Dealing with Information Overload When Using Social Media for Emergency Management: Emerging Solutions

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ABSTRACT

Several recent studies point the way to enabling emergency response managers to be able to find relevant posts and incorporate them into their sensemaking and decision making processes. Among the approaches that have improved the ability to find the most relevant information are the social conventions of creating topic groups and tags and of "retweeting;" the use of trained volunteers to filter and summarize posts for responders; automated notifications of trending topics; natural language processing of posts; techniques for identifying posts from the disaster site; and the use of GIS and crisis maps to visually represent the distribution of incidents.

Keywords

Information overload, social media, emergency management.

INTRODUCTION

Social media, primarily used as ways to keep in touch with friends, family, colleagues, are also turned to in times of crisis. Citizen-side information generation and dissemination activities are increasingly playing a critical role in disaster preparation, warning response and recovery (Liu, Palen, Sutton, Hughes and Vieweg, 2008.) Because the public are using social media during emergency events, most emergency managers have also begun to incorporate their use into their activities. For example, a recent survey of members of the International Association of Emergency Managers on the FirstResponder.gov listserv (MacEachren, Jaiswall, Robinson, Pezanowski , Savelyev, Mitral, Zhang and Blanford, 2011) found that over 95% used Facebook or other 'friend' networks for day to day personal activities, about half used it in emergencies; and about 43% used Twitter to gather information from the public and to communicate with the public during emergencies. One reason why more do not use social media during emergencies is that their organizations do not support or may actually prohibit such official use. But another reason is that they may not know how to effectively deal with the flood of information to find those pieces of information that would help them to form and continuously revise their response plan based on unfolding events.

There are four major issues with the use of social media for disaster management that may underlie prohibitions and decrease use of social media even when it is not prohibited: information overload, trustworthiness of the data, lack of reliable access during power outages, and privacy/ civil liberties protection of users. This paper presents a focused literature review of issues related to information overload and potential solutions to the problem, in the realm of social media use in emergency management.

THE INFORMATION OVERLOAD ISSUE

Information overload has traditionally been defined as information presented at a rate too fast for a person to process. An early exploration of the information overload problem in Computer-Mediated Communication (Hiltz and Turoff, 1985, p. 682) is still applicable to the use of social media in crisis management:

… in the context of CMC… the term refers first to the delivery of too many communications and to an increase in social density that gives individuals access to more communications than they can easily respond to, and second to what might be termed information entropy, whereby incoming messages are not sufficiently organized by topic or content to be easily recognized as important …

Even under non-crisis conditions, users of social media often experience information overload. For example, a recent study of Facebook users (Shrivastav, Collins, Hiltz, and Dwyer, 2012) found that the average user sometimes feels overloaded by the "news feed" structure. One partial solution to the information overload problem in trying to use social media in crisis response is to use remote "digital volunteers" to help find, filter, and organize potentially relevant information. However, this is not enough. Verma, Vieweg, Corvey, Palen, Martin, Palmer, Schram and Anderson (2011, p. 385), state the problem so well,

So much information is now broadcast during mass emergencies that it is infeasible for humans to effectively find it, much less organize, make sense of, and act on it. To locate useful information, computational methods must be developed and implemented to augment human efforts at information comprehension and integration.

Note the phrase "make sense of." In order to be able to effectively manage response to a disaster, emergency workers have to first develop "situational awareness" and then put together the information in a process of "sensemaking." Situational awareness has been described by Endsley (1995) as a three stage process of perception, comprehension, and then 'projection" (use of the information for decision making by projecting the situation into the future and deciding what must be done to prevent further problems). Klein, Moon and Hoffman (2006) later divided this into two distinct phases; situational awareness is about acquiring the knowledge and sensemaking is about a process of comprehending the "big picture" by putting together different pieces of information to see the pattern and make decisions.

In the remainder of this paper, we first briefly describe emergent social conventions and technical features of social media that can be useful in organizing and filtering the information posted in order to obtain situational awareness. This is followed by a review of several very promising studies published recently that demonstrate the use of human volunteers and/ or computational methods for decreasing information overload for emergency managers who want to be able to use social media effectively. We end with our conclusions about directions for future research.

TECHNIQUES FOR LESSENING INFORMATION OVERLOAD

Using the "Twitterverse" in Emergencies: Hashtags and Retweeting

The Twitter platform supports both broadcasting and receiving tweets through an online web portal and via the text-messaging feature on most mobile phones. Additionally, a variety of third-party applications enhance Twitter service on the web and mobile platforms, and users in cooperation with Twitter have developed a number of practices to assist information filtering and retrieval in what is now referred to as the "Twitterverse."

