Communicating the Emergency: Preliminary findings on the elements of an effective public warning message

Erica Kuligowski
National Institute of Standards and Technology, Gaithersburg, MD USA
erica.kuligowski@nist.gov

Abstract
When an emergency occurs, it is not always sufficient to simply initiate alarm bells. Individuals may not know what the alarm bell means and, in turn, may respond inappropriately to its sound. Many buildings have installed mass notification or emergency communication systems allowing for the dissemination of information in the event of an emergency. However, there is a lack of guidance on how to effectively use current emergency communication systems. Especially with the development of newer technologies, such as mobile devices or social networking tools, guidance on message content and dissemination is crucial to ensure effective and safe response of building occupants during an emergency. This paper presents preliminary research findings from an ongoing project aimed at identifying appropriate emergency message content and dissemination techniques for various types of emergencies in buildings and building campuses in the United States. The paper ends with a discussion of the cultural differences that may complicate these findings, hopefully prompting emergency managers in other countries to begin to identify the vulnerabilities within their communities and ways to improve public response in emergencies through effective emergency communication.

Introduction

At present, many buildings and building campuses in the United States are installing mass notification or emergency communication systems to improve communication from the building or emergency officials to the public. The U.S. National Fire Alarm and Signaling Code (NFPA 72), 2010 edition, provides requirements for the application, performance and installation of emergency communication (or mass notification) technology (NFPA 2010). However, NFPA 72 provides little guidance on how to use these systems for effective emergency communication. Additionally, many countries use British Standard BS 5839 -- Fire Detection and Fire Alarm Systems for Buildings -- Part 8 (BS 5839-8:2008), in which chapters 20 and 21 discuss emergency messages and dissemination techniques. Some mention is made of the components of message delivery including the manner in which messages should be delivered (e.g., clear, concise and in a calm and authoritative manner), intelligibility, message duration, and the importance of an alert tone. However, little guidance is given on the *specifics* of the message, including message content and length, speaking rate, frequency of delivery, and other important aspects of emergency notification.

In the United States, there is little guidance or requirements outside of the building codes for message providers on the content and dissemination strategies for emergency messages. The message providers in a disaster may not have the necessary tools, techniques, guidance, and training required to provide information to the public when a disaster is imminent or unfolding. There is also a lack of standardized messages for specific emergency and

technology combinations for message providers to use when a given emergency occurs. Information transfer becomes particularly difficult in the United States since message providers are usually local officials or building managers that are extremely busy on a daily basis and do not necessarily have the time and/or institutional support to attend training sessions or perform their own research on public warnings. In most instances, messages are "created" moments before they are disseminated with little or no reference to the expertise or research on effective public warnings.

The purpose of this research project is to provide guidance on message creation for a full range of building emergencies likely to occur in the United States. This document will include guidelines on how to structure a warning message for different types of technology, how to disseminate that message appropriately, and examples of this method through the use of generic templates and canned messages for different types of emergencies. The first phase of this project is a literature review that outlines the current state of understanding of notification technology, dissemination approaches, and data on human response to warnings. The second phase of this project is the development of the best practices document. This paper provides the progress to-date on the first phase literature review by presenting preliminary research findings on appropriate emergency message content and dissemination techniques for various types of emergencies in buildings and building campuses.

Human Response to Emergency Warnings

Over the last 50 years, many empirical studies have sought to systematically chart the social processes involved in human responses to disasters in the United States (Tierney, Lindell and Perry 2001; Mileti and Sorensen 1990; Drabek 1986). The Protective Action Decision Model (PADM), which is directly based on these empirical studies, provides a framework that describes the information flow and decision-making that influences protective actions taken in response to natural and technological disasters (Lindell and Perry 2004).

Specific to public warnings and emergency information, the PADM asserts that the process of decision-making in response to disasters begins when people are presented with warning messages. The introduction of these messages initiates a series of pre-decisional processes that must occur in order for the individual to perform protective actions, for example, evacuation or defending in place. First, the individual must perceive or receive the cue(s). Then, he or she must pay attention to the cue(s). Finally, the individual must comprehend the cue(s). Comprehension means understanding the information that is being conveyed.

