

# CHANGING CHANNELS: COMMUNICATING TSUNAMI WARNING INFORMATION IN HAWAII

**Jeannette Sutton,\* Brett Hansard, and Paul Hewett**

Argonne National Laboratory

Center for Integrated Emergency Preparedness

9700 South Cass Avenue, Building 221

Lemont, IL 60439-4844

[jsutton2@uccs.edu](mailto:jsutton2@uccs.edu); [bhansard@anl.gov](mailto:bhansard@anl.gov); [plhewett@anl.gov](mailto:plhewett@anl.gov)

## ABSTRACT

On the morning of February 27, 2010, a potentially destructive tsunami reached the Hawaiian Islands, following a powerful 8.8-magnitude earthquake that struck Chile the prior evening. In the approximately 15 hours between the time of the earthquake and the tsunami making landfall, information to warn the populations at risk was communicated through multiple official and unofficial channels, including social media networks. Focusing on the city of Hilo on the Island of Hawaii, the authors examine the strategies used to warn the public and the methods employed to gather and disseminate information and monitor public response. Emergency managers and news media that created and disseminated warning products were among those interviewed. (Follow-up interviews were conducted in March 2011 following the Japan earthquake and subsequent tsunami.) Key findings from this study showed that (1) traditional news media, especially local radio stations, continue to play a vital role in communicating emergency public information; (2) the use of new technology, such as social media, is widespread in a crisis, but only as part of a larger information-sharing strategy; and (3) pre-existing networks and community partnerships are the foundation for information sharing in an emergency. The authors argue that it is critical that responsible organizations use multiple channels to ensure warning messages are effectively communicated to the public.

*Key Words: crisis communication, emergency information, social media, tsunami, warnings, social science*

## 1 INTRODUCTION

The communication of timely and accurate information to people potentially at risk from a hazardous event is at the heart of an effective emergency response. Whether the information is focused on saving lives, protecting property, or calming fears, messages that are clear, concise, and instructive will increase public understanding and allow people to take practical steps to protect themselves before, during, and after a crisis. Conversely, the failure to provide such information often results in misinformation and speculation that may unnecessarily alarm people or cause them to act in ways that actually increase their potential for harm. As noted in the aftermath of Hurricane Katrina, people suffer when information is neither timely nor accurate, yet “achieving both timeliness and accuracy in an environment of 24/7 news and information and ever expanding media is difficult in the best of times; in the midst of chaos and uncertainty, it can be an immense challenge” [10].

---

\* Jeannette Sutton is also a Senior Research Scientist in the Trauma Health and Hazards Center, University of Colorado at Colorado Springs.

In recent years, new media technologies have rapidly and undeniably changed the way information is collected and shared, resulting in a dramatic increase in the number of channels – each with advantages and disadvantages – available to communicate emergency messages. It is clear that the emergence of new media is redefining the roles of government and media [7]. Many communities in the United States are integrating new technologies into their traditional warning methods, such as sirens and the emergency alert system (EAS). The traditional systems are now functioning alongside networked and Internet-based tools used to communicate warning messages. Yet the underlying goal (and challenge) of effective crisis communication remains essentially the same: get the right information to the right people at the right time so they can make the right decisions.

The distinction between alerts and warnings is important. Alerts indicate that something may happen or has happened. Alerts get people’s attention through sirens, flashing lights, or vibrating and buzzing devices. Warnings communicate what has happened or what is about to happen, who is at risk, where the risk is expected to occur and from what, and what protective actions to take. Warnings continue throughout the duration of a hazardous event after the population at risk has been alerted to pay attention. This study examines the strategies used to warn the public and the methods employed to gather and disseminate information and monitor public responses to emergency messages when a potentially destructive tsunami threatened the Hawaiian Islands on February 27, 2010. Particular emphasis is placed on the role played by new media.

## **1.1 Hawaii Tsunami Events**

Tsunamis are an ever-present threat to the people of Hawaii and have proven to be one of the most deadly natural disasters on the islands [4]. Historically, the city of Hilo<sup>1</sup> has been the target of many destructive tsunamis. Seven of the fifteen destructive tsunamis that reached the Big Island between 1812 and 1975 led to damage in Hilo; six of those seven were caused by earthquakes off the Chilean coast. Of particular note was a tsunami in 1946 that killed 159 people on the island, including 96 in Hilo, and another tsunami in 1960 that killed 61 people in Hilo [5]. Approximately 25 percent of the property and population of Hilo are located within its tsunami inundation area [3]. Prior to the February 2010 event, Hawaii had not experienced a tsunami evacuation since 1994; while that tsunami did not have local impacts, it drew public attention to the significant risk associated with earthquakes and ocean movements. The February 26, 2010, Chilean earthquake was a reminder of the potential for destruction, as the world observed death and devastation in Chile and tsunami waves traveled the Pacific Ocean, reaching Hawaii the following morning.

