thing now, the Ham operators can work off a web-based computer; they don't have to have, you don't have to have the mikes and everything else to do the stuff anymore.

JW: OH! IS THAT RIGHT?

EMInt4: It's just put in and then sent out.

JW: AND THERE'S A PRETTY GOOD NETWORK ACROSS THE STATE ON THAT, ISN'T THERE?

EMInt4: I think there is, and I think they are still trying to build them and trying to get more interest back into them now that you don't have to have all that extra equipment that you used to have to have.

JW: YES, BECAUSE IT USED TO BE QUITE A COMPLEX SETUP THAT YOU HAD. OKAY. GREAT. LET'S LOOK AT THE NEXT QUESTION. THAT HAS TO DO WITH THE SOURCES USED TO COMMUNICATE TO PUSH THE MESSAGE OUT TO THE PUBLIC. WHAT THEY SELECTED WAS FIRST WAS THE NWS, THAT WAS #1, #2 WAS LIVE TV BROADCASTS AND THAT WAS FOLLOWED BY LIVE RADIO BROADCASTS AS #3. THE LAST ONE WAS THE CONTRACT WEATHER SERVICE; IT WAS #9 AND THE WEATHER CHANNEL WAS SELECTED AS #8. IN YOUR ESTIMATION, HOW DO THOSE FIT IN? WOULD YOU CHANGE THE ORDER IN THAT FROM YOUR PERSONAL STANDPOINT?

EMInt4: Now this is going out to the public? No, I'd leave that the same because that's where we get our information and instead of it having to come just through us, let it go directly out from the weather service, which is good.

JW: OKAY. GOOD. THE THIRD QUESTION WE HAD WAS TALKING ABOUT WHETHER THEY AGREED OR DISAGREED ON SOME THINGS. ACTUALLY, THERE ARE SIX QUESTIONS THERE, I GUESS. SO WHEN WE LOOKED AT THE NUMBERS ON THAT, THE HIGHEST ONE THAT MOST OF THE EMERGENCY MANAGERS LOOKED AT, IN FACT THERE WERE 60% OF THEM THAT COMPLETELY AGREED, WAS THAT EMERGENCY MANAGEMENT NEEDS TO TAKE A MORE ACTIVE ROLE IN PUBLIC EDUCATION AND THEN THE GENERALLY AGREED WAS 37%. IT WAS PRETTY CLOSE TO 98% ON THAT, IN FACT IT WAS OVER 98% ACTUALLY, FROM THAT STANDPOINT. SO DOES THAT RESONATE WITH YOU AS FAR AS WHAT YOU THINK THE OVERALL CONCENSUS IS WITH MANAGERS?

EMInt4: Yeah. I think in any format, Emergency Management needs to take that role as part of our public education. But if that community, and I'm not talking, I'm just talking in general, if that community doesn't have an active, you have some counties in TN that have a part-time emergency manager - they are not paid, they are volunteers – that can overwhelm them because that's not going to be part of their priority-wise issue. Part of that falls back on, I think would fall back on communities and their public officials, how much do you want your people to be safe? What's your public safety mindset? And without that, emergency management really can't do much of anything. But here we've pushed that real hard and we do a lot of public education.

JW: ANOTHER ONE THAT RECEIVED PRETTY HIGH, IN FACT IT WAS ABOUT 98% WHEN COMPLETELY AGREED OR GENERALLY AGREED, WAS LOOKING AT THE PUBLIC'S UNDERSTANDING OF ALERTS AND WARNINGS TERMINOLOGY. AND THAT SEEMS TO BE PRETTY PREVALENT ACROSS, NOT JUST TN, BUT ACROSS ALL OVER THE COUNTRY. WHAT'S YOUR THOUGHTS ON THAT?

EMInt4: I agree with that. I think people still get a little confused between a watch and a warning. And also, I think another thing that we've seen, or tend to have seen a pattern with, is the news media is great, but sometimes they overdo it. They went from not doing it well, now they're going above and beyond, and so now people are just really getting desensitized; going, "You know, this is another false warning, forget it, I'm not going to go run and hide again." They've got to find a medium without going overboard, but supplying enough and accurate information. I think that's where, that's just, you know, weather is going to be different, no matter what. I think that's where that is going to come in at, is that it has to be a consensus as to what's too much and what's not and just bombardment all the time, people aren't going to listen to it anymore.

JW: WE ADDRESSED THAT IN THE NEXT QUESTION.

EMInt4: I keep jumping ahead here.

JW: NO, NO, YOU'RE DOING FINE! I WANT TO KEEP THIS INFORMAL, BECAUSE THESE ARE IMPORTANT ISSUES. ONE OF THE THINGS ALONG THAT SAME LINE, BUT IT WAS KIND OF REVERSED AND REALLY HAD THE LOWER PERCENTAGES, WAS THE EFFECTIVENESS OF TORNADO EDUCATION AND TRAINING MATERIALS. GENERALLY, A LOT OF THOSE COME OUT OF THE NWS, FEMA, THINGS OF THAT NATURE, AND IT WAS KIND OF SURPRISING THAT IT WAS ONE OF THE ONES THAT THEY DIDN'T THINK WAS THAT EFFECTIVE, WHAT WOULD YOUR TAKE BE ON THAT?

EMInt4: Well, most of the time when FEMA tries to get it out, they usually get it out after the tornado has hit, or the hurricane's hit. NWS influence, again like I said, you have a lot of news time that they do things with but they try to plug some things in.

JW: THESE ARE TRAINING MATERIALS? OR ARE THESE THE HARD COPIES THAT YOU MIGHT GET ON THE INTERNET?

EMInt4: Right. Just for instance, NWS, we get down for storm spotter training. Well, they had to cut that portion of funding so there's no public materials to be able to hand out at storm spotter training.

JW: IS THAT RIGHT?

EMInt4: So what good does that do? They can come and watch the video, but they have nothing to take home to go ahead and relook and reaffirm what was talked about. Once again, their funding source isn't there. FEMA, I try and get a lot of FEMA material, I don't get a whole lot; now they have a lot on disaster recovery, they have a lot of other things that way. Red Cross – a lot of the stuff you try to get from them, you have to buy it. I don't have the extra money to buy this material. So, you know, there's a lot of things they have, booklets and stuff, but you have to purchase them. We're not going to purchase them; we don't have that in our budget either. But yet you want us to help you get this information out. Overall, I would tend to probably agree with that. Once again, how many people have the internet? Who is going to look at it in advance? Who's going to gather that information in advance? You know, and then ultimately, it falls down on the individual. It really does. No matter how much government or businesses or anybody puts this out, it's you as an individual – if you don't see a need for it, you aren't going to try and do anything. That's only the end issue there.

JW: ANOTHER QUESTION THAT GOT EITHER COMPLETELY OR GENERALLY AGREED TO RESPONSE WAS THE ASPECT OF HAVING MORE EMPHASIS ON TORNADO PREPAREDNESS IN THE SCHOOLS. WHAT'S YOUR THOUGHT ON THAT?

EMInt4: Yes. Definitely, that is a high quality and personally, as a taxpayer, I would like to see schools when they start rebuilding or remodeling or updating that they actually, they have grants out there and funding and actually make storm ready facilities. Maybe not the whole, but at least a section of that building that you can use as storm ready for tornadoes. You can reinforce walls. But a lot of schools, they turn around and they want all the glass and trimmings. You don't have glass during a tornado, folks! You know, that's not an excessive measure; it may look pretty on the outside but the effectiveness of it is not. And not just for storms. It's not effective for someone wanting to shoot them, for shooters. It's not effective protection of our children.

JW: SO WHAT DO YOU THINK AS FAR AS HAVING CLASSES OR INSTRUCTION TIME SET ASIDE FOR – TORNODOES ARE ONE THING, BUT MAYBE SEVERE WEATHER OVERALL?

