



Social Media Monitoring – An Assessment for Emergency Management: 2015

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The contribution of Opus Research to The Public Alerting and Social Media Monitoring report is based on the research of Abigail [Abi] Beatson conducted as part of her PhD studies at Victoria University of Wellington, New Zealand. The Public Alerting and Social Media Monitoring report may use the material produced by Opus Research, provided that Abi Beatson's moral right to assert authorship be acknowledged, and that Abi Beatson retain the right to include all her original research in her PhD thesis, despite its prior publication.

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Keywords

Social media, social media monitoring, situational awareness, emergency management, monitoring functionality.

1 Executive Summary

Social media is increasingly being recognised for its potential to (1) provide a fast and direct line for emergency managers to communicate with the public, and (2) as a valuable source of first-hand knowledge derived from a crisis-affected community, which can then inform and supplement situational awareness and decision making. There has also been a discernible shift in public expectations of the use of social media as part of the response efforts in an emergency, including the expectation of near real-time public engagement and the monitoring for requests for help and services through social media, especially when traditional communication channels are overwhelmed or inoperable.

The practice of social media monitoring tracks, archives, and analyses the content that is produced on and through social media. The purpose of this report is to assess the state of social media monitoring products as at 2015, especially in terms of its use for emergency management, and provide guidance to New Zealand's Civil Defence Emergency Management (CDEM) sector on this. This report will draw on, contextualise, and develop the increasingly growing body of research and national and international case-study analysis regarding existing social media products that can be used for CDEM monitoring purposes. The report is divided into sections that correspond to three specific but related tasks:

1. A synthesis of recent New Zealand and international research projects and reviews of existing social media monitoring products, including a review of the available literature and discussion of various background issues relating to CDEM monitoring requirements.
2. An analysis of the social media monitoring functions and capabilities that support and enable these CDEM monitoring requirements.
3. A review of the necessary verification procedures, resourcing, policies, and ethical considerations in regard to the use of social media for monitoring purposes.

At this point in time it is commonly found that the resources, training, and technological capability are not in place to meet public expectations of social media monitoring by the CDEM sector: consequently we face the risk of needing to build this capability 'on the fly' during an emergency. This research seeks to address this by providing a thorough account of considerations for use of social media for monitoring in emergency management in 2015.

It is noted that there are many challenges in adopting existing 'plug and play' products for social media monitoring given that social media platforms can change their features, new social media monitoring products are regularly appearing, and most have an emphasis on Twitter. Short term recommendations focus on building realistic capacity and resilience for utilising currently popular social media. Longer term recommendations focus on a nationally led collaboration with one or more internationally leading organisations in the field to adopt a well tested and proven product.

2 Research Background

2.1 Framing Social Media

The conceptual framework outlined by Hughes et al. defines social media as “Internet-based applications that promote high social interaction and user-content generation often at a one-to-many or a many-to-many scale” (2014a: 350). Popular examples of social media applications include Facebook, Twitter, YouTube, and Instagram: with Facebook and Twitter being two examples that are currently the dominant channels chosen for use in emergency response (Whitelaw 2014:1). Social media now plays an “integral part” in modern global communications (Tyshchuk et al. 2012: 818): this development in communication practices and available technologies now provides emergency management organizations with a direct and fast line of communication with a growing body of technologically literate New Zealanders. As Giroux et al. describe, a “key driver” of this trend is the advent of Information Communication Technologies (ICTs), and they explain and summarise this relationship:

ICT refers to technologies that provide access to information via the Internet, wireless networks, cell phones, and other communication media. Social media can be understood as communication services that employ interactive online ICT (often referred to as Web 2.0 technologies) to enable the exchange of user-generated content (2013: 5).

2.2 Why Mobile Technology Matters

Social media provides a new and enhanced methodological toolkit to support situational awareness for emergency managers in disaster response contexts. This includes a growing number of eyewitness texts, photos, videos, and volunteered geographic information (on maps) that contribute to the information available in a crisis event (Hughes 2014a: 349). Central to this information propagation is the increasing ownership of multimedia recording technologies (such as smartphones) that are now creating and enabling what Goodchild (2007: 211) describes as networks of “citizen sensors”. Reports coming from on-the-ground are of particular interest to emergency practitioners, where “first responders” are often victims of the disaster themselves and they can provide timely information as to the impact of the event and any specific needs for assistance (Dynes 1994 quoted in Imran et al. 2014: 5).

2.3 Online Convergent Behaviour

Individuals are increasingly using social media to establish online communities during a crisis event so that “members can both seek and share information” (Hughes et al. 2014a: 353). As the Red Cross World Disasters Report states: “disaster-affected communities today are increasingly likely to be ‘digital communities’ as well – that is, both generators and consumers of digital information” (Red Cross 2013). As Hughes et al. (2008: 1) explain, sociologists “have documented the nature of convergence onto the physical sites of disasters... and now, increasingly, parallels of such behaviour can be seen on-line”. The work of Hughes et al. (2008) explains the similarities of this online convergence using existing explanations of offline convergent behaviour during disaster events. However, they also emphasize several important differences: that the number of people who can converge around a disaster event online is almost limitless; that the speed within which people and information can converge is changing; and that participation is not defined by geographic boundaries (Hughes et al. 2008:1).

Twitter is just one example of where information converges across the Internet: it creates “sites” of interaction where individuals and groups digitally converge during disasters (Palen et al. 2007: 729). The content and patterns of communication in these “sites” varies, depending on the stage and type of crisis event. However, the work of Vieweg (2012) identifies 35 types of messages, divided into three overarching categories, that give an indication of the types of information posted

and shared on Twitter, relating to social, built and physical environments (Imran 2014: 8). Imran et al. elaborate on these categories, explaining that the “social environment messages describe anything having to do with people and their reactions to the crisis, built environment messages correspond to information and updates about property and infrastructure, and physical environment messages include updates about the hazard agent, weather, and other environmental factors” (2014: 9). Understanding the types of information posted and shared through social media channels in any event is an important consideration for emergency managers: they need to know that what are likely to find, and not find, on social media in the midst of a response (Vieweg 2014: 14).

2.4 Online Emergent Behaviour

Online communities come into existence in order to find ways to adapt and respond to, and hopefully resolve, their immediate needs. Communities become aware of the need for adaptation and additional responses when “demands are not met by existing organizations, [when] traditional tasks and structures are insufficient or inappropriate, and/or [when] the community feels it is necessary to respond to or resolve their crisis situation” (Giroux et al. 2012:7 quoting Drabek et al. 2003). This highly complex network of community interactions, enabled by the increased connectivity that technology provides, leads to a self-organized form of coordination in crisis response that often precedes any formal or organisational policy or practice. As Hughes et al. (2014a: 362) explain: “[t]he frequent and rapid interactions that occur between people in these information exchanges shape the digital representation of the disaster. The behaviours that we see exhibited today are signs of what is to come; more critically, they provide us with the material for deliberately creating what is to come in the form of practice, policy, and technology design”. Sutton also argues that these “information seeking behaviours further illustrate the mounting need for changes in emergency response management policy that take into account the changing, ICT-extended information arena of disaster, and recognize its advantages” (2008: 2).