## **1.2 February 27, 2010, Tsunami**

At approximately 8:34 p.m. (all times Hawaiian Standard Time) on February 26, 2010, a magnitude-8.8 earthquake occurred in the subduction zone off the south-central coast of Chile. Its epicenter was relatively close to the location of the Chilean earthquake that generated the devastating 1960 tsunami. Within minutes, the Pacific Tsunami Warning Center (PTWC), located in Ewa Beach on the Island of Oahu, issued an earthquake observation message, followed shortly by a tsunami watch and warning for South America’s Pacific coast. On February 27, at 12:45 a.m., the PTWC issued a tsunami warning for the entire Pacific area, including Hawaii [15].

---

<sup>1</sup> Located on the Big Island’s east coast, Hilo is Hawaii County’s seat of government and its largest city.

Predicted travel times for the tsunami gave Hawaii County officials several hours to prepare for the arrival of the seismic wave. The PTWC predicted the tsunami waves would strike Hilo at 11:19 a.m. on February 27, with expected wave heights of 2.5 meters (8.2 feet) [15]. Waves of that height have the potential to cause damage and move small watercraft, cause damage to wooden buildings, and cause coastal flooding [16]. Following its emergency operations plan, Hawaii County Civil Defense activated its tsunami warning sirens at 6:00 a.m. [2]. Thus, Hilo and the rest of the Big Island woke to sirens alerting people to evacuate coastal areas before the arrival of the tsunami.

Following established procedures, Hawaii County Civil Defense sounded the warning sirens every hour until 11:00 a.m. – stopping just before the predicted tsunami arrival time [2]. The tsunami waves arrived in Hilo at 11:38 a.m., with wave heights of less than 1 meter (3.1 feet) [14]. Shortly thereafter, Hawaii County issued the “all clear” alert [2]. At 4:12 p.m. on February 27, the PTWC canceled all tsunami warnings and watches for Hawaii [15].

## **2 THEORY AND LITERATURE REVIEW**

Warning systems consist of many actors and functions: hazard detection, risk assessment, response management, and public response. Hazard detection occurs via monitoring, analysis, and prediction. Risk assessment takes place within both the natural and technological environment. Response management includes data interpretation and decisions to alert and warn populations at risk, develop messages, identify communication methods and channels, and monitor public response. Public response can function somewhat independently as the public warns itself, interprets official information, confirms information from various sources, chooses to take (or not take) protective action, and warns others [13].

A number of recent studies have examined the key factors that influence public response to warnings [1, 19]. Factors examined included socio-economic status, roles of responsibility for others, personal beliefs, experiences, knowledge of the hazard, and perceptions of risk, as well as messages and social and physical cues [1]. The most important conclusion from these studies is that the message, including the number and type of communication channels, the frequency of communication, and the message content, style, and source, is the greatest predictor of protective action response in a disaster.

Warning messages are commonly disseminated via a number of channels, including face-to-face communication (neighbor-to-neighbor, door-to-door) and broadcast media (radio and television). The Internet has become a key source of warning information as well, as individuals register for e-mail listservs that deliver information to their desktop computers and mobile phones, enabling them to receive direct information from official sources. Some local governments are now choosing to adopt additional channels for information dissemination as a strategy to diversify their outreach mechanisms and to build redundancy across communication channels [8, 9]. New communication mechanisms include social media and social networks, such

as Facebook<sup>2</sup> and Twitter,<sup>3</sup> as well as opt-in registries like Nixle<sup>4</sup> and other proprietary systems that repost news releases, images, and videos as real-time situational updates of response efforts.

The public also uses networked social media technologies to warn each other in the midst of a disaster. Twitter channels are now routinely used to convey eyewitness information from those on the ground and often relay real-time digital images. Public contributions to the tweet stream may also include serial transmission of information deemed valuable to “retweet,” such as unmet needs or calls for volunteers and assistance, evacuation and shelter information, and status information about the hazard event [17]. In some cases, public tweets have included direct requests for help and have resulted in lives saved [11, 20]. Facebook groups have been used to organize volunteer efforts, request donations, relay important response and recovery information, and share messages of sadness and condolence [18].

