3. Improving Weather and Emergency Management Messaging: The Tulsa Weather Message Experiment

Kenneth J. Galluppi[1], Steven F. Piltz [2], Kathy Nuckles[3*], Burrell E. Montz[4,] James Correia[5], and Rachel Riley[6]

[1] Arizona State University
[2] National Weather Service Forecast Office, Tulsa, OK
[3]CommPower Inc., Camarillo, CA
East Carolina University, Greenville, NC
[4]University of Oklahoma, Norman OK

1. INTRODUCTION

The success and value of conveying critical knowledge about forecasted weather events and their impacts to the emergency management community for operational decision-making are contingent upon two primary factors, content understanding and available delivery mechanisms. As part of an ongoing collaboration with the National Oceanic and Atmospheric Administration, researchers from Arizona State University, East Carolina University, and the University of Oklahoma are exploring dimensions of operational considerations from the perspective of the emergency management community. This presentation overviews early findings of a scenario-based operation experiment involving the National Weather Service Tulsa Forecast Office, government emergency management, and large public venues in Tulsa, Oklahoma to shed light on the value of combined messaging and consistent dissemination across available technologies. The first dimension of message content generation allows for participants with varying roles to collaborate in the creation of a message that explains the hazard forecast, potential localized impacts, and localized actions to be taken by the public at large venues. The second dimension explores the use of available dissemination pathways to reach officials and the public in order to ascertain what venue operators and emergency managers consider to be most useful and effective. For the dissemination, we employed CommPower's iNotify public alert and warning system.

Early results indicate that emergency and safety managers find value in the ability to communicate in a combined manner due to consistency of information, localization to operations, and clearer understanding of the event and actions to be taken by the public. Further, use of technologies that can be tailored to a spectrum of social media, mobile apps, and local venue capabilities is powerful and worthy of further consideration.

*Corresponding Author Address: Advance Technology Innovation Center, Arizona State University MC4280, Mesa, AZ 85212; email: galluppi@asu.edu

2. BACKGROUND ASSUMPTIONS

Previous research under the Weather for Emergency Management (WxEM) project focused on factors that influence the decision making of emergency managers during weather-driven events. That work documented the networks through which information flows among the various emergency support functions involved during severe weather (Losego et al., 2011; Montz et al., 2014). Specifically, the generation and utilization of information about hazards, their impacts, assessment of vulnerability and action consequences, and related decisions occur within the context of a complex, dynamic system of multi-disciplinary teams charged with the management of risk to property and lives. Communicating information in this context has its unique set of challenges. To constrain the issues being addressed in this experiment, we define the following assumptions based on previous WxEM work:

- Emergency Management (EM) is a complex, dynamic, and often ad hoc set of communities.
- EM consists of official EM agencies, public venue operations, media, and individuals.
- EMs are looking to "understand" a situation beyond being "aware."
- Weather understanding is based on 6 critical elements: WHAT, WHERE, WHEN, HOW LONG, CURRENT IMPACTS, and HOW SURE ARE WE?
- Situational understanding is based on the context of what actions to take.
- Decisions are based on clear understanding of all information as a knowledge "packet."
- The packet needs to change based on decisions, actions, and timelines that vary across organization or individual responsibility.
- Information gathering, interpretation, and dissemination lead to information flow issues.
- Situational understanding is compromised due to content and dissemination shortfalls.

3. PROBLEM AND HYPOTHESIS

Gaining complete understanding of a disaster situation requires the assimilation and synthesis of complex information that exists in incomplete and fragmented forms developed and disseminated by a fragmented community. This makes understanding and contextualizing decisions and actions very difficult

for the broad range of operational needs in emergency management. The capability to disseminate is also fragmented and hindered by information channels through available technologies. The result is that critical information is often not available to the right person, at the right time, in a form that can easily be incorporated into a situational mental model.

To address whether correcting the fragmentation issue can help with improved communications that lead to better understanding and better decision-making, we devised the following Tulsa Messaging Experiment with the following hypothesis:

By providing a collaborative pathway for gathering, contextualizing, and dissemination of information, a clearer and consistent understanding of a situation is achieved leading to improved EM decision-making.