2.5 Social Media Use in Emergency Management

The value of social media is increasingly being recognised by emergency managers. Its value has been recognized in terms of its ability to function as an effective communication mechanism, by providing a fast and direct line for emergency managers to communicate with the public (Hughes 2014b:727). However, user-generated content has also been shown to provide valuable information. As Vieweg et al. (2014:8) explain: “despite the (well understood and often inherent) bias of social media data, eyewitness accounts, first-hand knowledge and additional useful information captured via social media can still augment situational awareness”. Other research supports this finding, especially in regard to supporting situational awareness for “specific related tasks” in an emergency (Hughes et al. 2014a: 355). By way of example, the work of Patrick Meier (2012) found that between “8 per cent to 65 per cent of all tweets generated during disasters were informative and relevant” (World Disasters Report 2013: 74). As the Red Cross World Disasters Report states: “[w]hen disaster strikes, many of these SMS and Facebook posts relay critical crisis information. Indeed, recent data-driven research on social media use during disasters has shown that user-generated content posted on Twitter, for instance, can be informative and relevant for disaster response” (Red Cross 2013). It is therefore no surprise that there is a demand from emergency managers to not only monitor and track the information being shared to support situational awareness, but also to be aware of, and correct, any misinformation and rumours.

3 Social Media Monitoring

3.1 Public Expectations and the State of the Field

Important issues were raised by the 2012 American Red Cross survey regarding public expectations of the use of social media as part of response efforts. The survey found that 76 per cent of adults expect help to arrive in less than three hours if they posted an emergency-related request on social media (American Red Cross 2012). Additionally, a similar survey was conducted by the Red Cross in Canada, which found that: “63% of Canadians think emergency services such as fire and police should be prepared to respond to a call for help posted on a social media site such as Facebook or Twitter. One third of respondents believe help would arrive if such a call was posted through social media” (Canadian Red Cross 2012). These results underlie public expectations that emergency agencies will monitor social media platforms, placing particular emphasis on when requests for help may be posted during an emergency.

However, along with evolving user expectations, social media technologies and patterns of use are also rapidly evolving. Keeping up-to-speed with these developments can be a challenging task for emergency managers as new forms of social media appear daily and existing uses of social media evolve (Hughes 2014b: 727). This is also complicated because many social media monitoring organisations predominantly focus on data extraction and filtering methods and not on the social media-monitoring requirements of emergency managers (Imran 2015:7). In light of this, this report considers social media monitoring tools that have either been specifically built with the social media monitoring requirements of emergency managers in mind, or can be easily adapted to fulfil these requirements.

3.2 CDEM Monitoring Requirements

There is a quite limited amount of research that specifically focuses on ways to process social media data that addresses and is centred on the specific information requirements of emergency managers. However, the research that is available provides a valuable contribution. The work of Cameron et al. (2012: 696) summarises the information requirements of emergency managers:

3.2.1 Table 1 Information requirements of emergency managers

- Detect unexpected or unusual incidents, possibly ahead of official communications;
- Condense and summarise messages about an incident maintaining awareness of aggregated content without having to read individual messages;
- Classify and review high-value messages during an incident (e.g. messages describing infrastructure damage or cries for help); understand the impact of an incident on people and infrastructure;
- Identify, track, and manage issues within an incident as they arise, develop, and conclude; pro-actively identify and manage issues that may last for hours, days or weeks;
- Perform forensic analysis of incidents by analysing social media content from before, during, and after an incident.

Source: Cameron et al. (2012: 696)

The Waikato Group Emergency Management Office (GEMO) identified a number of CDEM monitoring purposes for which social media could be used in times of both business as usual (BAU) and emergency response and recovery:

3.2.2 Table 2 Examples of Waikato Group Emergency Management Office (GEMO) CDEM social media monitoring purposes

- Alerting EOC and emergency response staff
- Tracking official emergency alerts
- Providing situational awareness (i.e. identifying hotspots of activity and rapid needs assessment)
- Information verification and rumour control
- Identifying key social media response partners
- Identifying influencers and working with important actors (i.e. local volunteer networks)
- Crowdsourcing and crisis mapping
- Monitoring and utilising international volunteer networks (i.e. Digital Humanitarian Network)
- Providing input to essential policies and considerations (i.e. ethics and legal)
- Planning work structure and resourcing
- Identifying opportunities for building relationships with communities
- Identifying CDEM marketing opportunities
- Monitoring uptake and success of promotional CDEM activities (“e.g. Get Ready, Get Thru” or “Shakeout”)
- Identifying key stakeholders and potential community intel sources

Additionally, research conducted by the Virtual Social Media Working Group (established by the United States Department of Homeland Security) provides an account of how the Clark Regional Emergency Services Agency (CRESA) structures its specific information requirements when monitoring social media during a large-scale event, including:

3.2.3 Table 3 Examples of CRESA social media monitoring information requirements

- Individuals unable to reach or utilize the 911 system
- Needs and resources (available and needed)
- Structure outages, infrastructure damage, and damage assessments
- Life safety issues
- Rumours and misinformation (unverified versus untrue)
- Accuracy of county-specific information being shared by other parties

Source: Virtual Social Media Working Group (2014:14)

While there are hundreds of social media monitoring tools available, only a designated few specifically focus on these monitoring requirements. There are also very few tools that contain the complete functionality that satisfies all of these requirements on one platform. The current state of the field is that specific platforms are often uniquely proficient at particular tasks and often focus on one data source, most commonly Twitter. The rapidly developing state of the field also means

that the different social media monitoring platforms have varying degrees of maturity and proof of capability in real-life situations (Imran 2015:6).

4 Enhanced Situational Awareness

4.1 Content Classifications

For this report we define and understand situational awareness as: “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” (Endsley 1995:5). Situational awareness has long been recognised as a central part of successful decision making for emergency managers, and understanding the impacts of any event is critical for implementing a successful response and recovery process. For many emergency managers situational awareness includes multiple sources, and, for many, this now also includes social media (Virtual Social Media Working Group 2014: 40). Social media cannot be incorporated into any response efforts unless emergency managers have a good general understanding of the categories of information contributed by the public through social media channels in an emergency event. As discussed in section 2.3 the work of Vieweg (2012) identifies 35 types of messages posted and shared on Twitter, which are divided into three overarching categories based on whether they relate to social, built or physical environments. The work of Imran et al. provides an in-depth analysis and detailed breakdown of the “various dimensions of content posted on social media during high impact events” (Imran 2014: 21). This is a valuable resource as it provides emergency managers with a framework to comprehend the categories of information commonly contributed by the public through social media channels in an emergency.

Additionally, social media monitoring, if integrated and combined with other sources, provides an extended and valuable application for enhanced situational awareness. In short, “social media data, if integrated or combined with other information channels, can enhance general situational awareness; provide context to traditional channels; and serve as a means to verify, follow up on, and counteract information provided to and from the public and the field” (Virtual Social Media Working Group 2014:21). Therefore, social media data can help “complete the picture” of an emergency situation (Vieweg et al. 2014:9). However, the information needs of response agencies can change markedly from one event to another, and the levels of specificity required from social media data also depend on an agency’s missions or goals. By way of example, “in a small event, specific details may be necessary; however, during a major and dramatic event, general trends may be sufficient” (Virtual Social Media Working Group 2014:21). These pre-existing conditions inform the specific monitoring requirements of emergency managers; and while “it may be possible to conduct a landscape analysis of social media channels... targeted aggregation and searches may prove more effective to identify information that specifically addresses the objectives and information requirements” of emergency responders during an emergency (Virtual Social Media Working Group 2014:14).