After the three pre-decisional processes are completed, Lindell and Perry (2004) characterize the core of the decision-making model as a series of five questions:

- Is there a real threat that I need to pay attention to? [If yes, then the individual believes the threat]
- Do I need to take protective action? [If yes, then the individual concludes that he needs to take protective action]
- What can be done to achieve protection? [The individual begins searching for possible protective action strategies]
- What is the best method of protection? [The individual chooses one of the action strategies developed in the previous stage and develops a protective action strategy/plan]
- Does protective action need to be taken now? [If yes, the individual follows the plan developed in the previous stage]

Individuals must "answer" each question in order to proceed through the perceptual-behavioral sequence, in which the outcome of the process is the performance of a behavioral action. A graphic of the process is shown in Figure 1.

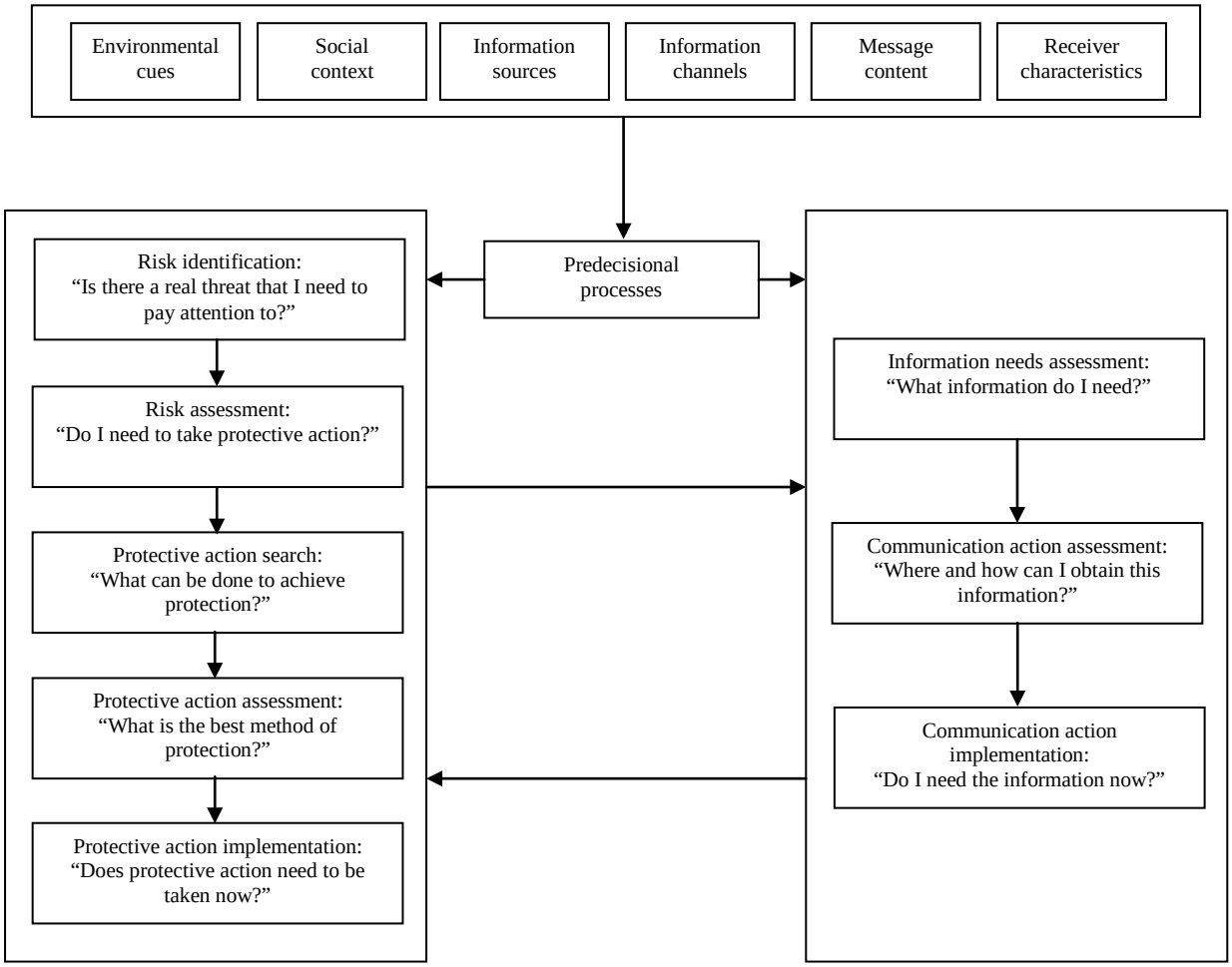

Figure 1: The Protective Action Decision Model (Source - Lindell and Perry [2004] redrawn from p. 47)