Message content available via social media has the potential to significantly increase the taking of appropriate protective actions by the public at risk [14]. Online content can include visual images, such as pictures or videos from the scene of the event, maps showing the exact locations of evacuation zones and emergency shelters, and depictions of the correct way to don protective gear. Such visual images, included with clear, instructive messages, have the potential to increase understanding of who is at risk, what the risk is, and what to do in response to that risk [14].

As the public contributes information via social media, the public become a valuable source of information for officials who monitor online chatter for situational awareness. Social “milling” is a primary factor in the diffusion of information as individuals make decisions about protective action [6]. Milling online or “e-milling” occurs as individuals assess information from various sources, interpret information, and warn others [19]. As networked individuals contribute to the online conversation stream, emergency managers and others involved in the dissemination of information, such as the news media, have an opportunity to observe e-milling activities and to adjust their warning messages based on expressed public responses.

While there have been many recent conversations about the value of social media for crisis and disaster communications [12], including its role as a redundant channel to reach diverse audiences, its ability to deliver images as well as audio and text-based messages, and its connectivity as a social network, little is known about the extent to which it is truly integrated into warning systems at the local level. Section 3 describes this study’s research methods in the city of Hilo.

### 3 RESEARCH METHODS

The research was carried out in three distinct phases, each using qualitative methods. In-depth face-to-face interviews were conducted with key informants on three of the Hawaiian Islands nine months after the February 2010 tsunami event. A series of follow-up phone

---

<sup>2</sup> Facebook is a social networking service and Web site on which users may create personal profiles, add other users as friends, exchange messages, and join common interest groups; <http://en.wikipedia.org/wiki/Facebook>.

<sup>3</sup> Twitter is a real-time information service where information is exchanged in short messages called tweets of 140 characters or less; <http://twitter.com/about>.

<sup>4</sup> Nixle is a location-based, geographically targeted information service designed for use by law enforcement and government agencies to connect with local residents over cell phone, e-mail, and Web; <http://en.wikipedia.org/wiki/Nixle>.

interviews were conducted with many of these same informants almost immediately following the March 2011 tsunami event, yielding comparative results. While this report is focused on the February 2010 tsunami, the findings are consistent with the response to the March 2011 tsunami as well, unless otherwise noted. Research methods are described in detail below.

### **3.1 Phase 1: August 30–September 3, 2010**

Preliminary research was conducted in Hawaii from August 30 to September 3, 2010. The main purpose was to learn about the primary organizations responsible for alerts and warnings in Hawaii and to identify a set of interviewees who would be critical to the study. Investigators visited several of the Hawaiian Islands, concentrating in areas with historic tsunami experience. As a result of this preliminary investigation, investigators focused their research efforts on Hilo (a community with a significant tsunami history) on the Big Island of Hawaii.

### **3.2 Phase 2: November 8–12, 2010**

Face-to-face interviews were conducted November 8–12, 2010. A total of fifteen interviews were conducted on the islands of Hawaii, Oahu, and Maui. Interviewees included representatives from county civil defense; county government; business security; Voluntary Organizations Active in Disaster (VOAD)/faith-based organizations; University of Hawaii at Hilo; Citizen's Corps; Pacific Disaster Center (PDC); PTWC; and several local radio and newsgathering organizations.

Interview questions focused on strategies and methods used to communicate among organizations involved in the tsunami response and strategies to communicate with populations at risk. These interviews included questions about the different channels used, the content of information included in these channels, and the changes that occurred over the phases of the event (alert, warning, monitoring, all clear). Interviewees were also asked to describe their perceptions about the effectiveness of crisis communication during the tsunami and to characterize the public response. All interviews were audio taped and transcribed for analysis.

### **3.3 Phase 3: March 2011**

Follow-up interviews were completed by phone with seven key informants approximately three weeks after the March 2011 Japan earthquake and tsunami. Interviewees were asked about the similarities and differences between the February 2010 and the March 2011 tsunami events in order to identify any changes that may have occurred in relation to communication channels and messaging strategies used to warn and communicate with the populations at risk. As in phase 2, all interviews were audio taped and transcribed for analysis.

### **3.4 Data Analysis Methods**

Qualitative methods of thematic content coding were used to analyze the data. Investigators identified emerging themes related to information sharing between organizations and with the public, focusing specifically on preparedness activities, alerting mechanism, and warning channels and messages. Themes were compared across sectors to identify linear, complementary, and differing approaches to information sharing during the warning phase of the tsunami event.