EMInt4: I think part of it needs to come in your Science. I think it’s - besides your Science classes, you also need to have it in general and schools need to practice those. Yes, they are mandated to have a fire drill. Yes, they are mandated this. They walk through the stuff each time. Or they will say, “Ok, this is the Fire Drill.” They just set the alarm off and everybody just does what they want to do. Same thing with the tornado. But actually working your plan and making sure your children understand why this is being done and the purpose of it. Explain it to them that this is something they can do to help their families at home and this is where you gather information and this is where you listen to things.

JW: GOOD. OKAY. ANOTHER QUESTION THAT WAS INTERESTING THAT HAD SOME DISAGREEMENT ON IT WAS THE QUESTION ADDRESSING THE ADEQUACY OF CURRENT WEATHER, SEVERE WEATHER ALERTS. WHAT DO YOU ATTRIBUTE THE RESPONSE NUMBERS TO? IN FACT, WE HAD 12% GENERALLY DISAGREE.

EMInt4: You mean question A?

JW: YES, A.

EMInt4: That’s where that comes into what I was talking about before. When Katrina hit everybody said there wasn’t enough information. Now they’ve gone overboard, it’s too much, so people are just praying, “It’s not hitting here; why are you stressing out over this issue? Nothing’s going to happen.” I would probably tend to agree with them on that and like I said once again, the meteorologists are doing the best they can to try and get where this is going to go. They are not in control of the controls for the weather. But at the same time, I think if you give too much of the crying wolf syndrome, people are going to tend to ignore it. And I think that’s what’s gone on. So it doesn’t matter how much information we get out there, how much we push this, it’s crying wolf. Every time they’ve said there is going to be one here, nothing has happened. People don’t like being woke up in the middle of the night. People don’t like doing that. TN is different from TX, where I’m from. In TX, I could see the tornadoes coming. Here I can’t. I’ve got to get accustomed to that. People used to different climates, I think is another thing. And they are not quite sure, so they look to the weather service to try and help and then it begins to go, “They don’t even know what they are talking about in this state, you know, they’re crazy.” I would tend to agree with that.

JW: BECAUSE YOU AND I COME FROM – YOU KNOW I’M FROM OKLAHOMA – SO WE BOTH COME FROM A TORNADO STATE, SO IT’S INTERESTING ON THAT NOTE. THOSE TORNADO RELATED QUESTIONS ARE THE ONES THAT I THOUGHT WERE INTERESTING TO SEE THE TAKE ON. LET’S GO TO THE FOURTH QUESTION THAT

ADDRESSES WHY PEOPLE HEED OR DO NOT HEED THE WARNINGS. WE HAVE SOME INTERESTING STATS ON THAT, SUCH AS ON PUBLIC COMPLACENCY. THE RESPONSE PERCENTAGE WAS 93, ALMOST 94% SAID THAT THEY AGREED WITH THE PUBLIC COMPLACENCY BEING VERY HIGH. AND THEN ANOTHER QUESTION WE GOT A HIGH RESPONSE ON WAS THE CONFUSION OVER THE SEVERE WEATHER, THE ALERTS AND WARNINGS, AND WE TALKED A LITTLE BIT ABOUT THAT. ONE OF THE INTERESTING RESPONSES WAS THAT CAME UP WAS THE LACK OF SIRENS. IT WAS HALF, ABOUT 50%, AGREED TO THAT. NOT EVERY COUNTY HAS SIRENS OR EVERY CITY HAS SIRENS. WHAT IS YOUR OPINION REGARDING SIRENS AS A USEFUL WARNING TECHNOLOGY?

EMInt4: First of all, it depends on where you got the majority of your information from the first 50% that agreed with it. If they are from a larger municipality, like metro, larger communities where there's a lot of people out at all hours of the night, have venues that people can go to, I can see where they are saying they need a siren. The other problem is that if you get, that they would have also, even if they were outdoors, is those sirens can't be heard indoors. But #2, if you've got large buildings and you've got one place downtown, a siren is not going to go anywhere. People still are not going to hear it. If you have large ball parks, let's say the Titan's Dome, having a siren there would be good, I would think. Possibly because you have a lot of people that you've got to get to cover and that would help alert because a lot of them will hear that more than they would do the other, if they can hear over the yelling. The same thing for the other. I don't agree with sirens; in Texas they were great; in Oklahoma they would be fine because we're flat, there's nothing there to block them. The problem that you have also though is like we had here in Columbia, their siren, the reason that community's siren didn't go off was because Centerville there got hit. Prior to that, which is where the power source came for their siren, which knocked it out before it got to them. So that's why this siren didn't go off. You can't depend just on that. They are high maintenance; costly. You know, there are some of them that have the old ones that, fine, if someone runs over there and hits the switch, well by that time, it's done and other with, you know, and not worth anything. So to me I would lean more toward they are not good.

JW: OKAY. NOW ON THE PUBLIC COMPLACENCY – WHAT'S YOUR THOUGHTS ON THAT?

EMInt4: I agree. I really do. I think, like I said before, that the weather service has gone overboard and they are just continually pounding the same thing. You don't need to be slack enough to where you don't stress, but you don't need to go overboard and cry wolf all the time. The complacency there, once again, that's also going to fall no matter how much the community tries to or emergency management or news service or the government or anybody puts out information, shares information, does training. I've had some people tell me, "You know, if it's going to hit, it's going to hit. If He's ready to take me, He's going to take me." They don't care. Then you have the other ones though, the minute it starts going, they are hiding because it's a thunder storm and it's not even coming to our area. So now they are overly done. You're causing a lot of mental anguish for one, and then other thing is the complacency is just really – it's up to them ultimately whether the individual wants to do it or not.

JW: ONE OF THE THINGS THAT I THOUGHT WAS UNIQUE AND REALLY KIND OF GOT ME LOOKING AT SOME OF THE WARNING PROCESSES WAS WHEN I CAME HERE TO TENNESSEE, YOU KNOW I SPENT TWO YEARS DOWN IN LOUISIANA, BUT I SPENT ABOUT 40 SOME YEARS IN OKLAHOMA. MY FIRST OBSERVATIONS WERE WATCHING THE WEATHER TV STATIONS, AND ALL THEIR GRAPHICS. THEY'VE GOT ALL THESE ROTATIONS GOING ON, IT LOOKED LIKE WE HAD 30 TORNADOES. I SAID, "WHAT THE HECK IS GOING ON? THIS DOESN'T MAKE ANY SENSE." HOW MUCH OF A DESENSITIZATION IMPACT DO YOU THINK THIS HAS ON THE PUBLIC? OVERREPORTING IS ANOTHER FACTOR?

EMInt4: You're correct. If we could see how much, but you've got to understand the reason there has to be people on the ground is to see the tornado; those graphics are only showing so far above in the air. They can have as much rotation as they want and it could be clear underneath us. You've got that desensitization, and at the same time… I grew up on the Gulf coast in TX. I was down in Texas City, TX. I've been through hurricanes; I've been through tornadoes, you know, but our thing was, my mom said, "Hurricanes coming." She watched it where the path is, she says, "It's going to hit around us. We're packing up; we're going to Grandma's for a vacation." And we're up and gone. It's not, "Oh, let's wait and see." At the same time, I think the weather services and the news media that gets out there and stands out there in the middle of it all, "Don't anybody come out!" and looking like a bunch of idiots – like, we can tell there are going to be storms with this, why are you being such an idiot and putting your life in danger? It's not worth them doing that. Fine, set a camera up and run like heck to get out. I think that adds to it, too. If the weather people can do it, we can, too. Why worry about it if they are not?

JW: IN TALKING WITH SOME MEDIA PEOPLE, ONE OF THE THINGS I SAW WAS A REAL COMMERCIAL ELEMENT REGARDING SEVERE WEATHER BROADCASTING. BECAUSE IT IS A MARKETTING FUNCTION. IN OTHER WORDS, THEY ARE COMPETING IN THE SAME MARKET WITH ALL THESE OTHER STATIONS AND THEY

ALMOST SEEM TO TRY TO SEE WHO CAN OUT DO EACH OTHER ON SOME OF THIS REPORTING. DOES THIS MAKE THE PUBLE HYPERSENSITIVE?