The first stage of the decision model involves the issue of risk or threat identification. If the individual receives, pays attention to, and comprehends cues associated with an event, he or she first asks: "Is there a real threat that I should pay attention to?" In this stage, the individual decides if there is actually something occurring that may require action, sometimes referred to as warning belief (Mileti 1974). If the individual's answer is yes, then he or she is said to believe the threat, and subsequently moves on to consider the next question in the process.

The second stage of the decision model is referred to as risk assessment. Research has shown that a person's perception of personal risk, or "the individual's expectation of personal exposure to death, injury, or property damage" is highly correlated with disaster response (Lindell and Perry 2004:51). In this stage, also known as personalizing risk (Mileti and Sorensen 1990), the individual determines the likelihood of personal consequences that could result from the threat and asks himself or herself the following: "Do I need to take protective action?" Essentially, at this point, which is also discussed in human factors research as "situation awareness" (Groner 2009), the individual tries to gain insight on the potential outcomes of the disaster and what those potential outcomes mean to his or her safety. The

more certain, severe, and immediate the risk is perceived to be, the more likely the individual is to perform protective actions (Perry, Lindell and Greene 1981).

In the third and fourth stages, the individual engages in a decision-making process to identify 1) what can be done to achieve protection, and 2) the best available method for achieving this protection. The third stage consists of a search for protective actions, and the outcome of this stage is a set of possible protective actions from which to choose. After establishing at least one protective action option, individuals engage in the fourth stage of the PADM: protective action assessment. This stage involves assessment of the potential option(s), evaluating the option(s) in comparison with taking no action and continuing with normal activities, and then selecting the best method of protective action.

Factors that Inhibit Human Response

Passage through these stages is often problematic. There are several factors which could prevent an individual from perceiving (hearing or seeing, for example) the warning message, paying attention to it, comprehending the message, believing the message, personalizing the risk, and then developing an appropriate line of action(s) to perform.

The first factor type that can inhibit human response to warnings is source-related factors, or factors that originate from the source disseminating the message. There are a variety of communication modes that can be used to disseminate messages, including phones (both landlines and cell phones), voice communication systems, digital signage, a live person, alarm tones or bells, strobe lights, and internet-based modes, such as text messages, websites and social networking tools. Many of these communication modes contain inherent limitations that may inhibit occupant response to a warning message. For example, some of the communication modes, such as alarm bells or strobes, do not provide any message material at all. While they may alert individuals to the fact that an emergency is taking place, such as the use of strobes for the emergency-trained hearing impaired population, they provide no additional information on what is going on and what should be done about it. Additionally, some of the internet-based modes, such as text messages or social networking sites, limit the amount of information that can be provided by specifying a maximum character size for each message.

The second factor that may inhibit a population's safe and effective response to a warning message is environmental distractions. In some cases, buildings have systems in place that provide non-emergency information to building occupants on a regular basis. An example of these buildings is airports. Occupants waiting at airline gates are constantly receiving audible and visual messages about departure information, seat changes, and delays. These regular messages can interfere with the ability to provide emergency messages as well as the message's ability to grab occupants' attention since the occupants may not differentiate the emergency message from the regular messages. Another environmental concern is the dynamic nature of the hazard itself. Changing disaster conditions inside or outside the warning area may require individuals to take different actions for safety than were previously suggested to them. It may be complicated to change or update individuals on the current appropriate actions to take. This is especially true if a previous message has told them to perform a different action altogether.