4.2 Public-to-Public Communication Sharing

A central part of the effectiveness of social media is that it can immediately generate peer-to-peer communication. However, this type of communication sharing also creates an “information marketplace” where emergency managers participate as a voice among many (Preston et al. 2013:6). Consequently, individuals and organisations can now also become influential information brokers in an emergency. Importantly, this means that social media has changed “the type of sources that people use and how they reach their decisions” (Wendling et al. 2013: 8). It is critically important that emergency managers are aware of these influential sources of information, available to the public in an emergency, so as to get a better idea of both the level of public awareness and the kind of information they are using to inform their decisions. For example, during the impending approach of Cyclone Pam in March (2015), a community-initiated Facebook group

titled ‘Cyclone Pam NZ Updates’ rapidly built an audience of over 8,000, by offering to provide: “[i]nformation for New Zealanders and updates on Cyclone Pam’s track towards New Zealand” (Masters 2015). Group members used this page to post their own updates to the other followers of the page and establish a support and resource network for the affected community. Community sites like this one are of value in an emergency, but it is important to ensure that the information being shared is accurate, comprehensive, and up to date.

4.3 Social Media as a Communication Backchannel

In an emergency, social media channels can also become a “lifeline” for individuals to communicate with family and friends, find information about victims, and receive official announcements where Internet access is available (Appleby 2013: 7, Dabner 2012: 69). Social media can also function as a “backchannel” communication mechanism by providing “peer-to-peer communications that are not part of the official discourse of the event” (Palen 2008: 77). This can also be useful for affected communities to communicate local information (such as the promotion of volunteer activities) often not available through traditional media channels. This use of social media can be especially prevalent when other communication systems are inoperable. By way of example, Anikeeva et al. explain that “[o]ne key advantage of social media platforms ...[is] that they tend to be more robust than standard websites and less likely to fail during periods of high traffic, which may occur during emergency events” (2015: 6). This was the case in the aftermath of the magnitude 9.0 Great East Japan Earthquake, where social media often functioned as a replacement communication mechanism because of the limited operability of the traditional communication infrastructure immediately after the earthquake (Kaigo 2012:31). As Sutton et al. explain: “[o]pportunities for participation by members of the public are expanding the information arena of disaster. Social media supports “backchannel” communications, allowing for wide-scale interaction that can be collectively resourceful, self-policing, and generative of information that is otherwise hard to obtain” (2008: 1).

4.4 Social Media Monitoring of Trusted Agencies and Individuals

Establishing a list of verified social media accounts before an emergency is an essential part of the social media monitoring strategy and process. These credible sources can help to confirm an event, and provide information as to what other official actors are sharing with their social media audiences. This also supports enhanced situational awareness and fact checking when an event occurs. By way of example, using the list functionality on Twitter, it is possible to establish a curated list of official and trusted Twitter user accounts. This functionality then curates a stream of Tweets from the users on that list, to support the monitoring of trusted agencies and individuals.

Alternatively, features such as the Facebook Interest Lists also make it possible to filter activity by the pages and people on Facebook that are relevant to your monitoring criteria. However, it is important to establish these list features before any emergency event, as the process can be time consuming. Silverman et al. summarise the key points to address when building and maintaining a network of trusted sources, including the following two key criteria:

- Build a list of reliable sources that include both official and unofficial such as first responders, academic experts, NGOs, government offices, etc. Gather not only social media accounts but also phone numbers and emails in a shared database/spreadsheet.
- Create Twitter Lists that are organized in logical groups based on topics or geographical location. Find the reliable sources through Twitter advanced searches and by following specific hashtags. You can also use Facebook Interest Lists and Google Plus circles, subscribe to YouTube channels and build playlists .

5 Monitoring Functionality

5.1 Historical/Real-time Data

Social media monitoring tools enable the opportunity to observe human behaviours and interactions in near real-time. In particular cases, such as social media monitoring for emergency management, it is critically important that these platforms provide real-time updates and alerts without delay. However, some platforms have a data latency, taking several hours to days to process conversations on the social web. It is important to establish how long a social media monitoring provider will take to provide metrics and analysis and, if there is a delay, how long this time-period will be. Most social media monitoring platforms also offer access to a limited amount of historical data prior to the date monitoring has commenced. However, it is important to establish how far back this data access goes.

5.2 Data Volume

The quantity of social media data generated through social media channels in an emergency can be overwhelming for emergency managers, and analysing this data can be very time-consuming. In a large-scale event that lasts for several days, millions of messages may be recorded (Imran et al. 2014: 13). By way of example, during Hurricane Sandy, 3.5 million Tweets were reported in a period of 24 hours (Ngak 2012). During the Christchurch earthquake the hashtag #eqnz (earthquake New Zealand) averaged 100 tweets per minute in the hours following the earthquake, and it generated nearly 50,000 tweets that day (Bruns et al. 2012a: 13). Social media monitoring tools have now become essential to track, monitor, and analyse this information during an event.

5.3 Application Programming Interfaces (API) and Data Access

Third party systems rely on the use of Application Programming Interfaces (APIs) to have access to the data present on the different social media platforms. However, as Imran et al. explain, “the details of APIs vary substantially from one platform to another, and also change over time. Additionally, all APIs that we are aware of are resource-limited in some way” (2014: 9). Understanding the different APIs and their limitations is an important step in choosing any social media monitoring platform as that might impact the quality of the information being processed by the monitoring platform. By way of example, the three different APIs for Twitter include the Twitter’s Search API, Streaming API and the Twitter Firehose, with each offering different methodologies and levels of access to Twitter data. A select number of organisations have access to the full Twitter ‘Firehose’, a name given to the complete real-time stream of Tweets that flows through Twitter each day. In comparison, Twitter’s streaming API only offers access to a certain percentage of Tweets, estimated to be a random sample of 1% of the full Firehose of tweets. Therefore, “if using a free aggregation or analysis tool to search tweets, one only has access to approximately 1 per cent of all available tweets published at the time of aggregation through the API” (Virtual Social Media Working Group 2014: 30). Additionally, the data returned from the Facebook Graph API (e.g. status updates, location, interests) is limited by, and reliant on, the privacy and permission settings of individual users. This is a critical juncture for emergency managers assessing the value of social media monitoring tools and platforms, as data access remains an important consideration for a comprehensive social media monitoring approach.

5.4 Data Sources

The range of conversation coverage that is available is important, as the search results will only be as good as data initially inputted for analysis; and it is important that specific data sources are not overlooked. There is a wide range of data sources available to choose from, including Twitter, Facebook, images, videos, mainstream news and comments, blogs and forums. It is important to apply careful consideration to what data sources a social media-monitoring platform does and does

not offer, and to consider if the functionality also enables a refined search framework, so as to be able to exclude unwanted data sources at a particular point in time.