EMInt4: Well, and my thing is, I turn around and say, “If he’s going to be an idiot like that, I’m not going to watch that channel.” I mean, that’s ridiculous. He’s putting his life in danger; they are putting him in danger, and they are being idiots. People have seen storms come in. If you have a worthwhile reason for being there, okay, but life safety has to come first. It doesn’t matter how much you’re going to stand out there. If you want to go be beat up, fine, go do it; but not on public TV. That’s personal.

JW: ANOTHER RESPONSE THAT WAS HIGH ADDRESSED THE FAMILIARITY WITH SEASONAL WEATHER, YOUR THOUGHT?

EMInt4: Now for me, that’s one thing I push around here when we host our fairs. Because #1, I’m from TX. TX weather and TN weather is a little different, especially where I’m from. Because I was right there with the tornadoes and the hurricanes. Hurricanes are *coming by(?)*, and you may get the residual, but at the same time I can’t understand why schools get shut down because of raining here, and they’re going, “Well, we have to because of the hollers.” It’s only raining! What I don’t understand is about the bounce and the way the clouds come in. So I think that is a lot, because you have a lot of people moving from FL up here; you’ve got a lot of people moving in from AL. Weather is different where you move to. The type of environment or the landscape that you live in is different. And without understand that, and understanding how it affects you in this area, I think that is a… I would agree with that, just because of that. We’ve pushed that a lot with our fair and that’s the one thing I get from weather service out here. I said, “Your main purpose is to explain the difference between a tornado warning and a tornado watch.” I want to help the people here understand why the weather patterns may hit differently here than they would in TX or OK or somewhere else, because the landscape is going to be different.

JW: ONE SEGEMENT OF QUESTION NUMBER 5 WE ARE LOOKING AT EDUCATING THE PUBLIC IN TORNADO PREPAREDNESS AND WHO HAS RESPONSIBILITIES FOR THAT. THE RESULTS SHOWED THE HIGHEST RESPONSE AT 98% WHICH WAS THE NATIONAL WEATHER SERVICE AND THEN THAT WAS FOLLOWED BY, IN FACT, IT WAS EQUALLY POINTED OUT WITH THE SAME PERCENTAGE EXACTLY, WAS THE LOCAL EMERGENCY MANAGEMENT AGENCY. SO BOTH OF THOSE WERE RECEIVED AS THE HIGHEST; THEY FELT THAT THEY WERE RESPONSIBLE FOR THAT. THE NEXT ONE WAS LOCAL GOVERNMENT AND THEN THAT WAS FOLLOWED BY THE SCHOOLS, AND THEY HAD SOME INTEREST IN THAT. THE NON-GOVERNMENT

ENTITIES, SUCH AS THE RED CROSS OR SOME OTHER GROUPS LIKE THAT, ACTUALLY RECEIVED THE LOWEST ONES AS FAR AS BEING RESPONSIBLE FOR THE EDUCATION ASPECT. THEN WHEN WE LOOKED AT THE HIGHEST ONE THAT HAD THE LESS RESPONSBLE AND IT WAS PRIVATE INDUSTRY. THE CONCENSUS HERE WAS THAT THEY REALLY DID NOT HAVE MUCH PLAY AS FAR AS EDUCATING THE PUBLIC ON THAT. AND THEN NON-GOVERNMENT FOLLOWED. WHAT ARE YOUR THOUGHTS?

EMInt4: Once again, this is educating the public. Local emergency management, I do feel has a huge responsibility because our role is public safety. Our concern is public safety, no matter whether it's weather, hazard materials, whatever. And if we can't help educate the public on it, then we're failing at our jobs. On the other hand of local emergency management is that they don't have the support from their public officials to help do this. They can't do it on their own. They can't make people do this. So once again, if you have counties that have no full time emergency management personnel to be able to focus on public education or you don't stress the emphasis for that, that's on that public entity, that government there. The NWS, I think once again, we have, they need to work in hand with local emergency management. When changes come up they need to, I think that's where we pull together and we try, because I can help promote it, but I can't tell you what a weather pattern is going to do or what it doesn't do. That's where I have to have their expertise. So those two I think do kind of roll hand in hand. But once again, we try to emphasize, "Hey guys, you need to try and get as accurate as you can and quit blowing this thing out of proportion." I disagree with the public industry or private industry because their employees are public just as well. They can at least if nothing else educate their employees, and stress that throughout, just like they do fire, just like the schools do. And I think that is something that private industry needs to begin to look at and focus on because they need to think of it like this: they need to help educate their employees to be prepared. If their employees aren't prepared, their employees don't have their families prepared to last 72 hours. Their employees aren't going to show up for work. I don't care if anything has happened because I'm going to take care of my family first. Where if they had stressed that and they work on the goal of educating them, then they will be able to come in and they'll feel like they are able to help. Even if the industry is not going to open up their business, they may be able to help the community. But if they don't have the personnel there, it's not going to do them any good. Schools help educate the kids; kids can help educate the parents. Still a public entity. Local government… let's see, you said local government…

JW: THERE WE SEE THAT 97% OF RESPONDING EMERGENCY MANAGERS FELT RESPONSIBLE.

EMInt4: Local government I believe is where they need to help their local emergency management. If they don't have a local emergency management, they need to have someone in their agency stress coming on board for public safety, in regard to this and being prepared. Because I can guarantee you if local government, if any of these communities get hit right now, they are not going to be prepared themselves to even get back up for resiliency. They are not, because they are not thinking that way. They are thinking of the now; they aren't prepared for what happens. And once again, they need to educate their employees because if their employees don't have to take care of their families and have them prepared, they aren't showing up for work. It all falls in together there.

JW: NOW THE LAST QUESTION. THIS WAS MORE OF AN OPEN-ENDED QUESTION AND WE TALKED ABOUT THE NUMBER OF DEATHS IN TORNADIC ACTIVITIES WE HAD AND HOW LOOKING AT THE OVERALL SYSTEM OF WHAT WE HAVE NOW AND WHAT WE COULD DO BETTER TO REALLY GET THE PUBLIC TO RESPOND BETTER, OBTAIN MORE KNOWLEDGE AND DEMONSTRATE BETTER POSITIVE RESPONSE BEHAVIORS. THE QUESTION WAS BROKEN IT DOWN INTO A COUPLE OF AREAS AND THE MAJORITY OF THE RESPONSES ADDRESSED THE AREA OF DISASTER EDUCATION. THAT FOLLOWED EQUALLY ALONG THE LINES WITH THE TECHNOLOGY RELATED IMPROVEMENTS AND ALSO THE COMMUNICATION DEALING WITH THE ALERTS AND WARNINGS. THE LAST ONE RECEIVED ABOUT 10% DEALING WITH EMERGENCY MANAGEMENT SYSTEM RELATED IMPROVEMENTS, FUNDING AND THINGS OF THAT NATURE FOR EMERGENCY PREPAREDNESS AND EMERGENCY MANAGEMENT ACTIVITIES. IN REGARD TO THAT, WHAT DO YOU THINK AND YOU DON'T HAVE TO FOLLOW ANY OF THOSE CATEGORIES, WHERE COULD WE IMPROVE THE ALERTING SYSTEM WITHIN EMERGENCY MANAGEMENT? WHAT DO YOU THINK WE NEED TO DO FROM THE SYSTEM STANDPOINT LOOKING AT THE WHOLE SYSTEM AND NOT JUST MAYBE A PARTICULAR AREA? WHAT MIGHT SOME OF YOUR THOUGHTS BE?

