

## WARNINGS

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In 2000, the Natural Hazards Review published a review of hazard warning systems (Sorensen, 2000), describing the gains made in hazard detection, communication practices, and technological infrastructure to relay messages to those at risk. The conclusion, however, was a bleak assessment that progress was still needed, stating that “the United States has no comprehensive national warning strategy that covers all hazards in all places” (p. 119). That same year, the National Science and Technology Council (2000) set forth a research agenda with recommendations to develop a standard method by which to deliver alerts and warnings for all hazards across a variety of dissemination systems. This led to the Common Alerting Protocol data structure (first approved as CAP 1.0 in 2004), and later, in 2006, the Integrated Public Alert and Warning System (IPAWS), which includes a modernized nationwide Emergency Alert System.

IPAWS also paved the way for collaboration between the FCC and the telecommunications industry to develop mobile alerting. In 2011, communities across the U.S. experienced the roll out of what may become the single, unifying, alert system, crossing all hazards and all jurisdictions, to personally alert individuals across all sectors of society facing imminent threat. Wireless Emergency Alerts, or WEA (formerly known as the Commercial Mobile Alert Service, or CMAS) is used to issue mobile, short text messages, to individuals in geo-targeted areas, under conditions of hazard or threat, as well as to deliver AMBER alerts and presidential alerts.

WEA is just one example of technological innovation that has spurred a proliferation of research on warning technologies, messaging, organizational capacity, and public behavioral response under imminent threat. *In this paper, I will limit my discussion to three questions: how are warning technologies changing; how are these technologies changing messages; how are these technologies changing public response to warnings. I will conclude with a discussion about needs for future research including methodological and theoretical approaches to data collection and analysis.*

### **How are warning technologies changing?**

Sirens in their pockets. Prior research efforts on alerts and warnings, conducted by leading scholars such as Drabek (1968), Dynes, Quarantelli (Dynes and Quarantelli, 1973), and Mileti (Mileti and Beck, 1975), as well as Tierney (Dynes and Tierney, 1994), Sorensen (Sorensen and Mileti, 1987), Perry, and Lindell (Perry et al., 1982) focused on systems dependent upon fixed-place, stationary sirens, traditional television and radio broadcast media, and word of mouth diffusion. With the advances in mobile technology and the ubiquity of computing activities, alerts and warnings have the potential to reach more people, more quickly, in a networked fashion. Notable changes include the implementation of National Systems such as WEA, the development of proprietary subscription services, and the integration of social media, such as Twitter and Facebook, into emergency communication plans, and the creation of smartphone apps for personal alerting. Through these systems, the delivery of alert and warning messages

have become more geographically targeted and linguistically relevant, while having the potential to reduce barriers for persons with disabilities.

As noted by Sorensen (2000), many public warning practices remain decentralized across different governments and the private sector, resulting in uneven warning practices throughout the U.S. Technological challenges, including lack of device penetration, over-warning due to insufficient geographical specificity, message channel constraints, and a lack of public education about new messaging technologies require significant research efforts and strategies to transfer new findings to effective design. Research programs funded by U.S. Department of Homeland Security, Science and Technology Directorate, WEA Research, Development, Testing and Evaluation Program, multiple directorates (such as Engineering, CMMI-IMEE) within the National Science Foundation, and the National Institute for Disability Rehabilitation Research are all making strides to address these key issues.

### **How are warning technologies changing messages?**

OMG-RUOK? Empirical research has demonstrated that the content and style of a message is the strongest predictor that people under threat will take protective action (Mileti and Sorensen, 1990). This crosses all hazard types and individual level co-variables, to affect individual understanding, perceived credibility and trust, message personalization, and information search and confirmation, or milling, activities. Effective warning messages will include content about the hazard and its impact, the location/population under threat, protective action guidance, the message source, and the time by which take and end action. In addition, messages should be delivered in a style that is clear, specific, consistent, certain, and accurate. However, with the diffusion of mobile alerting technologies, the increased adoption of social media, and the growth in text-based, short messaging services, some aspects of message content and style now differ from those disseminated through former, more traditional means.

Research efforts are focused on examining message content and style, message diffusion, and message amplification related to mobile and social media-based alert and warning activities. Due to channel constraints, networked communications, and competition for public attention, the delivery of precise, unambiguous, highly salient messages matter even more today than ever before. The question remains about the ability of short messages to overcome pre-event hazard perceptions and to reduce information seeking under periods of imminent threat. Pre-event message development, including content scripting and content testing, aligned with public education campaigns have the potential to positively affect public response (Sellnow et al., 2010; Wood et al., 2012 ). The design of hazard specific messaging templates to assist public information officers relay information in consistent formats may also aid practitioners in their day to day activities as well as periods of heightened stress (Sutton et al., 2014).

### **How are messaging capabilities changing public responses to warnings:**

Backchannel Communications and Collective Intelligence. Recent investigations on the uses of computer mediated communication in disaster have demonstrated a shift away from a reliance on public officials for information to real-time information sharing among eye-witnesses (Sutton et al. 2008), crowd-sourced information, and curated content online (Vieweg et al., 2008). With the growing capability for the public to communicate online and publicly, in a multimedia capacity

via the “backchannel,” official organizations are struggling (Hughes and Palen, 2012) to incorporate new, real-time communication channels into their incident command structures and coordinate messages across agencies to reduce confusion and limit public milling.

A digital divide between those who have access, skills, and knowledge and those who do not, remains a limitation to alerts and warning over new technology channels. Few studies have obtained statistically representative samples to examine alert and warning penetration, message diffusion, channel preference, and compliance with protective action guidance following a disaster event. Research on real time message retransmission via social media has revealed evidence of increased participation online during heightened periods of threat, increased attention directed toward local officials, and varying levels of message salience among online publics (Sutton et al., 2013).

### **What are the ways forward?**

New Research Methods. With the growing reliance upon mobile devices and new media for alerts and warnings, we must consider shifting the unit of analysis away from the household and identify new methodological approaches that account for demographic characteristics, and diversity of spaces (Gow et al., 2008). In addition, social media data affords observation of real time communications and changing network dynamics over the course of communicative events. Furthermore, studies of aggregate online search trends (see for instance Sherman-Morris et al., 2011 who examined Google Trends data) or observations of cursor movements on webpages can add insight into information search activities (Huang, White, and Dumais, 2011) and salience of web-page content as hazard events unfold, offering insight into information needs under periods of crisis.

New methods will require partnerships with scholars and researchers outside of the traditional disaster research disciplines, such as demographers, computer, information, and library scientists, experts in social network analysis, and many others.

Expanding Models, Paradigms, and Theories. Research efforts on new alert and warning technologies, messages and messaging will benefit by drawing from empirically tested, theoretically based models, such as the Protective Action Decision Model (Lindell and Perry, 2012) and the conceptual model identified by Mileti and Sorensen (1990). Concepts within these models can be further refined and clarified by borrowing from research efforts in crisis, risk, and health communication research, as well as social geography and information science.

With technological advances, existing communication paradigms (such as the *transmission*-oriented “sender-message-channel-receiver” model (Berlo, 1960)) no longer adequately capture the changing communication environment where the receiver is a full participant in warning dissemination. Online backchannel and networked communications will require new explanations and models that derive from *transactional* communication theory, applied to the disaster context, or more interpretivist orientations to communications (Dervin and Naumer, 2010). In addition, WEA and social media warnings function under channel constraints not formerly encountered in broadcast messaging, altering the landscape of message content as well as messaging activities. New frameworks will be necessary to explore the changing nature of

information dissemination under channel constraints and to push forward our knowledge of human behavioral response to warning messages.

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