A lot of the examples discussed focus on Twitter. This is because the majority of Twitter users share their information publicly, as a default setting. Alternative platforms, such as Facebook, are limited in their capability for being monitored by tools due to a complex relationship between API terms of service and the privacy settings enabled by individual users. Additionally, these policies are subject to change. By way of example, Facebook have introduced a mandatory switch to a new API in early 2015, which significantly limits the search capabilities of many social media monitoring providers at this point in time. It is recommended to talk to individual providers about these limitations.

5.5 Identifying Influencers

As already discussed, social media now provides the public with multiple and overlapping information channels that have a direct impact on “the type of sources that people use and how they reach their decisions” (Wendling et al. 2013: 8). In response to this growing trend, many social media monitoring platforms now enable the identification of specific individuals or organisations who are driving conversations online, or have established themselves as a reliable and credible source of emergency information during an event. This functionality is also useful for emergency managers who need to understand their share of voice in the market. These ‘influencers’ can also include organisational ambassadors, who promote the work and propagate the messages of emergency organisations. It is therefore useful to use this functionality to build a list of non-official authoritative sources and influencers, and to monitor these to ensure that information communicated by the public is both informative and correct. As Hughes et al. explain: “[m]embers of the public, as long as they can discern reasonable credibility of the source, will also consider the viability of user-generated content... During high-response times, PIOs [public information officers] often monitor social media streams to ensure that information communicated by the public is correct. Even though they are not authorized to respond to these communications, they will step in to correct misunderstandings” (2014a: 358).

5.6 Geo-location

The capability of filtering social media data by region, such as a particular locality or place, is still being developed. However, this functionality is important for emergency managers as the first on-the-ground reports of an emergency are now increasingly coming from social media channels. Additionally, this functionality may provide information on the locality and corresponding needs of people affected by an event. Early research also suggests that individuals have a higher sense of social responsibility if they are close to the disaster, leading to more accurate information sharing through social media channels (Thomson 2012: 69).

Many social media monitoring platforms now include location as a data filter. However, it is important to understand the limitations of this monitoring criteria. By way of example, it is often difficult to identify the location of an individual posting on Twitter. De Longueville et al. provide a useful summary of the complexities in establishing location information through Twitter:

a user’s location is provided on their profile page but this location is expected to be the place where they live and not their location when a tweet is made. Notably, applications running on GPS-enabled smart phones allow users to automatically update this location field each time a tweet is posted... Secondly, tweets themselves can contain geographic coordinates or more often place names that can be geocoded (2009: 74).

As De Longueville et al. explain, a user’s location is usually provided on their profile page, but this does not necessarily correspond to the location where the Tweet was posted, unless they choose to update this information when a Tweet is made. Alternatively, location data is sometimes available through ‘geocoding’, the method of locating geographical references in the text, such as a place or street name (2009: 74). However, there are specific issues and limitations with regard to this

functionality. Firstly, only a very small number of Tweets contain geographical location data enabled by the user when a Tweet is posted (Imran 2014: 12). Secondly, even if this data is available, the information can quickly become inaccurate as the individual moves from one location to the next (Virtual Social Media Working Group 2014: 29). Finally, any information sourced from ‘geocoding’ may not actually correspond to the location of the individual, and the possibility of individuals providing false geo-location data must also be considered. Moreover, the availability of geo-located data relies heavily on users’ privacy settings and their will to share their location or not, not to mention that social media platforms might change their internal system at their will, which might prevent geo-location information being exposed through their APIs. Facebook also provides the option to add location information to a post, and, as with Twitter, users must ‘opt-in’ to share this information with their networks or the wider public. Some emergency managers and humanitarian responders are starting to encourage the public to ‘opt-in’ and enable their location data when posting in an emergency. This is a developing practice, but one that must be carefully considered in regard to both privacy and security risks.

Each social media platform has specific rules and frameworks for determining what location data is made available when user information is posted. Therefore, it is important to have a clear understanding as to the methodologies any social media monitoring provider uses to source geo-located data before its value can be ascertained. For example, services that just rely on users ‘opting-in’ to provide location data will only capture a small percentage of the social media content uploaded in any event; and location information sourced from individual profiles may also prove to be inaccurate. It’s important to note that, although geo-location data may be inaccurate or not present in a social media message, reviewing this message can still prove useful. Part of the monitoring process includes manual evaluation procedures such as identifying key landmarks in images and text and, even though the location of a post might have wrong geo-location data, a human reviewing those messages might still extract useful emergency information from that message.

5.7 Keyword Search

Most social media monitoring platforms provide the functionality to input specific keywords for data capture and analysis. Once established, this search profile should provide wide-ranging coverage of conversations across the web relevant to the keyword(s) being investigated, displayed chronologically, and updated in near real-time. The set of keyword options can include individual words, word combinations, phrases, Twitter handles, hashtags, etc. This functionality remains important as social media monitoring can only be successfully implemented when specific terms are used to identify information related to the event being monitored. Importantly, filtering techniques should also provide the functionality to block certain keywords or profiles to enable a refined search framework and avoid spam. It is also important from the outset to understand the limits of this search functionality in terms of the relevant organisations providing the monitoring tool. For example, many social media platforms limit the amount of data that can be returned within a given timeframe. It is therefore important to have a good understanding of the projected volume and flow of data, before choosing a particular monitoring tool.

5.8 Natural Language Processing

Liddy (2001: 2) describes natural language processing (NLP) as “the computerized approach to analysing text that is based on both a set of theories and a set of technologies”. One of the aims of natural language processing is “to accomplish human-like language processing” (Liddy 2001: 2) such as text summarization, text processing, and information extraction. Natural language processing is increasingly being applied to crisis monitoring and providing valuable capability in processing the mounting quantity of social media data generated through social media channels in an emergency. By way of example, the Artificial Intelligence for Disaster Response (AIDR) platform “leverages machine learning to automatically identify informative content on Twitter during disasters” (Meier 2013).

5.9 Trends

A topic trend graph enables you to see the ebb and flow of conversation over a period of time by grouping similar messages. This is important for gaining an overview of peaks in conversations, and the associated events or topics driving heightened online activity. Trend monitoring may be valuable in order to identify sub-events within a crisis, such as food, water, health and shelter needs. Topic trends are mapped over a period of time, and it should be possible to drill down to investigate spikes in the number of posts or articles that have ignited conversations. Some of the top-level social media monitoring platforms also offer the ability to view topic trend graphs by various filters, such as sentiment, language, media type or region. However, it is important to note that peaks in activity do not necessarily correlate with the affected regions. For example, during Superstorm Sandy social media data was concentrated in less-impacted areas, such as New York City, instead of more-affected neighbourhoods such as South Queens (Tellman et al. 2015:4). This may be reflective of a “considerable bias in social media data toward those located in urban areas, with access to telecommunication networks” (Vieweg et al 2014: 8).