EMInt4: I know one of our things that we just went through was trying to get an early warning system for the county. After doing a lot of research on different things, and then fighting with the, you know, we're told by local officials, we want to know what we can do to get an early warning system or a siren or whatever. We explained the things that are not feasible; we can't do this; we would recommend this. Then they have to come up with some funding. Are they going to charge the residents or not charge the residents? That's going to affect who signs up because some people are on limited incomes as it is. Also before it can go into effect, the county tries to figure out how we need to pay for this. Because once we get it up we can't take it away; it will be a continual thing. I think part of it is the assist of your local officials. I feel they need to have a better understanding of what emergency management does to help educate citizens in their communities. If they don't have a local emergency management, they need to get someone there to be able to do this. And you don't do it one time and say, "Oh, okay, well, we've done it; that's it; not again because we can't afford it." That's not how it works. If you want to keep the focus on being a resiliency to your community, being able to get your community back up after a disaster hits, you have to a focus on this. Without this focus, and that includes the education part, doing public education, geared toward that, not a public ed to where you just go and sit the fire trucks up and everybody climbs on and it looks pretty, and it's done. That's good to have at the events but you need to focus events and your public education directly to your groups, your other ones that are community oriented, your churches, everyone else that you can get in there. Because they can touch more people that you can. There's two of us. We can't touch that many people. But yet at the same time, we do the best we can and we do get out; groups will start doing these _________________, are asking these questions, are going through this. Now once we shared the information with them, what they do with that information is up to them. What we have figured out and it's not really technology wise not yet because not everybody has a computer. Everybody thinks, "Oh, well, they use computers or cell phones and so we don't have to worry about anything else." You can't do that. You've got elderly folks that don't; you've got people who can't afford those items; you've got other people that don't use them. So you have to maintain that you do the other part too. So one of the things that we did was we created a book, a preparedness guide. So basically, you're going to take this home. If I was to sit here and ask you, "Do you have a family emergency plan in place?" you're going to tell me no or yes. The majority of them tell me, "Well, we don't do it for a fire. Okay, what about the rest of your plan? What do you mean? Well, I've gone to several of them before I really got into this. Oh, yeah, I need to do this; I need to have a 72-hour kit and I need to do this here and what goes in that kit?" And then I go home and I'm going this is too overwhelming. I don't know where to start. So it never gets done. So this guide that we've got, which I've share with you, that I've shared with everybody else, all my emergency managers, and it i's out; Metro has it out. A bunch of them are printing these up and getting them out at all their public events. So it's a guide that tells you what disasters could hit you in TN. And then there is a workbook that goes with it, which is basically a fill-in the blank type plan. So it's going to help walk you through – they need to take the time to educate themselves and educate their kids and get this going. Once again, we can put it out there but now whether they go home and do it is another story. That's where you're coming up with cost-wise and different things. You've got to have money to print these things; you've got to have this, you know. Even though we're giving them out free, we've got a cost somewhere. A lot of it is going to fall back on that. And that's what a lot of counties are used to struggling with – how do we pay for such things? This is another added thing. One thing we do; we plan for an all hazard approach. That means that we cover anything, not just weather. Your resiliency - to being able to respond to those – your citizens understanding and being able to give back quickly; businesses to be able to get back quickly. That is what needs to happen, because that's how your community is going to survive. I know I've had the opportunity of doing public ed down in Lewis county, and it's been interesting. There's a group that I work with, they want to help, but they want to be prepared first. At the same time, it's hard to get businesses, and I know businesses have their specific jobs that they are doing, they don't really see the need. There is a big need for them to be able to educate their people, their employees, and have a plan to be able to get back into business as quickly as possible. And sometimes I don't think businesses think of it that way. They think, "Oh, we can keep going; we're big enough." It doesn't matter. If you have a lot of damage, you're not going to get back up. If you have employees that have been affected, you're not going to get employees back to work, which is going to affect you and you won't be able to help the community. It all falls together and unless this mindset comes in of life safety, then by your public officials, your emergency services working together, your local businesses, your schools, everybody on the same page, I think you are going to have this disconnect all along. Some will do it; some won't. Kind of a so-so attitude and then complacency sets in.

JW: DO YOU THINK IF WE PUT A REAL EMPHASIS IN THE SCHOOLS IN MAKING PREPAREDNESS MAYBE IN GENERAL, A REAL FOCUS IN THE CURRICULUM? DO YOU THINK THAT WOULD HELP OVER A PERIOD OF TIME? THAT EVERY YEAR IT'S JUST LIKE MATH AND SCIENCE, SAY WITHIN YOUR SCIENCE CLASSES OR MAYBE YOUR HEALTH COURSES, PLACE PREPAREDNESS RELATED COURSE AS PART OF THE REGULAR CURRICULUM?

EMInt4: I think that would help to educate the kids. But I think the other part is bringing it out toward the school board, get them on board, get the parents involved via your PTAs or whatever those things are called now-a-days. There's been a lot of times that kids have seen this and gone through this and gotten this in there and then they go home and they are the ones that have saved their parents lives because of this. I think you can't just put it all on the kids to be able to do that. I think you need to. I think at some point it needs to be added into your Science class. I don't think it needs to be a separate course, basically just have a section on that. And help them understand about the community and the resiliency of the community and how it functions. Not just science, but maybe one of the other courses that would fit along with what you do. Because you could do it a different way – you could do the science part and cover more of the weather and how it affects you there, and then you could do, maybe in your math part, look if this community is hit, and they were not prepared, this is what they needed to do to be prepared, and fit it in to the plan. Lessons for life, lesson planning. We could probably do that.

JW: GREAT IDEA.

EMInt4: And you could fit them to different scenarios because they are going to affect every part of your life, no matter what. That's where I would do that at.

JW: THAT PRETTY MUCH IS ALL I HAVE. ANY COMMENTS FROM A MANAGEMENT PERSPECTIVE THAT WE HAVEN'T TALKED ABOUT?

EMInt4: No, I think we all need to work together. I appreciate you giving me the opportunity to be part of this.

JW: THANK YOU FOR TAKING YOUR TIME TO INTERVIEW WITH ME. IT WAS REALLY VERY HELPFUL.

Appendix 16: Interview Example from the Deaf and Hard of Hearing Group

(Individual/Professional)

RECORDING WITH D/HInt5, F, >50, Deaf and Hard of Hearing Professional
APRIL 2, 2014 1:20PM – 2:35PM

JW: THANK YOU FOR YOUR WILLINGNESS TO BE INTERVIEWED REGARDING THE RESULTS OF THE DEAF AND HARD OF HEARING SURVEY RESULTS. FOR THE RECORD, YOU HAVE READ AND SIGNED THE RELEASE RELATED TO THIS INTERVIEW. THERE ARE SOME VARIOUS AREAS THAT I WANTED TO GET YOUR OPINION ON AS FAR THE RESULTS THAT WE HAVE. FOR THIS INTERVIEW, THE RESULTS FROM THE SURVEY QUESTIONS I WILL BE ASKING YOU ABOUT ON NOT IN THE SAME ORDER AS THE SURVEY ITSELF. PLEASE FEEL FREE AT ANY TIME TO INTERPRET WITH ANY QUESTIONS OR CLARIFYING STATEMENTS YOU WOULD LIKE TO ASK OR ADD.

JW: LET'S GET STARTED: WHEN WE LOOKED AT SELF IDENTIFICATION REGARDING POPULATION DEMOGRAPHICS ARE THOSE NUMBERS PROBABLY PRETTY CLOSE TO WHAT YOU WOULD ASSUME THE REGULAR POPULATION IS OR IS THIS KIND OF DIFFERENT FROM WHAT WE WOULD NORMALLY SEE?

D/HInt5: I think you have a higher percentage of people that have identified themselves as deaf, as compared to the rest of the population. The large majority, the huge overwhelming majority of the population will be hard of hearing, especially if you take into account the elderly population, because hearing loss increases substantially with age.

JW: IS THERE A GOOD GUIDE FOR DEAF DEFINING CATEGORIES?

D/HInt5: Of hearing loss? Audiologically there is, I can find or I can pull up, or you can go online. If there is basically no hearing loss, then there's a category according to decibel loss, mild, moderate, severe, and profound in all categories. Each one of those is associated with a decibel level of hearing loss. So no hearing loss is 0-15 decibels or something, 15-25, you know, is a mild hearing loss, so there are defined decibels and you can check that on line, you can Google it; because of the categories.

JW: THERE IS NO STANDARD DEFINITION OF THOSE?