4. MESSAGING AND DISSEMINATING

To conduct this experiment, we identified a variety of large public venues that have an official who is in charge of safety actions and getting information to the attending public. These venues have both operational decisions and dissemination needs, whereas, government emergency management agencies have standard operating procedures that lay out who gathers, organizes, disseminates, and makes decisions, based on current capabilities and rigid structures. To avoid having participants fall back on their procedures and not think about new collaborative possibilities, we tapped safety operations that have similar needs without complicated procedures and roles. These venues include the public schools; a large, outdoor sports arena; an industrial park; a commuter-based university campus; a large retail outlet; a large airport; and both a large and small emergency management operations. Officials from these entities have identified what localized time and location forecast information means for their operational consideration in light of personal understanding of provided weather forecasts and lead-time information. They have defined their needs for clear, concise and consistent information that they can use and pass along with additional information they generate relating to actions for the public to take. While this study is still in its infancy, participants are thinking beyond the traditional emergency notifications to explore what actionable information the public needs to understand about the weather and what to do to protect themselves given a venue layout that they may or may not be familiar with.

To explore dissemination capabilities we employed the use of CommPower's iNOTIFY technology to allow venues the flexibility to define, choose and tailor their message dissemination to Weather Radio-like broadcasts, sirens and public address (PA) systems, to use the most popular social media formats, email and text notices, and to use local display monitors, or computer displays. In other words, iNotify took the technological challenges away from the need to collaborate and create actionable messages. The purpose of the experiment is to enable emergency managers and venue operators the freedom to explore ideas about what constitutes effective messaging and dissemination. While the Tulsa experiment is being performed on a local basis, the reader is advised that Canada is deploying the same iNOTIFY technology nationwide for a similar messaging capability as the NOAA Weather Radio with the added capability of robust localized management that includes live audio broadcasting, TV/radio linkages, phone trees, and other disseminations. It is our intent to monitor how the system is used to see if the same messaging value exists on a larger deployment as seen at a local level.

The fragmentation and collaborative modes of messaging are depicted in Figures 1 and 2. In Figure 1, the current community practice, weather information containing the six critical elements is scattered across many products. Many bits of information are lost due to the lack of knowledge of how to find and interpret critical information. Further, information that is gathered is then assembled and interpreted before being passed along to others. The result of current practices is the fragmentation of the message meaning and context into many parallel streams of information. For comparison, the experiment enabled participants to collaborate to gather, interpret and integrate messages into a streamlined set of messages oriented towards specific needs and actions. The comparison is depicted in Figure 2 that shows the collaboration and results of fewer, clearer and relevant messages.

5. APPROACH

The study was conducted in two parts, a messaging survey, and a field experiment to construct and disseminate messages.The messaging survey (n=900),was gathered from emergency managers throughout the east, southeast, and midwest where severe weather messaging is routine business and covers a diversity of hazards. It is important to note that our use of the term emergency managers includes 15 emergency support groups such as fire, police, transportation, communications, health care, as well as county emergency managers.

The surveys covered a diverse set of topics to ascertain what information EMs are looking for and need for understanding, what EMs do with the information, and what they do if the information is incomplete. The survey results confirmed many of

the assumptions listed previously as well as set parameters for the field part of the experiment.

In the field portion of the experiment, participants were asked to collaboratively react to a tornadic scenario by selecting and interpreting products, describing how complete information was, and what actions and disseminations they would carry out. Because of the capabilities that iNotify provided to the participants, they were able to create meaningful messages in text or graphics in collaboration with the National Weather Service Tulsa Office that provided various products that included as many of the six critical elements as possible. For example, through collaboration with their local EMs, the Tulsa Office created their "petal" graphic showing understandable information about tornado movements. EMs could react to information more readily as it was presented in the iNOTIFY system and react with their value-add messages that targeted what needed to be understood and by whom.

The approach identified issues with fragmentation as well as prototyping potential and collaborative solutions.