5.9.1 Trend Application: Sentiment Analysis

Some social media monitoring platforms also offer a sentiment analysis. This is where the sentiment of a sentence, or phrase, is identified as positive, neutral or negative and then collated to visualise sentiment trends over time or regarding specific topics, organisations, projects or campaigns. Natural language processing techniques are often used with many social media monitoring platforms claiming a percentage level of accuracy. However, it is important to ensure care and rigour in reporting the percentage of error in reports and crosschecking the data to gauge the actual level of accuracy, if using this functionality.

5.9.2 Trend Application: Alerts and Early Warning

Trend analysis can also function as an alerting or early warning service. One method is to identify sharp increases in social media posts within a specific time that contain particular pre-established keywords, such as ‘#eqnz’ (earthquake New Zealand). For example, the Twitter-specific platform Twitinfo “detects events by identifying sharp increases in the frequency of tweets that contain the particular user-defined query as compared to the historical weighted running average of tweets that contain the same query” (Imran et al. 2014: 17).

5.9.3 Trend Application: Retweets

Retweets, or the re-posting of someone else's Tweet with your Twitter followers, is another important trending mechanism. Retweets can be viewed as a peer-nominated recommendation mechanism, and research by Starbird et al. found that “Twitterers use the retweet convention as an informal recommendation system, to pass on information they feel is important for others to know” (2010: 3). In light of this, tracking retweets may be a valuable tool for emergency managers to identify valuable response information (Moore et al. 2014: 5). The retweet functionality may also mean that “[e]ven though Twitter messages flow by quickly, the messages that contain the most important information tend to reappear” (Hughes 2014c: 4).

However, there are limitations to this monitoring criteria. Firstly, information propagated multiple times over does not signify proof of accuracy or truth (De Longueville 2009:78). Information that is retweeted multiple times over can also make it difficult to verify the original author. Additionally, complications can arise when “slightly altered duplicate messages may result in rescue workers returning to an area multiple times, believing message alterations are a new request for assistance as compared to messaging error” (Moore et al. 2014: 5).

5.9.4 Trend Application: Hashtags

Twitter conversations are often coordinated by hashtags (#). Hashtags are keywords or abbreviations, prefixed by the symbol #, and are used to signify subject areas and collate together these corresponding Tweets into one stream for viewing (Bruns et al 2011:1). The Twitter hashtag #eqnz (earthquake New Zealand) is the most commonly used hashtag for earthquakes nationwide. The UN Office for the Coordination of Humanitarian Affairs (UNOCHA) report, titled ‘Hashtag Standards for Emergencies’, provides a valuable contribution to the discussion of the use, and standardization, of hashtags during an emergency. They encourage:

the standardization of three types of hashtags during a crisis: a disaster name hashtag, a public reporting hashtag and an emergency response hashtag” (Moore et al. 2014: 7). Each hashtag is intended to fulfil a specific role, including ensuring the continuity of information; public tracking of needs, people and supplies; and providing a platform to facilitate direct assistance (Moore et al. 2014: 7).

An example of the public reporting hashtag could be #ireport or #isee (Moore et al. 2014: 8). However, the report also addresses the valid concerns of emergency managers that an emergency response hashtag “would result in people reporting through social media outside of designated monitoring times” (Moore et al. 2014: 7). This concern is a serious one, since New Zealand does not currently have the capability or organisational framework to implement an emergency response hashtag. However, it is important that emergency managers consider how they would respond to requests for emergency assistance through social media if traditional phones were overloaded or inoperable (Giroux et al. 2013: 17). The report titled ‘Lessons Learned: Social Media and Hurricane Sandy’ provides a valuable case in point, as it describes the experiences of the New York Fire Department (FDNY) during Hurricane Sandy, “as the storm progressed, individuals tweeted calls for help, reporting flooding, individuals trapped in buildings, and more. FDNY responded to these calls, asking for more information, contacting dispatch and relaying information regarding the individuals’ posts, and assisted when individuals were not able to get through to 911” (Virtual Social Media Working Group 2013: 19).

5.10 Image and Video Search Tools

Images can be the first on-the-ground reports during an emergency and it is important to have the processes in place to quickly find these key images for enhanced situational awareness. However, social media can become “flooded” with doctored or photo-shopped images (Giroux et al. 2013:4) and authentic images can be inaccurately labelled (Silverman 2014: 39). Therefore, verification procedures are essential to establish image credibility. Silverman et al. (2014: 36) identify the basic principles of image verification:

1. Establish the author/originator of the image
2. Corroborate the location, date and approximate time the image was taken
3. Confirm the image is what it is labelled/suggested to be showing
4. Obtain permission from the author/originator to use the image

Source: Silverman et al. (2014: 36)

The work of Silverman et al. (2014: 36) elaborates on these key points and provides valuable information on the principles and methodologies of image verification. These processes can also be supported by tools such as Google Reverse Search or TinEye, which enable emergency managers to find out “where an image came from, how it is being used, if modified versions of the image exist,

or if there is a higher resolution version” (TinEye n.d.). Being able to source images and videos from social media depends on the individual API policies of the platforms (such as YouTube or Flickr). However, if this functionality is not available from your social media monitoring provider then manual searches often provide various filtering functionality, such as keyword, date range and geolocation, depending on privacy settings.

5.11 Rumour Control

The propagation of rumours is a growing challenge for emergency managers, as social media enables the rapid spread of near real-time information during an emergency: monitoring the public response, and correcting any misinformation, is imperative. However, the volume of misinformation and unverified or unverifiable content can often be a challenge for emergency managers, given limited resources (Virtual Social Media Working Group 2013: 23). Giroux et al. explain some of the complexities of this new role for emergency managers:

Government actors are thus confronted with a rather challenging role: to both facilitate the spread of accurate information and leverage social media to reach the public through various channels, while also confronting the issues that arise when false or contradictory information emerges (2013: 5).

During Hurricane Sandy, for example, Twitter and Facebook were “flooded” with doctored or photo-shopped pictures (Giroux et al. 2013: 4). The spread of misinformation and rumours was also evident during the Christchurch earthquakes, as Walls (2011) explains:

Social media coverage surrounding the Christchurch earthquake has snowballed ... Twitter and Facebook followers are often beating TV crews to the punch when it comes to on the scene updates ... However, not all social media that glitters is gold. Frustration has become evident when old news is re-tweeted, often containing good news that has since been retracted. Misinformation has flown at the speed of light as desperate users find random re-tweets or pick up on the unfiltered speculations of those following coverage.

However, strategies and techniques, such as the use of Twitter hashtags by the Queensland Police during the Queensland floods of 2010 and 2011 have been developed to deal with this issue, and these have, in the main, been effective in successfully correcting misinformation and rumours during a crisis event. The Queensland Police Service Media Unit’s Twitter account directly addressed both rumours and misinformation that was being shared through social media using the hashtag #Mythbuster (Bruns et al. 2012b: 8). This Twitter account proved to be the leading participant in the #qldfloods hashtag - the central coordinating hashtag for flood-related activity on Twitter (Bruns et al. 2012b: 8). Additionally, the #Mythbuster tweets became the most retweeted messages from this account, alongside official notices to evacuate (Bruns et al. 2012b: 43).