D/HInt5: There is no standard definition and there is, you know, when people say someone is 'legally deaf,' there is no such thing as being "legally deaf." There is such a thing as being legally blind, but there is not a definition of having hearing loss. So there is no legal definition. The rest of the numbers are pretty in line, so it's definitely the hardest hearing that does make up a greater percentage of the population, but deaf is way high for this survey because he targeted that group to complete the survey.

JW: THE NEXT QUESTION I HAVE DEALS WITH THE MODE OF COMMUNCATIONS.

D/HInt5: Oh, way off. Whoa. Cued speech? You have 53 people? That's like… Okay, most commonly you are going to find people who are hard of hearing and speech read; you know, think of your parents or anyone else who may be of our age and communicates, they will use a hearing aid and will speech read. Sign language will be next, cued speech lags way behind for somebody definitely skewed this or you know, to that population. So I would say many fewer people cue. I just found, I think, one of probably a couple of people in the states that use cued speech. So other parts of the country do use cuing more, so this does definitely show a much greater participation on the part of people nationally, but I would put speech reading, sign language and then cued speech. And then writing will go across the board.

JW: OKAY. THEN WE HAVE PRIMARY LANGUAGE.

D/HInt5: Okay. And again, English is correct, but the number is usually higher for American sign-language. The other thing I'm finding is we're getting a higher percentage of Spanish speaking folks coming in, moving in, uh huh. Yeah.

JW: AND SOME OF THIS COULD BE SKEWED BECAUSE IT WASN'T A SPANISH POPULATION? AND THESE THINGS ARE REALLY MORE FOR MY UNDERSTANDING THAN THEY ARE ANYTHING ELSE. THEN YOU CAN SEE THE AGE DIFFERENCES IN HERE.

D/HInt5: And that's going to, other than the 70+, the reason the number is so low is my guess is because they didn't fill out the survey, but that would be an even higher number. So, but otherwise, hearing loss does increase with age and that's kind of what I take from that.

JW: RELATING TO GENDER, LOOKING AT THE FIGURES, THAT'S HOW THE MUNBERS BROKE DOWN AS REGARDS TO GENDER.

D/HInt5: You know, hearing loss doesn't affect one gender necessarily more than another that I'm aware of.

JW: ADDRESSING MOBILE DEVICES. I THINK THE QUESTION THAT I HAD IS REALLY DO THEY USE THOSE DEVICES REFLECTED IN THE NUMBERS FROM THE SURVEY – DO YOU THINK THAT'S A TREND NOWADAYS?

D/HINT5: Yeah, people are all over their mobile devices.

JW: ARE THEY REALLY? OKAY.

D/HINT5: Oh, yeah. That's the primary method of communication nowadays. Absolutely.

JW: THE WEATHER ALERT RADIO RATE WAS 30%. THAT WAS A LITTLE BIT HIGH. I THOUGHT THAT WAS HIGH PERSONALLY.

D/HINT5: That's way high. I was going to say go back and see what percentage is hard of hearing and out of the respondents if you had such a high number of hard of hearing people, then they would be getting it on the __________.

JW: RIGHT. OKAY. IT DOESN'T MEAN THAT THEY COULDN'T HEAR, IT JUST DOESN'T MEAN WHATEVER LEVEL IT IS?

D/HINT5: And as a matter of fact, when you asked about legal definitions of deaf, you know, that kind of thing. Part of it is sociological, umm, people self-describe themselves as deaf, when audiologically, they might be hard of hearing but that's how they affiliate with the community. So that doesn't surprise me necessarily. Especially with the larger number of hard of hearing people and their being the majority. So that would make sense. For the deaf population, it would be surprising. But we're covering the deaf and hard of hearing and that's the difference between the two.

JW: LOOKING INTO THE WHAT KIND OF ACTION WILL THEY TAKE IF THEY HEAR AN ALERT OR SOMETHING OF THIS NATURE – THESE ARE THE NUMBER BREAK DOWNS. THE COMMUNICATING WITH FAMILY MEMBERS SURPRISED ME A LITTLE BIT, BUT AGAIN, IT'S IN THE CONTEXT OF HOW THEY WOULD REVIEW THE QUESTION.

D/HINT5: Are you surprised that the high numbers people communicate with family members?

JW: YES.

D/HINT5: I'm thinking that if you go back to the question before when you talk about how you receive your information, if you're receiving it on the mobile device – they are going to get on it and they are going to start texting all their friends. Oh, yeah.

JW: SO YOU THINK THAT IS THE COMMON USAGE TODAY?

D/HINT5: Totally. I mean, word spreads like wildfire.

JW: SO THEY DO A LOT OF THAT.

D/HINT5: Oh, yeah.

JW: AND EVEN THE OLDER FOLKS, YOU THINK?

D/HINT5: How old is older? The 70 year olds will not, but most others do. Now, 70-year-old deaf people? Well, absolutely they will. They might get on a video phone and call.

JW: DO MOST HAVE THOSE DEVICES?

D/HINT5: If they can afford it, they have them. So they have to pay for their own high-speed internet connection to use it, but if they can afford that, then they will.

JW: OKAY. WE LOOKED AT PROTECTIVE ACTIONS AND WHETHER THEY HAVE A RESPONSE PLAN. NOW THE MAJORITY OF THEM DID NOT HAVE A RESPONSE PLAN, OBVIOUSLY AS YOU CAN SEE THE NUMBERS, BUT THIS IS HOW IT BROKE DOWN. I THOUGHT THE RESULTS WOULD SHOW THEY ARE GOING TO DO A COUPLE THINGD/HINT5: COMMUNICATE AND STAY INSIDE AND STAY TUNED. SO THOSE

SEEM TO BE A FOLLOW ALONG. FOR THE DEAF, DO YOU THINK THOSE NUMBERS ARE PROBABLY SKEWED.

D/HINT5: I think so.

JW: WHY WOULD YOU THINK THAT WOULD BE? JUST BECAUSE SOCIOLOGICALLY THEY…

D/HINT5: Sociologically, probably 2% of the population or something? I mean, a much smaller percentage now. The National Center for Health Statistics does, not an annual survey, but it's a sometime survey, I haven't figured out how often they do it, but they publish the results and I'm more than happy to send that to you. They give the statistics by a lot of the different areas that you've got here, and that's the best that's available anywhere in the country.

JW: IN REVIEWING THE CAPTIONING RESULTS, WHAT ARE YOUR THOUGHTS ON THE NUMBERS THAT WERE SHOWN?

D/HINT5: Here's the problem. There are a couple of problems. One is who is doing the captioning? If the station, so how the station feed is for the captioning, then that is so. If it's the broadcast feed, if it is clear, if it is legible, if the reception, depending on the weather conditions and the reception of the signals for your TV. Because oftentimes I will even turn on the TV set and I intentionally sometimes will look at the captioning, just to see the clarity and there's a huge differential between stations sometimes, between pre-recorded real time captioning, what's left off, and you know they say to contact the station, but if you're looking at a national weather channel vs. a local weather channel, and the captioning and the signals that comes through, those could all be variables if, in the best case scenario, the signals late and the captioning is clear, then can you understand it? Then that could answer the questions but oftentimes that is not the case. I don't know what you can deduce from that other than the attempt is made and sometimes the layout on the screen might interfere. But that's beside the point here. So I think the weather alert radio is going to be a huge deal if people indeed keep them connected. Easy to understand – here's the other thing. When you are talking about the pre-lingually deaf population, people who were deaf before they learn the language, when you have information running across the bottom of the screen and it's a verbatim translation, which is what captioning or the real-time captioning is, it can be way too wordy for a deaf person who's got no language, so that would be something that I think would need to be looked at as well. You know, short, brief, you know, this is what you need to know kind of thing would be a whole lot easier to understand than all of the running verbiage at the bottom because then they might be talking, talking, talking, talking, and then Take Shelter Now. They are not going to know.