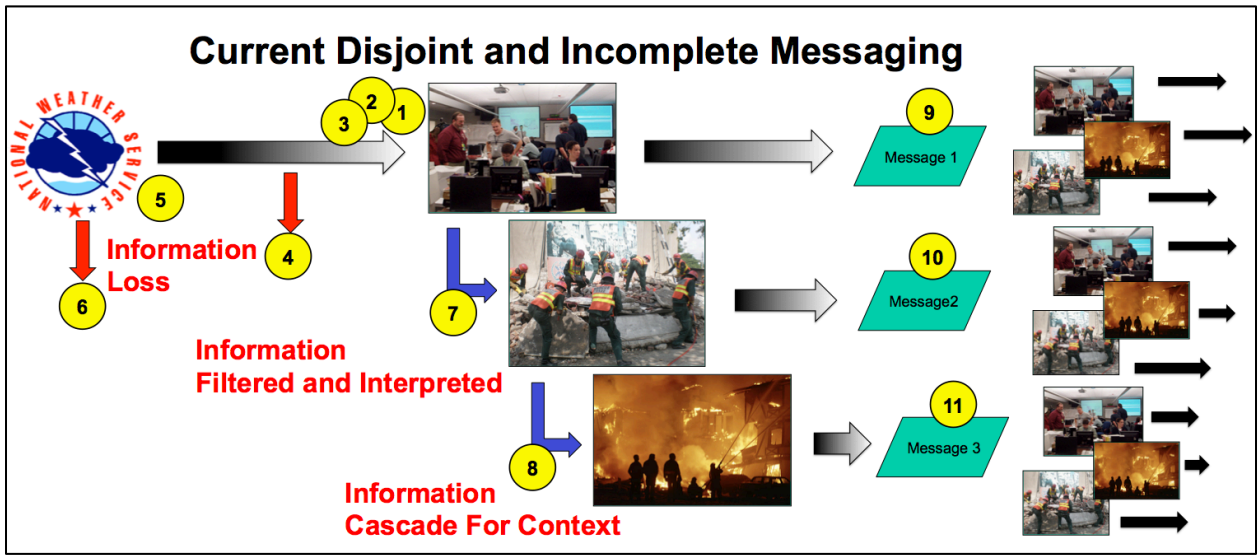

Figure 1: Current Fragmented Messaging Scenario, Resulting in Numerous Messages, Interpretations and Pathways.

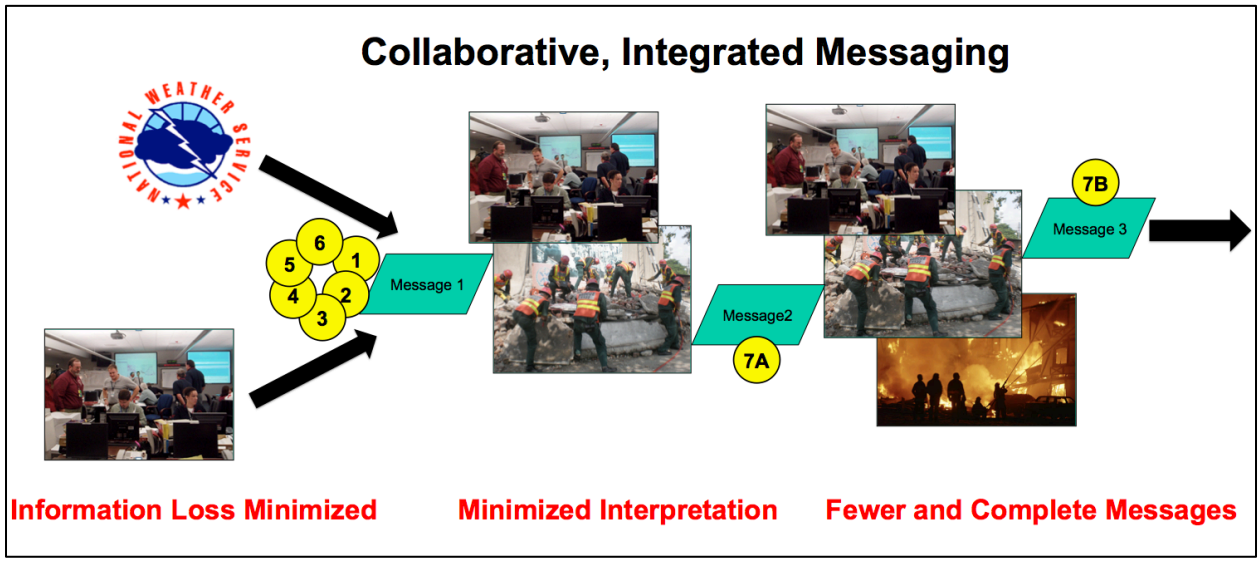

Figure 2: Collaborative Messaging Scenario, Resulting in Fewer Consistent Messages Leading to Understanding.