Another relevant example was the Hurricane Sandy Rumour Control Website, run by the Federal Emergency Management Agency (FEMA). Research conducted by the Virtual Social Media Working Group elaborates on how the website was used:

[a] green check mark, placed next to a post, indicated that the information was correct, whereas a red “x” indicated that the information was incorrect. Accurate information often included links to external sources for additional information (2013: 23).

This research also identified a number of the rumours that were dispelled, including bridge failures, a lack of critical resources, the locations of shelters, and the status of recovery efforts (Virtual Social Media Working Group 2013:23).

However, it is also important to note that the number of people participating on social media enables a peer-to-peer self-correcting mechanism. By way of example, research done by Mendoza

et al. (2010: 72) shows that information curatorship and self-correction was evident during the Chilean earthquake (2010), where tweets containing false information were challenged by others on Twitter (Mendoza et al. 2010: 76). However, even with this capacity to collectively self-correct, misinformation can still propagate widely and rapidly, either through misinterpretation or even misuse.

5.11.1 Rumour Management: Verifying Information

In light of the growing propagation of rumours and misinformation on social media during an emergency event, it is critically important that emergency managers have the necessary skills and established processes to verify social media information. Describing and accounting for this skill set is beyond the scope of this research, but this remains a central and critical part of the social media monitoring process. Important research that synthesises these verification processes can be found in 'The Verification Handbook' (2014), authored by the European Journalism Centre (EJC), which provides a concise and detailed account of both verification procedures and real world examples. As Silverman et al. point out "[a] disaster is not time to try and verify on the fly. It's not the moment to figure out what your standards and practices are for handling ... information" (2014: 10).

6 Technological and Social Considerations

6.1 Technological

Social media relies on an Internet connection, and the functionality of personal devices is reliant on limited battery life. Power outages are common in emergencies, nor is it always possible to rely on Internet connectivity. This was evident during the Christchurch earthquakes (2011), where many people and households were still without power a week or more after the event (Vavasour 2014:66). Social media platforms can also become ‘throttled’ or overloaded due to a spike in use, and it is important to be cautious about an overreliance on social media in an emergency. As Vavasour explains:

there are some who caution against this increasing focus and reliance on technology and the intricate systems that support it. Urban infrastructure has a tendency to become ‘blackboxed’, a process by which complex, interconnected components and networks come to be perceived as deceptively simple objects, and during a disaster these networks and objects can become spectacularly undone, in a process known as ‘un-blackboxing’ (2014: 55).

Additionally, in an emergency Internet connectivity and/or power may only be accessible to limited sectors of the population. It is important that those who are unable to establish an Internet connection, or even produce the same social media ‘volume’ as others, are not overlooked or ignored (Hughes et al. 2014a: 357). Therefore, “a lack of noise, when abnormal, may also signify points for further consideration, verification, or follow-up” (Virtual Social Media Working Group 2014: 13).

6.2 Social

Social media has a ‘discriminatory’ affect and bias towards “urban, affluent, tech-savvy people” (Vieweg et al. 2014). This means that the use of social media in an emergency can concurrently empower and disempower members of the community (Hughes 2014a: 361). As Giroux et al. point out, “if government concentrates too much on any one type of media (whether social or traditional), it will risk missing a part of the society” (2013: 20). Additionally, during an emergency the ones most in need of connectivity and information may be the ones also excluded from this resource, due to power or Internet outages. As Vavasour explains, “[t]echnology may have enabled instant worldwide discussion about a crisis, but those closest to the event may find themselves unable to participate in these electronic conversations” (2014:66).

6.3 Privacy

It is critically important that any data sourced from social media monitoring is not republished with identifying information that can be traced back to the original author. While data sourced through social media monitoring platforms may be considered to be in the public domain, clear policies need to be established that clearly delineate the use of this information, along with the reasons and purposes for collection and analysis. Any secondary use of the data or data sharing must also be clearly outlined, and all policies must comply with the relevant data privacy legislations. As Giroux et al. explain, “the use of social media for situational awareness could possibly raise privacy issues. Even if the monitored data is public communication, citizens potentially could get afraid of state authorities playing ‘big brother’. To avoid such allegations, authorities can clarify how they collect, store, use and forward information gained from social media monitoring” (2013: 12).

6.4 Legal

Specific legal concerns of emergency managers regarding the use of social media need to be addressed and clarified. These include the allocation of responsibility when requests for emergency assistance are received through social media platforms (Hughes 2014a: 359), and the allocation of responsibility for emergency managers who have posted false or misleading information on social media (Anikeeva et al. 2015: 7). It is therefore important that these issues are addressed and resolved, and that emergency managers are provided with the policies and legal frameworks and advice to support their work when using social media in emergencies.

6.5 Resourcing

Social media monitoring requires trained staff and resources. Upscaling these resources in an emergency is an important consideration; as Hughes et al. point out, “[t]he social media audience that emergency managers earnestly build and prepare in-between emergencies may find themselves frustrated when those same managers struggle to meet the online communication demand if a disaster were to happen” (2014c:1). Some large organisations now have social media units or departments, or alternatively they have dedicated teams of trained volunteers willing to assist and support emergency personnel in an emergency. However, as Lindsay et al. explain, the number of personnel and resources needed to use social media effectively in an emergency event has yet to be determined:

The number of personnel required to monitor multiple social media sources, verify the accuracy of incoming information, and respond to and redirect incoming messages is also uncertain... government[s] may experience a large volume of incoming messages from the public during a disaster. Responding to each message in a timely manner could be time consuming and might require an increase in the number of employees responding to incoming messages (2011: 3)

6.6 Standardisation and Integration with Incident Command Structures

With technological advances comes the need to address and actualise the operationalization of social media monitoring practices and reporting into traditional command structures. As Hughes et al. explain: “[e]mergency responders are trained in formal command-and-control protocols for managing emergencies and it is rarely clear how to integrate social media and other online tools effectively into these existing, formal procedures” (2014c: 1). Further research into these areas is being undertaken in 2016: more information can be found by contacting the author of this report.

7 Overview of Platforms

7.1.1 Table 4 Overview of some social media monitoring platforms including examples of functionality*

Platform name Example data source; example functionality	Reference and/or URL
Twitter Advanced Search (free) Twitter; selectable date range, geolocation, keyword search & filtering, sentiment analysis, keyword trending, image search capability	(https://twitter.com/search-advanced)
Twitter Lists (free) Twitter; functionality allows a stream of tweets to be created of users of interest, alerting available through third-party platforms	(https://support.twitter.com/articles/76460-using-twitter-lists)
TweetDeck (free) Twitter; tool that allows users to build a dashboard with multiple Twitter streams at the same time by various filtering functionalities	(https://tweetdeck.twitter.com)
Geofeedia Twitter, Facebook, Instagram, Youtube, Picasa, Flickr; ability to choose data sources, geolocation, keyword search & filtering, alerting.	(http://geofeedia.com)
Crisis Tracker (open source) Twitter; geolocation, keyword search and filtering, keyword trending	(https://github.com/JakobRogstadius/CrisisTracker)
Artificial Intelligence for Disaster Response (AIDR) (open source) Twitter; powerful keyword search and filtering, geolocation, natural language processing	(http://aidr.qcri.org)
Signal Twitter, Facebook; geolocation, keyword search & filtering	(http://www.getsignal.info)

Emergency Situation Awareness (ESA) developed by CSIRO

Twitter; selectable date range, keyword search and filtering, natural language processing, geolocation, keyword trending, alerting.