One of the most useful of the conventions developed for information filtering and dissemination on Twitter is the "hashtag," which takes the form of #[hashtag term], often appended at the end of the tweet. This can be used to filter the tweets by topic. Another convention is to incorporate the @symbol and the @username convention within a tweet to indicate that the message is for that person or organization, or relating to them. A third convention is the Retweet@[username], which indicates that a tweet is being passed on, and indicating its source. Still another convention is follow@[username] indicating that the Twitterer is recommending to their network that they become followers of somebody else. These conventions allow the very speedy spread of information about a crisis in the Twitterverse, often referred to as a post "going viral."

Starbird and Palen (2010) describe how these conventions were used during two disasters in spring 2009: flooding on the Red River and fires in Oklahoma. Their analysis showed that during an emergency, for tweets authored by local users and tweets that contain emergency-related search terms, retweets were more likely than non-retweets to be about the event. They also noted that users are more likely to retweet information originally distributed through Twitter accounts run by media, especially the local media, and traditional service organizations, as well as those originating from users in the disaster area itself, who supply first-person detailed descriptions of the evolving situation. Sources of photos of the disaster area are also frequently retweeted. Thus the retweet symbol can be used to help assess posts for relevance. Note that increasingly, major NGOs (Non-Government Organizations) such as the Red Cross, are taking the initiative to suggest appropriate hashtags for an emergency, and are proactively directing Twitterers to websites set up to handle evolving information on a disaster.

Next, we describe several studies that point to specific techniques for enabling emergency managers to find or receive the information they can use without having to wade through raw and mostly unhelpful posts. Several studies report progress on practices or computer programs that can identify incidents of interest, condense and summarize messages about an incident in order to maintain awareness of aggregated content, without onsite managers or responders having to read through individual messages.

Using "Voluntweeters" To Ease Information Overload

The Tweak the Tweet syntax is one of several Twitter microsyntax proposals, designed to assist in computational filtering and classification of emergency related information tweeted during an event (Starbird and Stamberger, 2010). An extension to the role of the hashtag was proposed for use by formal response agencies such as the Red Cross to encourage users to mark up tweets in a way that would allow computers to easily identify and parse key pieces of information, such as the type of report, location, contact, etc. This convention was put to good use during the Haiti earthquake of 2010, when volunteers from all over the world tried to help with filtering tweets to pass on those trying to respond on the ground in Haiti. The U. of Colorado research group broadcast a set of prescriptive hashtags to structure the communication related to Twitter, such as #need, #offer, and #loc; almost 300,000 tweets subsequently used the suggested syntax. The "voluntweeters" acted as translators and also directed the flow of critical information to responders on site. This demonstrated the usefulness of prescribed hashtags to make the Twitter stream more manageable, as well as the use of remote volunteers to help filter and direct information.

A subsequent account of the use of "digital volunteers" showed how they can also be used as liaisons between the overburdened personnel of official response organizations and the users of social media who want to receive information (St. Denis, Hughes, and Palen, 2012). The incident was a large scale forest fire in the Northwest U.S. Agency regulations actually prohibited the fire fighting personnel and incident commander from using social media themselves. Over the course of three weeks, eight digital volunteers reported directly to the incident commander, at her request, on what they were seeing on the social media, including issues and concerns being expressed by the public, and misinformation that needed to be dealt with. They also used Twitter to direct people to new information as it became available, including the official press releases. The authors suggest that variations of this model could be incorporated into emergency management organizations in the future.

"Natural Language processing to the Rescue?"

A recent study from the Colorado group (Verma et al., 2011) describes a program developed to automatically identify messages communicated via Twitter that can contribute to situational awareness. The authors collected Twitter messages from four different crisis events of varying nature and magnitude, then built and tested a classifier to automatically detect messages that may contribute to situational awareness. The system used a combination of hand-annotated and automatically-extracted linguistic features.

Using NLP and machine learning (ML) techniques, they developed a suite of classifiers to differentiate tweets across several dimensions: subjectivity, personal or impersonal style, and linguistic register (formal or informal style). Based on initial analyses of tweet content, they posited that tweets that contribute to situational awareness are likely to be written in a style that is objective, impersonal, and formal; therefore, the identification of subjectivity, personal style and formal register could provide useful features for extracting tweets that contain tactical information. When evaluated by hand coding of a sample of approximately 500 tweets from each of the disasters that were categorized as "on topic" and then analyzed by their natural language, the system was able to achieve over 80% accuracy on categorizing tweets that contribute to situational awareness. The authors conclude, "The results are promising, and have the potential to aid the general public in culling and analyzing information communicated during times of mass emergency" (Verma et al, 2011, p. 385).