Finally, there are factors related to the warning receivers, i.e., the population, that can inhibit an effective response to an emergency message. There are distinct sections of any population

that are likely to have difficulties following the steps of the decision-making process in order to respond to a warning. Gwynne (2007), in his research on ways in which to optimize fire alarm notification for high risk groups, identified various occupant types that could be vulnerable in relationship to emergency warnings. These occupant types include the following: individuals with sensory disabilities, such as those with hearing impairments, hearing loss, visual impairments, vision loss, and cognitive, thinking or learning disabilities, the aging population, children, individuals in large groups, people who are alone, untrained or unprimed people, people who are asleep, individuals who are intoxicated or are experiencing the same symptoms, such as those who are sleep deprived, non native speakers, and people who are committed to a particular activity when the alarm or warning begins. Gwynne identifies which of these vulnerabilities inhibits certain stages of the decision-making process, which he labels as receiving the signal/message, recognizing the signal/message, identifying the response, and responding.

The disaster condition itself can also induce vulnerabilities for the general population. For example, stress and anxiety during an emergency has been shown to reduce our capacity for paying attention and processing information (Chandler 2010; Keselman, Slaughter and Patel 2005). Additionally, when people spend a great deal of time in the same situation, for example, their workplace, and are used to receiving the same information, sounds, smells, etc., they can sometimes neglect to pay attention to new information. In essence, people screen out messages based on previous habits and conditioning (Chandler 2010). Even when people do pay attention and receive information, they are unlikely to understand messages containing highly technical terms, ambiguous language, an overloading of information, and categories or codes without proper training or explanation (Mileti and Sorensen 1990). Finally, once people understand the message, they are unlikely to believe it or personalize the risk because their first assumptions, regardless of the intensity of the information received, are often that 1) nothing unusual is occurring, and 2) if it is, I am not at risk. The first assumption is referred to in the literature as normalcy bias (Drabek 1986; Okabe and Mikami 1982) and the second is known as optimistic bias (Kunreuther 1991). These assumptions are further complicated if the at-risk population is frequently exposed to false alarms in the building because it makes it even easier to disbelieve the warning being given.

If, at any stage in the decision-making process, the individual is uncertain about the threat and/or the risk, he or she engages in additional information-seeking actions. The greater the ambiguity involved in the situation, the more likely that individuals will search for additional information that can guide their actions (Fahy and Proulx 1997; Mileti and O'Brien 1992). Information seeking is especially likely to occur when individuals think that time is available to gain additional insight on the question at hand. If information seeking is successful, in that the person at risk judges he or she has received enough information to assess the risk and/or respond, he or she will do so. However, if the information-seeking action is unsuccessful, then there will be additional searching for information as long as he or she is optimistic that other sources or channels can help (Lindell and Perry 2004). This could result in a significant amount of time spent seeking information, thus risking potential exposure to unsafe conditions.

Communication Techniques to Improve Human Response

In general, to improve public response to warning messages, individuals should be provided with evidence-based warning messages. Over 50 years of disaster-based social science research was collected and the findings were synthesized to determine the appropriate content

of warning messages and dissemination techniques for these messages during an emergency (Mileti and Sorensen 1990). Research shows that the message is one of the most important factors in determining the effectiveness of a warning system. A successful message must provide appropriate content, including information on the danger, guidance on what people should do about it, a description of the location of the risk or hazard, an idea of when people need to act, and the name or title of the source that is providing the information. Also, the style of the warning message is crucial. A more successful message is one that is specific, consistent, certain, clear, and accurate. And, by disseminating messages frequently and through the correct channels, they are more likely to achieve appropriate public response.

Additional research has been found highlighting methods to improve emergency communication. The following discussion will identify techniques for writing and disseminating public messages that have been shown to improve *each stage* of the emergency decision-making process – including methods to improve occupant message perception, attention, comprehension, belief, and risk perception or personalization.

First, research has identified ways to increase the success of the first phase of decision-making: perception. Message providers should ensure that the messages can be heard, seen, and/or felt by the receiving population. It is important to not only consider the needs of the general population in reference to perception, but also occupants who are sleeping or intoxicated because they will need to receive messages or preferably, alert tones that are louder than general message volumes (50dB for the general population and at least 75dB for at-risk population to wake from sleep) (Bruck and Thomas 2008; Ball and Bruck 2004a; Ball and Bruck 2004b). Also, occupants who have sensory disabilities will require other means to receive the message, including closed captioning for the hearing impaired or visual signage or tactile alerting for the visually impaired.