(<https://esa.csiro.au>)

GeoViewer

Twitter; selectable date range, geolocation, keyword search & filtering, image search capability.

(<http://vision.sdsu.edu/hdma/geoviewer/sanDiego>)

Twitcident

Twitter; geolocation, keyword search and filtering, topic trend graph, keyword trending, image search capability, tracking retweets.

(wis.ewi.tudelft.nl/twitcident)

TweetTracker

Twitter; selectable date range, geolocation, keyword search and filtering, topic trend graph, selectable date range, keyword trending

(<http://tweettracker.fulton.asu.edu>)

Twitinfo

Twitter; keyword search & filtering, geolocation, topic trend graph, sentiment analysis

(<https://github.com/mitdbg/twitinfo>)
Marcus et al (2011).

*Table 3 only provides examples of product functionality as inferred from the product literature

8 Recommendations

Finding the right tools with which to carry out social media monitoring within an organisation can be a daunting and time-consuming task. The field has been saturated with vendors, all offering a different formulation for monitoring value and expertise, such as the methodology for data input, sentiment analysis and trends, alerts, and costing structure. Finding the right tools with which to carry out social media monitoring in the field of emergency management is in its infancy and involves complexities and challenges, such as how to classify and review high-value messages (for instance, requests for help), and how to identify, track, and respond to misinformation and rumours circulating through social media channels during an emergency event.

While there are hundreds of social media monitoring tools available, only a designated few focus on the specific requirements of emergency management. A lot of tools focus on Twitter. This is because the majority of Twitter users share their information publicly, as a default setting. Alternative platforms, such as Facebook, are limited in their capability for being monitored by tools due to a complex relationship between API terms of service and the privacy settings enabled by individual users. Additionally, these policies are subject to change. It is critical to note that APIs may severely limit the quantity of data (e.g. tweets or posts) actually being searched by monitoring tools. Those monitoring tool providers that have incorporated emergency management requirements into their services are at the cutting edge of developments in the field; many of these are currently the product of university and government collaborations.

In light of the above points and the fact that New Zealand's CDEM sector is currently heavily reliant on Facebook as the primary type of social media for communication and interaction with the public, the following recommendations are made;

1. In the short term it is important New Zealand's CDEM sector shifts its expectations from finding suitable 'plug and play' social media monitoring products and instead focuses on:
 - Building a large cache of consistently trained CDEM professionals with social media skills that can be deployed around the country during large scale emergencies
 - Building a large cache of suitably qualified and vetted social media volunteers that can be activated locally to support a large-scale emergency response
 - Ensuring social media users in the sector (both professionals and volunteers) carefully take into account the considerations and lessons of this report and other applicable material such as MCDEM publications that relate to community engagement (MCDEM, 2010a), consistent messaging (MCDEM, 2010b), public information management (MCDEM, 2013a) and volunteer coordination (MCDEM, 2013b) along with WREMO's *Social Media for Emergency Management – A good practice guide* (2014)
 - Reducing duplication of effort and increasing consistency of social media use within and across CDEM Groups
 - Continuing to build a larger base of 'likes' for CDEM Facebook sites so that:
 - i. Relationships with the public continue to strengthen and grow, subsequently building greater connections, trust and information flow between the public and government
 - ii. The public will know where the official source of information is during large-scale emergencies

All the while being careful to manage public expectations for a realistic level of service that the CDEM sector can provide

- Building a larger base of Twitter ‘followers’, especially for alerting and incident reporting, in order to better utilise social media monitoring products in the future
2. Longer term, New Zealand’s CDEM sector should focus on the development of a close collaboration with one or more leading organisations in the field. Examples of where this type of collaboration has already been successfully developed include:
- The Emergency Situation Awareness (ESA) system - developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in collaboration with emergency management in Australia;
 - TweetTracker - a product of Arizona State University and used by Humanity Road (a leading social media monitoring team of global volunteers);
 - Twiticident – part of the CrowdSense social media monitoring package and in collaboration of Delft University of Technology and Netherlands Organisation for Applied Scientific Research and trialled by Dutch emergency services.

In order to access the products of these collaborations, social media experts and emergency management practitioners will be needed to negotiate the most appropriate partnership. To avoid a multiplicity of CDEM representatives concurrently looking to build these relationships and leading to the inevitable consequence that some CDEM groups will purchase solutions that are not fit-for-purpose, a level of national co-ordination should also be considered. With the small number of social media monitoring platforms specifically focused on the media-monitoring requirements of emergency managers, this task will require careful thought, planning and negotiations in order to ensure the desired outcomes.

References

- American Red Cross. 2012. Americans using mobile apps in emergencies. Retrieved 29 April, 2015, from <http://www.redcross.org/news/press-release/More-Americans-Using-Mobile-Apps-in-Emergencies>.
- Anikeeva, O., Steenkamp, M., & Arbon, P. 2015. The future of social media use during emergencies in Australia: Insights from the 2014 Australian and New Zealand disaster and emergency management conference social media workshop. *Australian Journal of Emergency Management*. Vol 30. Issue 1.
- Appleby, L. 2013. Connecting the last mile: The role of communications in the great East Japan earthquake. *Internews Europe*.
- Bruns, A., & Burgess, J. E. (2011). The use of twitter hashtags in the formation of ad hoc publics.
- Bruns, A., & Burgess, J. E. 2012a. Local and global responses to disaster: #eqnz and the Christchurch earthquake. *Disaster and Emergency Management Conference, Conference Proceedings*.
- Bruns, A., Burgess, J. E., Crawford, K., & Shaw, F. 2012b. #Qldfloods and @ QPSMedia: Crisis communication on twitter in the 2011 South East Queensland floods.
- Cameron, M. A., Power, R., Robinson, B., & Yin, J. 2012. Emergency situation awareness from twitter for crisis management. *Proceedings of the 21st International Conference Companion on the World Wide Web*.
- Canadian Red Cross: Canadian survey on social media in emergencies. 2012. Retrieved 29 April, 2015, from <http://www.redcross.ca/blog/2012/10/tech-talk-canadian-survey-on-social-media-in-emerg>.
- Dabner, N. 2012. Breaking ground in the use of social media: A case study of a university earthquake response to inform educational design with Facebook. *The Internet and Higher Education*, 15(1), 69-78.

De Longueville, B., Smith, R. S., & Luraschi, G. 2009. OMG, from here, I can see the flames! A use case of mining location-based social networks to acquire spatio-temporal data on forest fires. Proceedings of the 2009 International Workshop on Location Based Social Networks, pp. 73-80.

Dynes, R. R. 1970. Organized behaviour in disaster. Lexington Books.

Endsley, M. R. 1995. Toward a theory of situation awareness in dynamic systems. Human Factors: The Journal of the Human Factors and Ergonomics Society, 37(1), 32-64.

Giroux, J., Roth, F., & Herzog, M. 2013. Using ICT & social media in disasters: Opportunities & risks for government. CSS Risk and Resilience Reports. Zurich, Switzerland: Centre for Security Studies.