Section 4 presents the findings of the analysis, concentrating on the messaging aspects of the warning (including channel diversity and e-milling). First, we describe the pre-event preparedness networks in Hilo that contributed to interorganizational information sharing and communication on- and offline, and the variety of channels used by public officials and the news

media to share and receive alerts about the tsunami event. Second, we discuss the ways that warning information was communicated throughout the tsunami event.

## 4 FINDINGS

### 4.1 Pre-event Preparedness Networks

Hilo has a population of approximately 45,000 and is the second largest city in the Hawaiian Islands. While the Big Island has no network television broadcast news stations (network television programming originates in Honolulu), local residents rely on more than a dozen AM and FM radio stations, two major daily newspapers, and several smaller weekly papers. These are complemented by online news sites like Hawaii 24/7. Hilo is also the seat for the Hawaii County Civil Defense, which is responsible for coordinating preparedness and response activities for the Big Island.

Historic memory about preparedness efforts on the Big Island is dominated by past tsunami experience and the recognition of the need for increased public education and communication among networked organizations. The 1994 tsunami event was the impetus for a strong local preparedness campaign in Hilo, resulting in increased knowledge about tsunami planning, including recognizing the physical signs of a tsunami, implementing alert systems and street signage, and integrating organizations at the local level. (That same year also saw the founding of the Pacific Tsunami Museum, located in Hilo and dedicated to tsunami education and awareness.) Local preparedness measures included increased communication among organizations through coordination with Community Emergency Response Team members, county VOAD, and the Island Visitor Security Association. Furthermore, the doors of the Emergency Operations Center (EOC) were opened to local news reporters, making them communication partners and extensions of the public information function within Civil Defense.

County officials have described local broadcast media as extremely important partners for disseminating hazard information to the public in times of emergency. One official from Civil Defense said:

[W]e have a really strong relationship to DJs at the local radio stations.... I can record a message...e-mail it, we call them up, "Can you play it for a couple minutes" and they do.... It's been a longstanding relationship that's been going on for decades.... We consider them the primary means of public notification. They're very engaged in providing information, in helping us out and getting that out there.

One media interviewee, formerly from the Los Angeles area, described this relationship as a local phenomenon not often experienced in other cities:

...[T]here was a lot of trust that you don't see in other places. I don't know if that's a cultural thing here locally where that is not uncommon to have a relationship like that, or if it's something particular to this island... [The director of Civil Defense] knows the reporters and vice versa and trusts them.

Media outlets have been outfitted with generators and promised fuel access if critical infrastructure is disabled and radio becomes the sole source of public information. News media receive press credentials and passes that allow them access to the EOC (though there remains a barrier between reporters and responders). This unique arrangement demonstrates the trust Civil Defense officials have in local reporters and the recognition by officials of the critical role

reporters play in disseminating emergency information. (It also highlights the necessity of establishing pre-event relationships to work out such details.) Throughout this response, media personnel were able to monitor EOC operations and did not need to wait for official briefings or news releases before disseminating information; they reported in real time any releasable information gathered within the EOC. (There do not appear to be any instances during the February 2010 or March 2011 responses in which information was mishandled by the news media stationed in the EOC.)

In the weeks prior to the February 2010 tsunami, Hilo conducted a tsunami drill, exercising the coordination among county departments, testing alert mechanisms, disseminating information via local media, and identifying areas for improvement. These yearly drills, along with monthly tests of the sirens and alert systems, help ensure the local government and its many partners are prepared for an actual event.

#### **4.2 Initial Alert**

Alerts serve a specific role in the warning system: to get the attention of those who are at risk so that they will seek out warning information. Alerts on the Big Island include sirens, EAS messages on broadcast radio and television, and public service announcements (PSAs). Additional strategies include going door-to-door to homes in the evacuation zone, helicopter flyovers of “off-the-grid” areas, and police patrols with bullhorns announcing mandatory evacuations. Hawaii County has also implemented a number of self-subscription services that provide alert information to desktop computers and mobile phones, raising the attention of those who have registered for key information.

City Watch, a self-subscription service managed by Hawaii County Civil Defense, sends geo-targeted voice messages to registered users. Messages are sent to individual computers, cell phones, and home phones/land lines, ensuring redundancy of channels with messages that are specific to the at-risk population. A second self-subscription service managed by Hawaii County Civil Defense is Talisman. This service is also location based, but it sends text-based mobile alerts from the county’s Web page. Nixle is a text messaging and e-mail service provided by the Hawaii County Police Department and is a primary vehicle for disseminating public safety information, such as road closures and criminal activity.