As far as improving people's ability to pay attention to the emergency information included in the message, the biggest impact that message providers can have is controlling the message length. If the message is too long, people are likely to stop paying attention before they have received all of the information in the message. Messages that are brief, specifically 27 words, 3 sentences and front loaded with the most important, relevant information are more successful at keeping people's attention so that they respond appropriately (Chandler 2010). Other sources suggest developing messages that use 27 words, disseminate the information in 9 seconds, and provide, on average, only 3 main messages when using print or broadcast media (EPA 2010). Also, message providers can grab the public's attention when using a voice, especially a live voice (Dobbs and Fung 2009; Proulx 2001) for the message source that is different from the voice that gives daily or other frequent (non-emergency) messages (Siegel and Burgoon 2002). In addition, to aid in the public's ability to pay attention to the emergency message, other visual or audible distractions, including the broadcast of simultaneous non-emergency messages, should be eliminated (Cooke, Garcia Lecumberri, and Barker 2008; Edworthy, Hellier and Rivers 2003, Gat and Keith 1978).

To facilitate the comprehension of the emergency message, message providers should pay close attention to the message text. According to Chandler (2010), U.S.-based messages are most successful if written at a 6^{th} grade or lower reading level, which is 4 grade levels below the average U.S. reading level (10^{th} grade), to accommodate for the effects of stress during emergencies. Although these findings may not transfer directly to countries outside of the U.S., the message here is that textual content of emergency messages should be provided at a reading level significantly lower than the population's average reading level to account for

difficulties in processing information during emergencies. Additionally, common words written in the active tense, especially those that describe the danger, aid in message comprehension.

The next phase of the decision-making process requires that the individual believe the warning message before responding appropriately. Research has shown that the source of the message influences whether a person believes the message, specifically noting that the believability of the message increases when the source is viewed as credible and/or familiar by the population. Source credibility is defined in terms of the source's expertise, including access to special skills or information, and trustworthiness or the perceived ability to communicate information about the disaster without bias (Lindell and Perry 2004). Source credibility can differ depending upon a number of factors, including the type of disaster, characteristics of the source, such as social role and believability, and characteristics of the public, such as past experience in disasters and social location (Mileti et al. 2006). For some groups, credible sources may be friends and relatives, and for other groups, credible sources may be disaster authorities, such as government officials (Greene, Perry and Lindell 1981).

The last phase in the decision-making process is risk perception, or the process in which an individual thinks that he or she is in danger. Certain elements of an emergency message can improve the likelihood that an individual will perceive risk in relationship to the event, including the way in which the message is delivered and the use of specific words within the message text. Research has shown that, for audible messages, speaking the message with an urgent tone and fast speaking rate facilitates an individual to perceive risk or urgency (Dobbs and Fung 2009; Jang 2007; Hellier et al. 1999). A higher frequency voice, often a female speaker, provided with an emotional tone tends to convey a greater sense of urgency as well (Jang 2007; Edworthy, Hellier and Rivers 2003; Hellier et al. 1999; Barzegar and Wogalter 1998; Edworthy, Clift-Matthews, and Crowther 1998). Finally, the use of words with negative connotations increases urgency, including words like deadly, danger, warning and caution (Hellier et al. 1999; Barzegar and Wogalter 1998; Edworthy, Clift-Matthews, and Crowther 1998; Leung and Hellier 1998).

Communication technology itself can also play a role in improving emergency communication. For example, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has begun to embrace the benefits of email, text messages, Twitter, Facebook, and other social networking technologies for mass notification in emergencies. The use of these web-based technologies has increased before and during disasters (American Red Cross 2010) by presenting small amounts of information in a dynamic, self-filtering environment, and in turn, redefining the rate at which people are receiving and disseminating emergency information.

Cultural Differences related to Emergency Communication

Universally, humans, regardless of culture, process warning messages in a similar manner. Despite their countries of origin, humans must perceive, pay attention to, comprehend, believe, and personalize the information in order for them to respond. However, it is possible that some of the communication techniques used to improve human response to emergency messages are more relevant to the English-speaking countries or even just the United States rather than other countries. Therefore, it is important for emergency managers and emergency officials to consider the relevance of the preliminary findings presented in this paper based upon the characteristics of the at-risk population. To aid them in this process, I have listed

some examples of questions for emergency managers and officials of other countries to bear in mind when assessing the findings of this research project as relevant (or not) to their population.