JW: SO YOU FEEL THERE IS A DISCONNECT BETWEEN THE THOSE ENTITIES WHO ADDRESS CAPTIONING FROM THE TV STATION VIEWPOINT AND THE DEAF AND HARD OF HEARING COMMUNITY?

D/HINT5: For sure. You know even an average reading level of a pre-lingually deaf adult is between the third and the fifth grade reading level. So it could be language levels, but once you start having all this verbiage.

JW: THAT'S A GOOD POINT. THE NEXT QUESTION I WOULD LIKE TO ADDRESS IS THE PLACEMENT AND YOU KIND OF SEE WHERE THE MAJORITY, EVERYBODY KIND OF FALLS. I BROKE THIS DOWN ALSO AS FAR AS AGE AND RACE AND SEX AND THERE REALLY WASN'T ALL THAT MUCH DIFFERENCE. YOU CAN SEE HERE WITH THE MAJORITY OF RESPONDENTS THE BOTTOM IS THE MOST PREFERRED AND THE TOP.

D/HINT5: That, and people are used to looking for captioning at the bottom, but for those who really look at captioning, the top is where the least amount of information is transmitted, so it's much easier to see it at the top.

JW: THAT'S INTERESTING.

D/HINT5: Because – think about it – they run all the disclaimers and everything else at the bottom not on the top.

JW: DO YOU THINK IF THEY STARTED RUNNING THEM AT THE TOP LIKE THAT IT WOULD PROBABLY CHANGE EVERYBODY'S THOUGHTS?

D/HINT5: I do.

JW: LET ME GET INTO THE QUALITY – YOU'VE GOT OVER 50-SOME, OR OVER 60-SOME PERCENT THINK THAT QUALTY IS FAIR TO POOR. THAT'S PRETTY TELLING REALLY.

D/HINT5: Yeah. That's what I was talking about. And I don't know how much of it is equipment at stations or how much is transmission of the signals or how much of it is a person's TV set – I don't know all the technical details.

JW: WELL, I DON'T THINK THERE'S ANYBODY THAT HAS REALLY STUDIED THAT TO BE HONEST WITH YOU.

D/HINT5: Probably not.

JW: AND THEN WE GOT INTO THE PREPAREDNESS, THESE ARE THE NUMBERS OF THE ONES WHO RESPONDED, THIS IS WHAT THEY SAID THEY HAD TAKEN FOR TRAINING.

D/HINT5: I'm surprised at the number of these people who said that they have taken CPR. I'm shocked.

JW: MY MAIN QUESTION IS DO THEY HAVE ENOUGH OF THESE TYPES OF TRAINING THINGS THAT WOULD PERTAIN TO THE DEAF AND HARD OF HEARING?

D/HINT5: No, they just did, didn't you say, just started training?

JW: RIGHT.

D/HINT5: Trevor did, you know, a storm spotter training class, and other things. But CPR, you know, I know I took a CPR course last year and became certified, and that was with a half a dozen other deaf and hard of hearing people. But 67 of them? And First Aid? I just don't think that they know what it is. I think they just responded without knowing. Some – I think some have taken it – but I think some didn't understand what is entailed. Now, the other thing is, if you had - how many hard of hearing people? They might. You know, so don't totally discount it if you are looking at it from the deaf side, then that's one set of issues. If you're looking at it from the hard of hearing side, then you did have a good number of hard of hearing respondents. And if people could check more than one, it's possible, it's absolutely possible. [No, we're good. We're moving – you're fine, we're totally fine.]

JW: THE NUMBERS YOU ARE LOOKING AT NOW ARE THE INDIVIDUALS THAT RESPONDED THAT THEY HAVE A FAMILY EMERGENCY RESPONSE PLAN AND THESE ARE THE DIFFERENT TRAINING CLASSES THEY ATTENED. SO WE HAVE TRIED TO LOOK AT THE CORRELATION BETWEEN HAVING A RESPONSE PLAN AND NOT.

D/HINT5: Well, the numbers are low so that's probably more on target. I bet these are more accurate than the chart before, would be my guess, statistically speaking. That would be my guess.

JW: THERE ARE MORE PEOPLE THAT DON'T HAVE RESPONSE PLANS, WHICH DOESN'T SURPRISE ME AT ALL. I MEAN, THAT'S PRETTY NORMAL.

D/HINT5: There were storm spotter training; I know there was one here at the library, I know that Trevor did one during that Red Cross thing so there have been a few opportunities for people to take those.

JW: AND THEN THESE ARE THE CLASSES THAT THEY WERE INTERESTED IN TAKING. IT SEEMS STRAIGHT FORWARD.

D/HINT5: Fifty-three percent not interested. But the highest personal preparedness training, I think that's probably spot-on – that the higher percentage would be 'how does that apply to me?' You know, what do I need to do to prepare for it? That would probably be it. And this is really, should be used to inform whatever program that we do with the EARS group as well. I think it would be very helpful.

JW: HOW IS TECHNOLOGY IMPACTING THIS?

D/HINT5: Yes, and no. With technology the way it is now, they are doing every, within the state of Tennessee every hospital has to do a newborn hearing screening to support the children, especially the high risk babies before they leave the hospital after they are born. In an effort to, because they find that statistically the kids do better and will not lag as far behind if they are identified earlier and if they are given interventions whether it's exposure to language or speech or implants, that is in another way, but more and more it is a fact that most of, I would imagine the majority of infant children today are being implanted with cochlear implant components at a much younger age. Yeah. Like below 18 months or below the age of 18 months. Which does give some auditory input. I think that it might change over time, that from right now when there is an internal component and an external component to cochlear implants, so at night or when you are in the shower and you take off the external port or component to the cochlear implant, then somebody's going to be deaf because you have to have it connected. For some people it does give speech, with other people it doesn't, it gives just generic lab sounds that they will be able to understand. So what people get from the technology, when someone goes to bed at night, they don't wear their hearing aid. The hearing aid is not on for 24 hours a day. Although at the Wellness Fair(?) this past weekend, there was one company who had an implant for ___________ hearing aid which I had never seen before, which was very interesting. I wish I had had time to hear more about it but, so the trend is at night, you know, which I bet, when more people are killed or more people are impacted, as they go to bed the people with implants take off that external component. People with hearing aids take off their hearing aids so their hearing is significantly worse and they would rely on other interventions or would need to rely on other interventions, you know. I know my mother, at night, takes off her hearing aid when she goes to bed or takes it off when she takes a nap. That's going to be, you don't always want to be connected because the technologies do not replicate sounds as we hear sound. So, hearings aids amplify sounds, cochlear implants also are not a replication of sound as we perceive sound. So it is an electronically produced sound. People have to re-learn what sounds sound like, or relate what they are now hearing to objects or birds or whatever they are hearing.

JW: OKAY. LET ME ASK YOU ANOTHER QUESTION. WHAT DIRECTION, IF YOU WERE ADVISING DISASTER PEOPLE IN MARKETING MANAGEMENT OR PROFESSIONALS IN THAT AREA DEALING WITH THE DEAF AND HARD-OF-HEARING COMMUNITY, WHAT DO YOU THINK WE NEED TO DO DIFFERENTLY? WHAT DIRECTION WOULD YOU FOCUS TRAINING AND PREPAREDNESS AND OTHER ACTIVITIES FOR THIS COMMUNITY?

D/HINT5: Yes, and yes. And the other thing I would do is, I think I would break it out for the deaf population versus the hard-of-hearing population because of their communications. They communicate differently and your statistics here are going to kind of point that out. And hard-of-hearing people affiliate more with the hearing population than deaf people do. So the types of interventions, whether it be language accommodations or captioning for implications(?), might be different for the populations. Much of whether it is training or preparedness or whatever and this gave some good examples. I think it is going to take a concerted effort to go after folks in different ways and it all will depend on their communication, how they communicate, because that's what the disability is – it's a communication disability. So what's your preferred method of communication? For some people it might be reading, for some people it might be looking at a power point. It's just going to vary, you know, we have everybody in here from little old ladies who used to be school teachers who've lost their hearing and the neighbor will come in with them and say, “Oh, you know, so and so doesn’t really understand anything but she’s very literate and she prefers the written.