Almost all interviewees reported that they received an initial alert on their mobile device via one of the subscription-based services managed by Hawaii County Civil Defense on the evening of February 26. Several county employees and media personnel stated that they also received a phone call directly from the EOC, indicating that they were to report immediately.

#### **4.3 Communicating Warning Information**

Far-field tsunami events have long lead times that allow for calculated risk assessment and decision-making among public officials. During the February 2010 tsunami event, there were approximately 15 hours from when the Chile earthquake occurred to when the tsunami arrived in the Hawaiian Islands. (In March 2011, there were approximately 6 hours between the Japan earthquake and the tsunami’s arrival.) In reference to the February 2010 tsunami, a PTWC official said, “We had everything going for us in that event.” He added:

The timing was right. They could sound sirens at 6 in the morning. What more ideal time, the start of the day? We had wonderful weather. There weren’t any weather issues to deal with. It was a Saturday, so it wasn’t a normal work day or school day.

As a point of comparison, the official said that an earthquake in the Aleutian Islands would only allow about 4 hours before tsunami impact and that a local earthquake in Hawaii could generate a tsunami that could potentially arrive onshore within minutes.

In this event, despite the relatively long time before the tsunami's expected arrival, the process of communicating warning information began almost immediately upon notification by Hawaii County Civil Defense – and long before the sirens went off the following morning. Local communication networks warned their constituent organizational partners; local, state, and national agencies shared information via online platforms; and radio stations began continuous local news coverage (which included streaming audio that could be accessed online by national and international listeners).

The three broadcasters interviewed for this study represent a dozen different radio stations on the Island of Hawaii. Two of the broadcasters stayed on the air continuously overnight, while the third started broadcasting early the next morning (explaining that its stations had to be on the air by the time the tsunami sirens sounded “because once people hear those sirens...the first reaction is always, put the radio on”). Of the three broadcasters, one simulcast exclusively on all its stations, another maintained separate station feeds until going to one signal at 5:00 a.m., and the third mixed simulcasting with separate station reporting.

#### **4.3.1 Channels**

In addition to the subscription-based notification services discussed earlier, the primary communication channels used by public officials on the Island of Hawaii are Web sites that can be updated with information on a routine basis. The EAS is used, and PSAs from public officials are also sent through local broadcast media, providing ongoing updates as a hazard situation changes. There has been little direct use of online social media as a channel to communicate ongoing risk to the public, with a few exceptions. (For example, in a newspaper report a spokesperson for the Honolulu Emergency Management Department said digital networking was used to get the word out quickly when areas of Oahu were being evacuated during the February 2010 event.)

Another exception comes from the PTWC, where one geophysicist has an “unofficial” presence on Twitter. (The PTWC is overseen by the National Oceanic Atmospheric Administration, which is currently establishing policies that will allow for an official PTWC presence on social media platforms.) This PTWC employee uses his personal Twitter account to observe tsunami-relevant online chatter and to provide updates during a tsunami event. During the February 2010 tsunami, he estimated that he sent more than 500 tweets, many of which were picked up by local online media. Further, major news broadcasters used Twitter to contact him directly throughout the event. He explained:

It's not a formal part of my job to deal with social media but for this particular event in Chile I was monitoring social media quite closely because for the past few tsunami events ... I've noticed a dramatic increase in how this information is being shared... I knew what the pattern would be like, and we saw the same pattern here, but it was much larger, 62,000 tweets...for this event and it was number one for most of the day on Twitter.

Hawaii-based radio stations use traditional broadcast communication channels and also integrate new media to reach individuals who are online and interactive. Several interviewees explained that radio remains the primary media channel to disseminate information in a crisis, saying that “broadcast radio is the ultimate broadband” in contrast with networked

communications because it is “less prone to outages” and “the bandwidth that mobile carriers have will be used up,” which suggests that an exclusive reliance on networked communications may be a failed strategy in future events.

Nevertheless, online communication is increasingly important to Big Island news media. Local radio stations and online news sites provide access points to original streaming video taken live at the scene, post real-time Twitter messages, and conduct interactive Facebook chats (both on personal and station accounts). In some cases, these sites are redundant channels for information dissemination, where information posted to a single site is repeated across the others. In other cases, online channels serve as novel access points to interactive information.

#### **4.3.2 Content**

Message content throughout the tsunami event was consistently developed and distributed by officials at Hawaii County Civil Defense. County departments played a supportive role and disseminated the same message in a coordinated fashion, using the channels described above. In general, these messages include the following warning information: (1) who the message is from,<sup>5</sup> (2) time sent, (3) description of event, (4) action steps, (5) reinforcement of critical action steps, and (6) mention of when to expect future updates.