5. SURVEY RESULTS

- EMs emphasize their need to find, understand and apply 6 critical elements, with mostly favorable comments for what, when, and where and less usable feedback on how long, current impacts, and confidence understanding.
- 80% of emergency managers pass information along to other emergency managers.
- Of those passing information along, 75% report they interpret and filter information first.
- 50% of emergency managers consider that they are in direct contact with the National Weather Service with nearly half using interactive chat to seek clarification and asking questions.
- When information is incomplete, emergency managers will contact NWS, figure things out on their own, seek other sources, talk to other EMs, or make their best guess based on experience.
- Technologies can be a barrier to communication and consistency of information.
- 61% are mostly aware and comfortable with NWS information products.
- Nearly half of EMs report inconsistency issues as a problem and 65% say it gets worse in time

6. MESSAGING RESULTS

The messaging experiment tapped schools, airports, EMS, an industrial park, a retail outlet, a sports arena and a concert arena for feedback on needs and message targeting. A weather scenario was able to be understood through combined messaging to add context related to the six elements. Adding context to messages was performed by all participants and not limited to the NWS. This clearly showed in collaboration, safety officials could better interpret and disseminate decisions and weather outcomes.

Using the iNotify infrastructure, participants were able to react to the scenario and information passing to create combined messages and aid in the gathering, assimilating and synthesis into operational understanding. Passing information along to others no longer was left up to individuals but took on a consolidated goal of understanding the event, its potential impact and change in risk to be managed.

While the experiment scenario played out, participants searched and found the six critical elements more quickly than was the casen working alone. Further, using the iNotify capability, participants added value by engaging on operational needs that would not be possible by weather personnel alone. An example of this is shown is Figure 3, where an EM added a circle of concern before sending a radar graphic along, and then explained to the recipients what the collaboration was revealing through an integrated “chat” session.

It is clear that with a message, text and/or graphics, that includes as many of the six critical elements, such as the Tulsa Petals, understanding greatly improves.

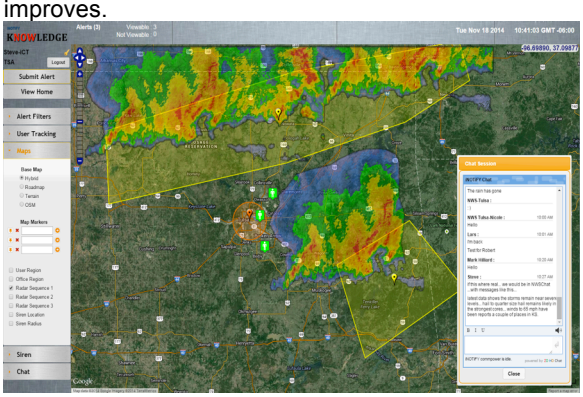

Figure 3. A robust collaboration between NWS and EMs showing and discussing hazard, impacts and actions.

5. CONCLUSIONS

Though the surveys confirmed that likely most emergency managers would perform in similar manners, for logistical reasons, the first field test was only with local EMs, schools and a sports arena but showed that EMs change their message gathering, interpretation, and dissemination when they can work in a collaborative setting. The current practice is to “train” EMs to understand the weather and let them gather and interpret. Current practices can be characterized by the fragmentation shown in Figure 1.

In this prototyping experiment, the evidence showed clearly that EM understanding and decision-making is greatly improved through collaborative messaging: pertinent information was more readily gathered and consisted of the 6 critical elements. Collaborative understanding required elements to be provided and interpreted by both the NWS forecaster and the operational decision makers, and not the county EM alone.

EMs reported that minimizing their time to gather, organize and information led to a greater understanding with higher confidence to make quicker decisions during events like a tornado event. Tulsa EMs are used to dealing with tornadoes but reported higher confidence due to comfort knowing they could readily ask for help while relying on group expertise, as opposed to current practices where collaboration does not readily exist.

Having a seamless communication pathway for gathering, discussing, and disseminating information was reported to be a time and effort savings that enabled better communications among the partners as well as to the public. Normally many who need updated information are out of the loop but can be brought in which creates a very different operational environment.

EMs further report that collaborative messaging and dissemination also greatly improves confidence by enabling context creation and ground truth verification that is hard to implement currently, This allows for greater localization of the impacts and corresponding decision and actions.

6. **REFERENCES**

Losego, J.L., K.J. Galluppi, B.E. Montz, C.F. Smith, S. Schotz, B.J. Etherton, W. Roberts, and G.S. Austin, 2011: *A Cooperative Pilot Project on Weather and Emergency Management Decision Support*. American Meteorological Society 27th Conference on Interactive Information Processing Systems (IIPS), Seattle, WA.https://ams.confex.com/ams/91Annual/webprogram/Paper183481.html.

Montz, B.E., K.J. Galluppi, K.J, J.L. Losego, and C.F. Smith, 2014: Winter weather decisions: North Carolina school closures, 2010-201l. *Meteorol. Appl*., DOI: 10.1002/met.1457