JW: WHY ISN’T THE TECHNOLGY FURTHER ADVANCED?

D/HINT5: Right. You know, a lot of what might be possible or should be working, you know, isn’t being utilized because there’s not enough money to sell it. The interventions probably could be started up, if there’s enough money, whether it’s going to be through a satellite transmission, because you can’t necessarily depend on cell towers transmissions during a disaster, or if you’re looking at various cables that can communicate and that you’re able to access; the technologies I think are advancing and are there to address the need, it’s how we are doing it; it’s not getting to a person necessarily, but you know, with cell phones, with the technologies that are available, I would think that working together we could come up with something. I think it can be done. And as technology has changed it’s getting easier and easier, but that doesn’t mean diddly squat. For the ideas that have been expressed here in terms of the interest areas and that kind of thing, it just depends on what’s the first priority in the disaster community. How does the disaster response community prioritize needs and what not, and then, how do we train people on what’s most critical first, second and third? And that should inform us then, you know, where we fall and what training should go first, second and third. It’s all related, we just have to look at it.

JW: IN PREPARING THE DEAF AND HARD OF HEARING COMMUNTY, WHAT PROCESSES DO WE NEED TO START FOCUSING ON GETTING PEOPLE ENGAGED?

D/HINT5: I would identify the communities that you want to access and that doesn’t necessarily identify who you want to serve in the community, okay? And then I think the first thought in my head was, well, what if you’re in a nursing home? Okay? And you’ve got deaf people there and you’ve got blind people there, and deaf-blind people there, and people with disability impairments and people who are physically challenged and people who are mentally ill, whatever, a cross-section, so breaking it down by need does not necessarily buy methodology, it wouldn’t work in that kind of situation; you would be better to address administration there and create a different type of training program, unless someone has the ability cognitively and physically to partake in a different type of training. Assisted living might be the same kind of thing. Those are the areas that I think of.

J: THE INSTITUTIONALIZED SETTINGS MAY BE A LITTLE DIFFERENT AND NEED TO BE APPROACHED DIFFERENTLY?

D/HINT5: The rest of the community, what we’re finding, especially in the deaf community, is that people aren’t affiliating with the formal deaf community anymore. They are not becoming members; they are becoming assimilated. The good part of assimilation is that everybody is mixing and mingling and becoming all part of one, on the other hand it makes it harder to serve deaf populations which to me makes it more iterative or interventions to be made on a more local basis. If they’re looking at TV, then those accommodations need to be built into the technologies that are used to transmit on the TV, or if people are using their cell phones, or whatever they are using to make those interventions, they need to be easily accessible regardless of the impairment. That works for early warnings; it doesn't necessarily work for training and preparedness because that might depend, although unless you are doing training online, if you are looking at disseminating media videos via YouTube or some other type of special media, then make sure that it's captioned; make sure there's a voice over; make sure that it's signed and design it so you can click on whatever mode of communication somebody needs, and in that way, you're there, instead of homing in on one. Because their needs are going to be different. I think at the Federal level there were, when TBI telecommunications for the deaf and hard of hearing, how he got here originally, they were doing some of that for the deaf community; they were making accessible videos that had the captioning and had the signing, and that's why we wanted to have this survey available in multiple formats, to make it easier regardless of who came to the website and filled out the website or sent it out, it was easy for them to manipulate, depending on what method of communication was used in this particular population. I would identify target populations and it's going to be one of a few populations, the underserved, disability populations, and kind of get to what their needs are and sometimes it might even be going through churches because that's where individuals very often seek support; if somebody is in need, whether it be spiritual or emotional support, whatever, or community centers. Unfortunately, what happens, what I see happen more and more, is people with hearing loss tend to do either one or two things. More often they will withdraw from people and from situations because they can't understand and they don't want to be made to feel dumb because they can't understand. They might be able to be articulate themselves, but they can't understand what someone is saying to them in conversations. When they get into situations where they have to communicate they will dominate the conversation until they are done and they will ask yes/no questions, where all you have to do is say yes or no, and you really can't have an open-ended conversation. Or they tend to withdraw, and I see it time and again and again. The truly hard of hearing population have nothing in common with the deaf population; they don't fit in the hearing population anymore, so they're somewhere in between in this nothing world, kind of thing. That's where the written communication is going to be very helpful. That's where technology such as the text technology might be more useful and especially in like shelters or places where people are going during the disaster. When they get to a safe place, what are we doing to accommodate those needs? I guess it just depends on what phase you're in, and how you would access those populations. I would identify the populations first, and then kind of figure out where they are, if you can. Sometimes it's knocking door to door but most often it's going through a family member or going through someone else who knows someone else to get to that person. I can't tell you how many individuals come to my work place and are not affiliated with anybody, or anything, but there are needs. And government can have all kinds of programs, but with an anti-government sentiment, you are going have to get it out to people whether it be through hospitals or healthcare or some recognized other place that everybody has to go to. Of course, you know, you hit the larger populations first, but then that leaves a bigger hole in the gap of people who are really in need, but are not found. Which is what has happened already. How do you hit those pockets? Identify them and then get a group of those people to get together with the emergency responders. If we can get yours on target that should be some of the discussions, instead of how can we bring everything just to the deaf community, it’s kind of broader and prioritized.

JW: THIS CONCLUDES THE INTERVIEW. THANK YOU VERY MUCH FOR YOUR TIME AND YOUR WILLINGNESS TO EXPRESS YOUR VIEWS. THIS HAS BEEN VERY INFORMATIVE AND ENLIGHTENING.

Appendix 17: Deaf and Hard of Hearing Survey Video Script

Emergency Preparedness Survey for the Deaf and Hard of Hearing Community

Video Script

(Mike Helms will sign the following introduction for Bridges)

Bridges, formerly the League for the Deaf and Hard of Hearing, is the premier provider of Deaf and hard of hearing programs and services in Nashville and surrounding counties and the gathering place for the Deaf and hard of hearing community in Nashville. Bridges is hosting this survey and encourages each of you to take a few minutes to complete the survey.

(Several still pictures depicting severe weather will be inserted at this location)

****Picture** **Picture** **Picture** **Picture** **Picture****


© copyright Gene Moore


Blue Ridge Rd., just before intersection with Glenwood Ave.
RIGHT LANE
MUST
TURN RIGHT

(Mike Helms will sign the survey Introduction)

Introduction:

The following survey is part of a research project designed to provide better alerting and warning procedures specifically addressing the deaf and hard of hearing community during severe weather such as tornado outbreaks. The overall objective of this research is to save lives and to understand more clearly the needs of the hearing loss public when severe weather alerts occur. In addition, the information gathered from this survey will help in developing better emergency education and training services designed to assist the deaf and hard of hearing community in their preparedness and response activities.

Things you should know about the survey.

- **You may decline to take the survey, participate or withdraw from participation at any time without consequences.**
- **Data from the survey will be stored in a secure and locked area. The data will be held for a period of 3 years and then destroyed.**
- **No personal identification information will be asked for.**
- **The research results will be used for publication.**
- **The survey consists of 20 questions and the time for taking the survey is estimated at 10-15 minutes.**

Thank you for your participation in this survey.

If you have any questions, need further information or have comments regarding this study, please contact John Walsh at the following:

(The below contact information will be displayed on the screen, Mike Helms WILL NOT sign the contact information)

John J. Walsh, Jr.

Assistant Professor

Assistant Director

Vanderbilt University

National Center for Emergency Preparedness

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Nashville, TN 37240-1104

Office: 615-322-1553

Fax: 615-322-5828

E-mail: john.walsh@vanderbilt.edu

INSTRUCTIONS FOR COMPLETING THE SURVEY

Watch the video and wait to answer the question after seeing all of the answer options.