Another organization that plays a role in sharing information with the public is the Maui-based PDC. The PDC takes information from official sources (such as the National Oceanic and Atmospheric Administration and the PTWC), aggregates it, and generates “risk-based information” that consists of scientific information that is interpreted and made useful for public consumption. Examples include a “travel time map” where warning information from the PTWC is used to generate maps showing the travel times of the tsunami wave; interactive online tsunami evacuation zones for the Hawaiian Islands; and a smartphone application called “Disaster Alert” that gives users access to active PDC hazards.

Message content is also directly affected by the perceived trustworthiness of the messenger by the receiver of the message. Local media emphasized that their on-air personalities are “trusted communicators” on the island. Because of this, local radio stations see their role as providing stability and consistency in crisis situations; when listeners tune in, they hear familiar, reassuring voices. These broadcasters were also in demand as sources of information for other Hawaii media and for media on the U.S. mainland. In a remark that was characteristic of the views of all the media interviewees, one broadcaster said:

People want the information...but I think more than anything they just want to know that somebody’s aware of it and there’s comfort in knowing that if something is coming, we’re there for them. I think that’s probably the biggest thing, just the security blanket.

The PDC also emphasized the value of human interaction on social media sites, arguing that in strategies to use online networks as purely redundant communication channels, such as to automatically post hazards and updates, there is no perceived human interaction, and therefore limited public interaction or response. When text is inputted by individuals, however, replies or comments from the public become the norm, thus increasing both interaction and response. As one interviewee explained, “People know how to distinguish between the automated machine

---

<sup>5</sup> Warning messages from Hawaii County Civil Defense are scripted for general public dissemination; therefore, they do not include the target population in the message.

and the person.” If a goal is to increase communication between the agency and persons who are at risk,

...you’ve got to still come out of your cave and not be complacent when something happens and be interacting as a human being with other human beings because it really is social in that nature.

This strategy is similar to that described by media interviewees who engaged listeners by encouraging them to call in and talk about their experiences and to post “personable” pictures and messages on Facebook. In doing so, they saw an upsurge in online activity as the predicted time for the tsunami arrival drew closer. In addition to the station’s social media sites, they also were active on their personal sites, sharing much of the same information (described as “professionally first, personally second”). One radio host, however, noted a potential caution about the demands of this hands-on approach. “I think it can’t hinder us unless we’re spending too much time on it and not paying attention to what we’re doing on-air.”

### **4.3.3 E-Milling**

The interviewees described searching behavior, or milling, in relation to online activities of information seeking through electronic channels. Observations of public e-milling were provided by those who are actively engaged in social media spaces and use social networking sites to monitor responses from the crowd and to post information in reply. For example, the geophysicist who tweeted from the PTWC explained that he monitored online activity to assess conversation content and to look for misinformation and rumors that could be addressed and dispelled via his personal Twitter account. He explained that by monitoring online information exchange at the micro level, you can

...see what’s happening in those various communities. You see and hear what they see. You see and hear what they are concerned about... It’s another way to connect to the audience; we see what they’re asking questions about.

Searching behavior was also the impetus for the PDC to develop various outreach pieces, including the interactive evacuation maps. Prior to the development of this online resource, Hawaiians relied on maps found on the inside pages of their local phone books, which required interpretation based on projected information. The PDC, through its monitoring of e-milling, developed a product that addressed an expressed need identified online.

E-milling also resulted in the creation of new products online during the tsunami event. One example is the creation of the citizen-driven Web site [hitsunami.info](http://hitsunami.info). Created by local Hawaii residents in the absence of a central clearinghouse of online communication technologies, this popular site was a combination of Twitter streams, YouTube videos, Flickr photos, and discussion boards. Those who built the mashup site recognized public information seeking activities, identified online resources, and made them available to those at risk.

## 5 DISCUSSION

The adoption of new media for disaster communications has been met with resistance by some emergency management organizations across the United States. Even as Federal Emergency Management Agency Administrator Craig Fugate emphasizes the new directions government must be willing to go to keep pace with a public that is increasingly using social networking tools, many emergency managers stand in opposition to – or are ambivalent about – the value of changing channels.

In Hilo, the decision to adopt new channels for redundant communication or to reach new populations via new tools was based on a number of factors, including personnel and resources, existing communication networks, and message saturation. The director of Hawaii County Civil Defense cautioned against adopting new technologies without having an effective strategy for their use to monitor online chatter or provide real-time updates. Instead, Civil Defense uses its local connections with organizations that have already invested in social media strategies in a “hub-and-spoke” approach to online communication. Through these networked communications, Civil Defense relies on trusted partners to communicate via new media so that it can concentrate on key emergency response tasks.