Giroux, J., & Roth, F. 2012. Conceptualizing the crisis mapping phenomenon - insights on behaviour and the coordination of agents and information in complex crisis. Risk and Resilience Reports Centre for Security Studies (CSS), ETH Zurich.

Goodchild, M. F. (2007). Citizens as sensors: The world of volunteered geography. GeoJournal, 69(4), 211-221.

Hughes, A., Palen, L., & Peterson, S. 2014a. Chapter 11: Social media and emergency management. Critical issues in disaster science and management. Federal Emergency Management Agency.

Hughes, A. L. 2014b. Participatory design for the social media needs of emergency public information officers. Proceedings of 11th International ISCRAM Conference.

Hughes, A. L., & Palen, L. 2012. The evolving role of the public information officer: An examination of social media in emergency management. Journal of Homeland Security and Emergency Management.

Hughes, A. L., St Denis, L. A., Palen, L., & Anderson, K. M. 2014c. Online public communications by police & fire services during the 2012 hurricane sandy. Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems, pp. 1505-1514.

- Hughes, L., Palen, L., Sutton, J., Liu, B., & Vieweg, S. 2008. Site-seeing in disasters: An examination of on-line social convergence. Proceedings of the 5th International ISCRAM Conference.
- Imran, M., Castillo, C., Diaz, F., & Vieweg, S. 2014. Processing social media messages in mass emergency: A survey. ArXiv Preprint arXiv:1407.7071.
- Kaigo, M. 2012. Social media usage during disasters and social capital: Twitter and the great East Japan earthquake. *Keio Communication Review*, 34, 19-35.
- Liddy, E. D. 2001. Natural language processing.
- Lindsay, B. R. 2011. Social media and disasters: Current uses, future options, and policy considerations. Congressional Research Service.
- Marcus, A., Bernstein, M. S., Badar, O., Karger, D. R., Madden, S., & Miller, R. C. (2011). Twitinfo: Aggregating and visualizing microblogs for event exploration. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 227-236.
- Masters, D. 2015. Cyclone Pam NZ updates. Facebook. Retrieved 2nd May, 2015, from <https://www.facebook.com/cyclonepamnz2015>.
- Meier, P. 2012. Debating the value of tweets for disaster response (intelligently). Retrieved 2nd May, 2015, from <http://irevolution.net/2012/12/17/debating-tweets-disaster/>.
- Meier, P. 2013. AIDR: Artificial intelligence for Disaster Response. Retrieved August 2015 from: <http://irevolution.net/2013/10/01/aidr-artificial-intelligence-for-disaster-response/>
- Mendoza, M., Poblete, B., & Castillo, C. 2010. Twitter under crisis: Can we trust what we RT? Proceedings of the First Workshop on Social Media Analytics, pp. 71-79.
- Ministry for Civil Defence Emergency Management (MCDEM). 2010a. Community Engagement in the CDEM Context [BPG 4/10]. MCDEM.

Ministry for Civil Defence Emergency Management (MCDEM). 2010b. Working from the same page: Consistent messages for CDEM. MCDEM.

Ministry for Civil Defence Emergency Management (MCDEM). 2013a. Public Information Management [DGL 14/13]. MCDEM.

Ministry for Civil Defence Emergency Management (MCDEM). 2013b. Volunteer Coordination in CDEM [DGL 15/13]. MCDEM.

Moore, R., & Verity, A. 2014. Hashtag standards for emergencies. UN Office for the Coordination of Humanitarian Affairs (UNOCHA).

Ngak, C. Social media a news source and tool during Superstorm Sandy. Retrieved May 8th, 2015, from <http://www.cbsnews.com/news/social-media-a-news-source-and-tool-during-superstorm-sandy/>.

Palen, L. 2008. Online social media in crisis events. *Educause Quarterly*, 31(3), 12.

Palen, L., & Liu, S. B. (2007). Citizen communications in crisis: Anticipating a future of ICT-supported public participation. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 727-736.

Preston, J., Binner, J., Branicki, L., Ferrario, M., Galla, T., Jones, N., et al. 2013. City evacuations: Preparedness, warning, action and recovery. Final report of the DFUSE project. (Game theory and adaptive networks for smart evacuations: EP/I005765/1).

Red Cross World Disasters Report. 2013. Focus on technology and the future of humanitarian action. Geneva, Switzerland: International Federation of Red Cross and Red Crescent Societies.

Silverman, C. (ed.) 2014. *Verification Handbook*. European Journalism Centre.

Starbird, K., Muzny, G., & Palen, L. 2012. Learning from the crowd: Collaborative filtering techniques for identifying on-the-ground twitterers during mass disruptions. *Proceedings of the 9th International ISCRAM Conference*.

Starbird, K., Palen, L., Hughes, A. L., & Vieweg, S. 2010. Chatter on the red: What hazards threat reveals about the social life of microblogged information. Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work, pp. 241-250.

Sutton, J., Palen, L., & Shklovski, I. 2008. Backchannels on the front lines: Emergent uses of social media in the 2007 southern California wildfires. Proceedings of the 5th International ISCRAM Conference, pp. 624-632.

Tellman, B., Schwarz, B., Burns, R., & Adams, C. 2015. Big data in the disaster cycle: Overview of use of big data and satellite imaging in monitoring risk and impact of disasters. United Nations Development Report.

Thomson, R., & Ito, N. 2012. Social responsibility and sharing behaviours online: The twitter-sphere's response to the Fukushima disaster. International Journal of Cyber Society and Education, 5(1), 55-74.

TinEye. (n.d.). About TinEye. Retrieved 8 May, 2015, from <https://www.tineye.com/about>.

Tyshchuk, Y., Hui, C., Grabowski, M., & Wallace, W. A. 2012. Social media and warning response impacts in extreme events: Results from a naturally occurring experiment. System Science (HICSS). 45th Hawaii International Conference, pp. 818-827.

Vavasour, K. 2014. www.useless.com: Crisis communications on shaky ground. MEDIANZ: Media Studies Journal of Aotearoa New Zealand, 14(1).

Vieweg, S. E. (2012). Situational awareness in mass emergency: A behavioural and linguistic analysis of microblogged communications.

Vieweg, S., Castillo, C., & Imran, M. 2014. Integrating social media communications into the rapid assessment of sudden onset disasters. Social Informatics (pp. 444-461). Springer.

Virtual Social Media Working Group and DHS First Responders Group. 2014. Using social media for enhanced situational awareness and decision support. Homeland Security.

Virtual Social Media Working Group and DHS First Responders Group. 2013. Lessons Learnt from Hurricane Sandy. Homeland Security.

Walls, A. 2011. Social media steps up in quake recovery. Retrieved 8th May, 2015, from <http://www.nbr.co.nz/article/social-media-steps-quake-recovery-ns-86739>.

Wellington Regional Emergency Management Office (WREMO). 2014. Social media for emergency management – A good practice guide. WREMO.

Wendling, C., Radisch, J., & Jacobzone, S. 2013. The use of social media in risk and crisis communication.

Whitelaw, T., & Henson, D. 2014. 'All that I'm hearing from you is white noise': Social media aggregation in emergency response.