There are several other examples of systems that use text analysis/ natural language processing, some in conjunction with characteristics of posters gleaned from their directories, to find posts that are relevant to a specific incident. For example, Cameron, Power, Robinson, and Yin (2012) describe ongoing work to detect, assess, summarize, and report messages of interest for crisis coordination published by Twitter. They developed a platform and client tools to demonstrate how relevant Twitter messages can be identified and utilized to inform the situation awareness of an emergency incident as it unfolds. Their system uses a clustering engine to gather and visually display clustering sets of tweets related to an incident. Another example of an automated filtering system is Twitcident (Abel, Hauff, Jouben, Tao and Stronkman, 2012), a web-based system for filtering, searching and analyzing social web based information about real-world incidents or crises.

Automatically Identifying Tweets from "On the Ground"

Tweets that are sent from those at the location of an emergency event can be especially valuable for providing "situational awareness." However, it is not easy to find these by searching without any analytical filtering support. Automated analyses that take advantage of "collaborative filtering" processes can substantially help with this process. Collaborative filtering is defined as "a technique for extracting meaning from the aggregate

behavior of a large number of users" (Starbird and Palen, 2012, p. 1) by using aspects of both individual and collective actions. They first used data from the Egyptian protests of 2011 to identify differences in how Twitterers recommended locals vs. non-locals, including retweeting locals more frequently. They also observed that the total number of times an account was retweeted, as well as the number of different tweets for which an account was retweeted, were positively related to being "on the ground" in those protests.

In the second study, a large sample of tweets from the Occupy Wall Street demonstrations in New York in October 2011 was assembled. They developed an automated filter using a technique called "asymmetric soft margins" and a "support vector machine" and then tested it on the sample data set. Features that were used included follower growth, times retweeted, and total number of tweets sent about the event, among others. This filter was able to successfully identify about 68% of the on the ground tweets, which is a significant improvement over trying to find the 5% of the total tweets that were on the ground, by hand.

A GIS to Aid Sensemaking

MacEachern et al. (2011) describe a prototype system that incorporates "geo-analytics;" that is, a system that includes analysis and visual displays from analyzed Twitter posts in the form of a map, to aid in situational analysis for crisis management. Their work also included a survey of emergency managers which covered not only what social media they currently use, but also the tools and features they would like to have to more effectively incorporate social media into their situational awareness and decision making activities. Among the most popular choices for features to include were Maps (95%), photos/video collections (71%), time graphs (60.5%), keyword clouds (58%) and clustering tools (47%). The prototype, called "Senseplace2," focuses on

leveraging explicit and implicit geographic information for tweets, on developing place-time-theme indexing schemes that support overview+detail methods and that scale analytical capabilities to relatively large tweet volumes, and on providing visual interface methods to enable understanding of place, time, and theme components of evolving situations (MacEachrern et. al., 2011, p. 181).

Senseplace2 works with Twitter, but could be extended to work with other social media. Among the features are a 'tweet list" that includes 500 identified/ selected most relevant tweets for any inquiry that they make, complete with a color-coded strip to indicate the relevance ranking of each selected Tweet. This list can be sorted by relevance, time or location. The tweets include live links so that a manager can view any photos or videos referenced in them. Secondly, there is a display in the form of a "tweet map," supporting simultaneously, a geographic overview of the location of the selected tweets, and the ability to get more detail by selecting places or applying spatial filtering. A "heatmap" is included in the overview tools that uses color to depict tweet frequency by concept (topic), time or place specifications (MacEachern et al. 2011).

CONCLUSION: RESEARCH TOPICS FOR THE FUTURE

Information systems designers need to provide better structures and features for collecting, validating, organizing, and visually transmitting citizen-generated information during disasters (Palen, Hiltz, and Liu, 2007). Continued failure to recognize that use of social media challenges conventional models and demands new informational relationships between official organizations and the public, portends a future where crises are managed much less well than they could be if "collective intelligence" is able to go to work on solving problems related to disasters. The selected studies described in this review provide promising foundations on which to build future systems and studies. In particular, natural language processing to filter and aggregate and analyze social media data streams, combined with geo-visual displays as part of the delivery of results, have a great deal of promise for overcoming the information overload problem faced by emergency managers who want to be able to efficiently use the information provided by the public during emergencies.

Social Media are a "disruptive technology"; they have changed the way we interact and respond as a society. It is crucial that technologies are developed to promote effective use and that organizations respond to increased use in ways that leverage the communication channel effectively. More studies are needed on how emergency managers in both government and NGO organizations in different parts of the world currently use social media, the problems they encounter, and the solutions they have developed that might be adapted by other organizations, including how best to incorporate digital volunteers into emergency response situations, as liaisons via social media between the public and the official on-site responders.

Twitter and other Social Media are being used and, one can speculate, will only increase in use in crises. The studies we reviewed indicate that researchers are actively engaged in not only understanding how and why social media is used, but are also developing technological solutions to issues such as information overload. These solutions will promote more effective use of social media. We intend to expand our literature review. A

compendium of studies can have a synergistic effect and be helpful in guiding research in the future.

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