Technology

What types of technology are used for emergency communication? Is it primarily audible or visual technology? What is the prevalence of social networking sites in general? If these are prevalent, have there been studies in your country to show that social networking sites have been used during recent disasters or building fires? If so, how have they been used?

At-risk population

Who, in the population, are you trying to protect? What are the population's vulnerabilities associated with perceiving, paying attention to, comprehending, believing and perceiving risk regarding the message?

What is the average reading level for the population during normal, non-emergency conditions?

What individuals or groups do the population consider as credible sources? Are government officials highly regarded as credible? Are emergency responders considered credible? What about television personalities, news anchors, or celebrities? Are these credible sources different for different members of the population? Would credibility rating or responses differ based upon the gender of the source?

Are different languages spoken in your country? What are the predominant languages spoken?
What words have negative connotations for each predominant language?

Future Research

Through this project, the National Institute of Standards and Technology (NIST) has begun to collect the wealth of knowledge on public warnings for local, U.S.-based message providers. Although this project focuses on providing messages to occupants of buildings and building campuses in the United States, this information can be useful to community-level message providers as well as emergency managers in other countries looking for guidance on emergency notification strategies. This project is ongoing and the next steps will be to collect additional research related to human response to visual signage and warning-related graphics, the quantification of message frequency, and message content and dissemination techniques for at-risk populations, including people with sensory disabilities, the aging population, people with cognitive disabilities, and children, among others.

References

American Red Cross. (2010). Social Media in Disasters and Emergencies. http://www.redcross.org/www-files/Documents/pdf/other/SocialMediaSlideDeck.pdf.

Ball, M. and D. Bruck, (2004a). The Salience of Fire Alarm Signals for Sleeping Individuals: A Novel Approach to Signal Design. 3rd International Symposium on Human Behaviour in Fire 2004. Belfast: Interscience Communications and Ulster University, pp. 303-314.

Ball, Michelle and D. Bruck, (2004b). ''The Effect of Alcohol Upon Response to Fire Alarm Signals in Sleeping Young Adults'', in J. Shields (Ed.). Proceedings of the Third International Symposium on Human Behaviour in Fire (pp. 291–302). London: Interscience Communications.