(Mike Helms will sign Question 1)

1. What source do you prefer to receive severe weather alerts, such as tornado warnings? (check all that apply)

- ☐ Computer applications
- ☐ Highway message boards
- ☐ Internet
- ☐ Mass telephone calls
- ☐ Mobile Device (cell phone, tablet. Laptop)
- ☐ TV station
- ☐ Weather Alert radio
- ☐ Other (please specify)

(Short pause between questions)

(Mike Helms will sign Question 2)

2. What actions do you take when there is a severe weather alert or tornado warning in your area?

- [ ] What actions do you take when there is a severe weather alert or tornado warning in your area? Communicate with family members
- [ ] Don't do anything
- [ ] Go to another location that is safe
- [ ] Stay inside in a safe place
- [ ] Turn on local television station

Other (please specify)

(Short pause between questions)

(Mike Helms will sign Question 3)

3. If you watch television weather broadcasts as a source for receiving weather alerts and tornado warnings, is the captioning...

	Yes	No
Could be more detailed as what to do?		○
Easy to understand?	○	○
Helpful in what actions to take?	○	○

(Short pause between questions)

(Mike Helms will sign question 4)

4. Where do you prefer closed captioning to be placed on your television screen?

- ○ Bottom
- ○ Left side
- ○ Right side
- ○ Top

(Short pause between questions)

(Mike Helms will sign question 5)

5. How would you rate the quality of the captioning during a live weather broadcast?

○ Good ○ Fair ○ Poor

If you have a comment, please add it here.

(Short pause between questions)

(Mike Helms will sign question 6)

6. Below is a list of emergency alert/warning devices, please check any that you have.

- ☐ Smoke Alarm Only
- ☐ Smoke Alarm with Strobe Light
- ☐ Smoke Alarm with Vibration Device
- ☐ Smoke Alarm with Strobe Light & Vibration Device
- ☐ Weather Alert Radio Only
- ☐ Weather Alert Radio with Strobe Light
- ☐ Weather Alert Radio with Vibration Device

☐ Weather Alert Radio with Strobe Light & Vibration Device

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 7)

7. Please give your reason for NOT having the following emergency alert/warning devices.

	Too expensive	Don't know where to buy	Did not know about this device	Do not need this device
Smoke Alarm with Strobe Light	☐	☐	☐	☐
Smoke Alarm with Vibration Device	☐	☐	☐	☐
Weather Alert Radio with Strobe Light	☐	☐	☐	☐
Weather Alert Radio with Vibration Device	☐	☐	☐	☐

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 8)

8. Please check the alert/warning device you would like help setting up.

- ☐ Do not need help setting up alert/warning device
- ☐ Smoke Alarm
- ☐ Weather Alert Radio

(Short pause between questions)

(Mike Helms will sign question 9)

9. Please check any of the emergency preparedness classes you have completed.

- ☐ Community Emergency Response Team (CERT)
- ☐ CPR
- ☐ First Aid
- ☐ Have not completed any emergency preparedness classes
- ☐ Personal Preparedness Training / Education (FEMA, Red Cross, etc.)
- ☐ Severe Weather / Storm Spotter
- ☐ Other

If Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 10)

10. Please check any of the emergency preparedness classes you are interested in taking.

- ☐ Community Emergency Response Team (CERT)
- ☐ CPR
- ☐ First Aid

☐ Not interested in taking any emergency preparedness classes

☐ Personal Preparedness Training / Education (FEMA, Red Cross, etc.)

☐ Severe Weather / Storm Spotter

☐ Other

If Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 11)

11. In the past 30 days, have you seen any messages or announcements telling people how to prepare if an emergency occurs in your community?

○ No

○ Yes

If you answered Yes, where did you see it?

(Short pause between questions)

(Mike Helms will sign question 12)

12. If you have an emergency/disaster supply kit at your home, which the following items are in your kit?

☐ I do not have an emergency/disaster supply kit

☐ 3 day supply of food

☐ 3 day supply of medicines

☐ 3 day supply of water

☐ Extra batteries

☐ First Aid kit

☐ Flashlight

(Short pause between questions)

(Mike Helms will sign question 13)

13. Do you have a Family Emergency Response Plan?

- ○ No
- ○ Yes

(Short pause between questions)

(Mike Helms will sign question 14)

14. How do you identify yourself?

- ☐ Deaf
- ☐ Deaf Blind
- ☐ Hard of Hearing
- ☐ Late Deafened
- ☐ I do not have hearing loss

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 15)

15. What is your primary mode of communication?

- ○ Cued speech
- ○ Sign Language
- ○ Speech reading
- ○ Writing
- ○ Other

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 16)

16. What is your primary language?

- American Sign Language (ASL)
- English
- Spanish

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 17)

17. What is your age?

(Short pause between questions)

(Mike Helms will sign question 18)

18. What is your gender?

- Female
- Male

(Short pause between questions)

(Mike Helms will sign question 19)

19. What is your race?

- American Indian

- Asian or Pacific Islander
- Black
- Eskimo or Aleut
- Hispanic / Latino
- White
- Other

Other (please specify)

(Short pause between questions)

(Mike Helms will sign question 20)

20. What is your zip code?

(Mike Helms will add a comment closing out the video)

“Thank you so much for answering the Emergency Preparedness Survey questions under the care of National Center for Emergency Preparedness, and Bridges, the premier provider for the Deaf and hard of hearing programs and services in Nashville and surrounding counties. We strive to provide adequate services to the Deaf and hard of hearing individuals when it comes to the unprecedented weather disasters in the State of Tennessee.”

Appendix 18: Enhanced Fujita Scale for Tornado Damage

Enhanced F Scale for Tornado Damage

FUJITA SCALE			DERIVED EF SCALE		**OPERATIONAL EF SCALE**	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

***** IMPORTANT NOTE ABOUT ENHANCED F-SCALE WINDS:** *The Enhanced F-scale still is a set of wind estimates (not measurements) based on damage.* Its uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to the 28 indicators listed below. These estimates vary with height and exposure. **Important**: The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, "one minute mile" speed.

Source: NOAA/National Weather Service, Storm Prediction Center

Appendix 19: Enhanced Fujita Scale Damage Indicators

Enhanced F Scale Damage Indicators

NUMBER (Details Linked)	DAMAGE INDICATOR	ABBREVIATION
1	Small barns, farm outbuildings	SBO
2	One- or two-family residences	FR12
3	Single-wide mobile home (MHSW)	MHSW
4	Double-wide mobile home	MHDW
5	Apt, condo, townhouse (3 stories or less)	ACT
6	Motel	M
7	Masonry apt. or motel	MAM
8	Small retail bldg. (fast food)	SRB
9	Small professional (doctor office, branch bank)	SPB
10	Strip mall	SM
11	Large shopping mall	LSM
12	Large, isolated ("big box") retail bldg.	LIRB
13	Automobile showroom	ASR
14	Automotive service building	ASB
15	School - 1-story elementary (interior or exterior halls)	ES
16	School - jr. or sr. high school	JHSH
17	Low-rise (1-4 story) bldg.	LRB
18	Mid-rise (5-20 story) bldg.	MRB
19	High-rise (over 20 stories)	HRB
20	Institutional bldg. (hospital, govt. or university)	IB
21	Metal building system	MBS
22	Service station canopy	SSC
23	Warehouse (tilt-up walls or heavy timber)	WHB

24	Transmission line tower	TLT
25	Free-standing tower	FST
26	Free standing pole (light, flag, luminary)	FSP
27	Tree - hardwood	TH
28	Tree - softwood	TS

Source: NOAA/National Weather Service, Storm Prediction Center

Appendix 20: National Weather Service Severe Thunderstorm Risk Categories

Understanding Severe Thunderstorm Risk Categories

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
• *Winds to 40 mph* • *Small hail*	• *Winds 40-60 mph* • *Hail up to 1"* • *Low tornado risk*	• *One or two tornadoes* • *Reports of strong winds/wind damage* • *Hail ~1", isolated 2"*	• *A few tornadoes* • *Several reports of wind damage* • *Damaging hail, 1 - 2"*	• *Strong tornadoes* • *Widespread wind damage* • *Destructive hail, 2" +*	• *Tornado outbreak* • *Derecho*

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

National Weather Service

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