Some local partners also caution about adopting new media, but mainly in terms of their reliance on information shared through these channels rather than on the channels themselves. Describing a persistent concern, one media manager explained:

We have a responsibility to verify, be accurate, focused on the facts, and to have consistency in the message. This may mean that information comes out more slowly than people want. Social media...there’s a fair amount of that that’s good, but there’s also the potential for misinformation to be out there as well.

In addition, some interviewees expressed concern about the ability of social media to reach vulnerable populations who are not online or who may be part of the “digital divide.” One interviewee explained that in Hilo,

[w]e have the oldest population in all the Hawaiian Islands, in fact it’s older than the U.S. on an average basis.... [T]hey turn on the radio when they hear the tsunami siren. That’s really important, because those are the people that probably need help most and aren’t going to use Facebook or [other social media].

These concerns were echoed with respect to the tourism population and its lack of knowledge about local hazards and communication channels, as well as individuals who live off the grid in Hawaii and choose not to connect electronically.

In contrast, some organizations are adopting new communication mechanisms as a part of their strategy to network with constituent organizations locally and internationally and to increase their public reach. For instance, following the February 2010 tsunami, the local VOAD set up Facebook and Twitter accounts. Although the VOAD sees its role as providing recovery information to those in need, as opposed to warning information, they have identified networked communication channels as a strategy for increasing internal information sharing and organization and for communicating with their national membership.

As organizations consider adopting new communication channels for information sharing, there is a growing awareness among new media users that many organizations are already behind the curve in terms of established public uses of social networks to relay real-time emergency

information. One key part of the warning system – e-milling and the processes of the public warning itself – indicates that a lack of engagement with social media may bring about unintended consequences, such as diminished situational awareness and reduced knowledge about local interpretations of risk messages, including misinformation and false rumors that could be potentially harmful.

## **6 RECOMMENDATIONS**

Social science research has long distinguished between the strategies and functions of alerts and warnings. This research has focused on the role of social media to communicate warning information, examining its use as a redundant channel, to relay varying types of content and to support milling online. Social media appear to play a supportive role for various subsystems within the warning system, especially within the management subsystem and among members of the public. (Additional case studies of local community uses of social media during emergencies are needed to show how the public is engaged with social media relative to other available channels.) Networked actors using online communication systems are likely to both search for and provide information relevant to taking protective action during a disaster situation, suggesting that official personnel will soon be required to pay attention to real-time information shared among the public online.

Warning partners, especially those responsible for communicating with the public, will be remiss if they remain disengaged from online information sharing in some capacity, whether through a hub-and-spoke-approach that leverages the capabilities of partner organizations or via development of an internal strategy to communicate and monitor online information directly. At the same time, new media are more evolution than revolution, suggesting not the repudiation and replacement of traditional communication channels but rather their transformation and growth. For all the opportunities these new communication technologies bring to disaster response and emergency management, the value of established media channels cannot be overlooked in a crisis, both for their strong existing relationships with audiences as well as for their aggressive efforts to build new kinds of interactive relationships with their listeners, viewers and readers.

In a truly networked environment, an organization does not have to duplicate the activities of its partners but must work together to collectively ensure that old and new media tools are being used strategically in the communication of timely and accurate emergency information, including a meaningful level of human interaction with anyone who is part of the dialogue.

## **7 ACKNOWLEDGMENTS**

This research was supported by the U. S. Army and Federal Emergency Management Agency Chemical Stockpile Emergency Preparedness Program under intergovernmental agreement through U.S. Department of Energy contract W-31-ENG-38. The authors retain responsibility for the content, which does not necessarily reflect the views of the sponsors or Argonne National Laboratory.