Barzegar, R. S. and M.S. Wogalter. (1998). Effects of auditorily presented warning signal words on intended carefulness. Contemporary Ergonomics, 311-315.
Bruck, D. and I. Thomas. (2008). Comparison of the Effectiveness of Different Fire Notification Signals in Sleeping Older Adults. Fire Technology, 44, 15-38.
BS 5839-8:2008. (2008). Fire Detection and Fire Alarm Systems for Buildings – Part 8: Code of practice for the design, installation, commissioning and maintenance of voice alarm systems.
Chandler, R. (2010). Emergency Notification. Santa Barbara: Praeger.
Cooke, M., M. L. Garcia-Lecumberri, and J. Barker. (2008). The foreign language cocktail party problem: Energetic and informational masking effects in non-native speech perception. The Journal of the Acoustical Society of America, 123, 414-427.
Dobbs, M. and A. Fung. (2009). Enhancing occupant response through neuro linguistics, Fire Safety Engineering International Conference. http://www.umowlai.com.au/pdf/publications/Fire/Enhancing%20Occupant%20Response%20Through%20Neuro%20Linguistics.pdf
Drabek, T. E. (1986). Human System Responses to Disaster: An Inventory of Sociological Findings. New York, NY: Springer-Verlag.
Edworthy J., E. Hellier , and J. Rivers. (2003). The use of male or female voices in warnings systems: A question of acoustics. Noise Health, 6, 39-50.
Edworthy, J., W. Clift-Matthews, and M. Crowther. (1998). Listener's understanding of warning signal words. In M. A Hanson (Ed.). Contemporary Ergonomics 1998 (pp. 316 – 320). London: Taylor & Francis.
EPA. (2007). Effective Risk and Crisis Communication during Water Security Emergencies: Summary Report of EPA Sponsored Message Mapping Workshops. http://www.epa.gov/nhsrc/pubs/600r07027.pdf
Fahy, R. F. and G. Proulx. (1997). Human Behavior in the World Trade Center Evacuation. In Y. Hasemi (Ed.). Fire Safety Science -- Proceedings of the Fifth International Symposium (pp. 713-724). London: Interscience Communications Ltd.
Gat, I. B. and R. W. Keith. (1978). An effect of linguistic experience: Auditory Word Discrimination by Native and Non-Native Speakers of English. International Journal of Audiology, 17, 339 – 345.
Greene, M., R.W. Perry, and M.K. Lindell. (1981). March, 1980 eruptions of Mt. St. Helens: Citizen perceptions of volcano hazard. Disasters, 5, 49-66.
Groner, N. (2009). A Situation Awareness Analysis for the Use of Elevators During Fire Emergencies. In 4th International Symposium on Human Behavior in Fire: Conference Proceedings (pp. 61-72). London: Interscience Communications Ltd.
Gwynne, S. M.V. (2007). Optimizing Fire Alarm Notification for High Risk Groups. Quincy, MA: The Fire Protection Research Foundation.
Hellier, E., B. Weedon, A. Adams, J. Edworthy, and K. Walters. (1999). Hazard Perceptions of Spoken Signal Words, In M. Hanson, E. J. Lovesey, S. A. Robertson (Eds.). Contemporary Ergonomics 1999 (pp. 158-162). Taylor & Francis.
Jang, P-S. (2007). Designing acoustic and non-acoustic parameters of synthesized speech warnings to control perceived urgency. International Journal of Industrial Ergonomics, 37, 213-223.
Keselman, A., L. Slaughter and V. L. Patel. (2005). Toward a framework for understanding lay public's comprehension of disaster and bioterrorism information. Journal of Biomedical Informatics, 38, 331-344.
Kunreuther, H. (1991). A Conceptual Framework for Managing Low Probability Events. Philadelphia, PA: Center for Risk and Decision Processes, University of Pennsylvania.
Leung, A. K. P. and E. Hellier. (1998). Perceived Hazard and Understandability of Signal Words and Warning Pictorials By Chinese Community in Britain. In M.A. Hanson (Ed.). Contemporary Ergonomics 1998 (pp. 321 – 325). London: Taylor & Francis.
Lindell, M. K. and R. W. Perry. (2004). Communicating Environmental Risk in Multiethnic Communities. Sage Publications.
Mileti, D. S. (1974). A Normative Causal Model Analysis of Disaster Warning Response. Boulder, CO: University of Colorado Department of Sociology.
Mileti, D. S., R. Bandy, L. B. Bourque, A. Johnson, M. Kano, L. Peek, J. Sutton, and M. Wood. (2006). Annotated Bibliography for Public Risk Communication on Warnings for Public Protective Actions Response and Public Education. http://www.colorado.edu/hazards/publications/informer/infrmr2/pubhazbibann.pdf.
Mileti, D. S. and P. O'Brien. (1992). Warnings during Disasters. Social Problems, 39, 40-57.
Mileti, D.S. and J.H. Sorensen. (1990). Communication of Emergency Public Warnings. ORNL-6609, Oak Ridge: National Laboratory.
NFPA. (2010). US National Fire Alarm and Signaling Code. Quincy: NFPA.

Okabe, K. and S. Mikami. (1982). A Study on the Socio-Psychological Effect of a False Warning of the Tokai Earthquake in Japan. A Paper presented at the Tenth World Congress of Sociology, Mexico City, Mexico, August.
Perry, R. W., M. K. Lindell, and M. R. Greene. (1981). Evacuation Planning in Emergency Management. Lexington, MA: Lexington Books.
Proulx, G. (2001). Occupant behaviour and evacuation. Proceedings of the 9th International Fire Protection Symposium (pp. 219-232), Munich.
Siegel, J.T. and J.K Burgoon. (2002). Expectancy theory approaches to prevention: Violating adolescent expectations to increase the effectiveness of public service announcements. In W.C. Crano & M. Burgoon (Eds.). Mass Media and Drug Prevention: Classic and Contemporary Theories and Research (pp. 163-186). New Jersey: Lawrence Erlbaum Associates, Inc.
Tierney, K. J., M. K. Lindell, and R. W. Perry. (2001). Facing the Unexpected: Disaster Preparedness and Response in the United States. Joseph Henry Press.

Acknowledgements

The Science and Technology Directorate of the U.S. Department of Homeland Security sponsored the production of this material under Interagency Agreement HSHQDC-07-X-00723 with NIST.