## 8 REFERENCES

1. Averill, J.D., D.S. Mileti, R.D. Peacock, E.D. Kuligowski, N. Groner, G. Proulx, P.A. Reneke, and H.E. Nelson, *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Occupant Behavior, Egress, and Emergency Communications*, NCSTART 1-7, National Institute of Standards and Technology, Gaithersburg, MD (2005).
2. Burnett, J., “Surge Spares East Hawaii,” *Hawaii Tribune-Herald* (published Sunday, February 28, 2010, 8:23 a.m. HST.), [http://www.hawaiitribune-herald.com/articles/2010/02/28/local\\_news/local01.txt](http://www.hawaiitribune-herald.com/articles/2010/02/28/local_news/local01.txt) (2010).
3. County of Hawaii, “Multi-Hazard Mitigation Plan,” Office of the Mayor, Hilo, HI (2010).
4. Dudley, W., *Tsunamis in Hawaii*, The Pacific Tsunami Museum, Hilo, HI (1999).
5. Dudley, W., and M. Lee, *Tsunami*, 2nd edition, University of Hawaii Press, Honolulu, HI (1998).
6. Finnegan J.R., Jr., and K. Viswanath, “Communication Theory and Health Behavior Change,” in K. Glanz, B.K. Rimer, and F.M. Lewis (eds.), *Health Behavior and Health Education: Theory, Research and Practice*, 3rd edition, Jossey-Bass, San Francisco, CA (2002).
7. Haddow, G.D., and K.S. Haddow, *Disaster Communications in a Changing Media World*, Butterworth-Heinemann Homeland Security Series, Elsevier, Burlington, MA (2009).
8. Hrdinova, J., N. Helbig, and C.S. Peters, *Designing Social Media Policy for Government: Eight Essential Elements*, The Research Foundation of State University of New York, [www.ctg.albany.edu](http://www.ctg.albany.edu) (2010).
9. Kingsley, C., A. Brummel, C. Lamb, J. Higgins, A. Biros, and C. Smith, “*Making the Most of Social Media: 7 Lessons from Successful Cities*,” Fels Institute of Government, Penn Arts and Sciences, [www.fels.upenn.edu](http://www.fels.upenn.edu) (ND).
10. May, A.L., *Informers in the Disaster Zone: The Lessons of Katrina*, Communications and Society Program, p. viii, The Aspen Institute, Washington, DC (2006).
11. Meier, P., and R. Munro, “The Unprecedented Role of SMS in Disaster Response: Learning from Haiti,” *SAIS Review*. **XXX**:2 (Summer–Fall 2010).
12. Mileti, D.S., “Social Media and Public Warnings,” *Proceedings for the Denver UASI Conference on Shared Strategies for Homeland Security*, Denver, CO, December 15, 2010, <http://www.slideshare.net/COEmergency/warnings-social-media-rev-3> (2010).
13. Mileti, D.S., “Warning Systems and Public Response: A Practitioner’s Briefing to Bridge the Gap between Social Science Research and Practice,” presented to the National Consortium for the Study of Terrorism and Responses to Terrorism (2011).

14. National Research Council, *Tsunami Warning and Preparedness – An Assessment of the U.S. Tsunami Program and the Nation’s Preparedness Efforts*, The National Academies Press, Washington, DC (2010).
15. PTWC (Pacific Tsunami Warning Center), “PTWC Messages–27 February 2010,” [http://itic.ioc-unesco.org/index.php?option=com\\_content&view=category&layout=blog&id=1444&Itemid=1444&lang=en](http://itic.ioc-unesco.org/index.php?option=com_content&view=category&layout=blog&id=1444&Itemid=1444&lang=en) (2010).
16. Papadopoulos, G.A., and F. Imamura, “A Proposal for a New Tsunami Intensity Scale,” *Proceedings of the International Tsunami Conference*, pp. 569–577 (2001).
17. Starbird, K., L. Palen, A.L. Hughes, and S. Vieweg, “Chatter on *The Red*: What Hazards Threat Reveals about the Social Life of Microblogged Information,” *CSCW 2010*. February 6-10, 2010, Savannah, GA (2010).
18. Torrey, C., M. Burke, M. Lee, A. Dey, S. Fussel, and S. Kiesler, “Connected Giving: Ordinary People Coordinating Disaster Relief on the Internet,” unpublished paper, Human Computer Interaction Institute, Carnegie Mellon University (ND).
19. Wood, M.M., D.S. Mileti, M. Kano, M.M. Kelly, R. Regan, and L.B. Bourque, “Communicating Actionable Risk for Terrorism and Other Hazards,” *Risk Analysis*, (Forthcoming).
20. Yates, D., and S. Paquette, “Emergency Knowledge Management and Social Media Technologies: A Case Study of the 2010 Haitian Earthquake,” *International Journal of Information Management*, **31**, pp. 6–13 (2011).

## 9 GOVERNMENT USE LICENSE STATEMENT

The submitted manuscript has been created by UChicago Argonne, LLC, Operator of Argonne National Laboratory ("Argonne"). Argonne, a U.S. Department of Energy Office of Science laboratory, is operated under Contract No. DE-AC02-06CH11357. The U.S. Government retains for itself, and others acting on its behalf, a paid-up nonexclusive, irrevocable worldwide license in said article to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.