

**EMERGENCY RESPONDERS AS INVENTORS:  
AN ACTION RESEARCH EXAMINATION OF PUBLIC INFORMATION WORK**

by

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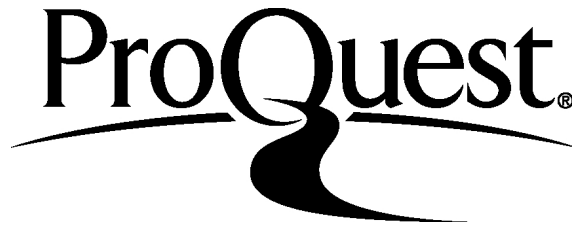
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An Action Research Examination of Public Information Work

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## **ABSTRACT OF THE DISSERTATION**

St. Denis, Lise Ann (Ph.D., Technology, Media and Society; ATLAS Institute)

Emergency Responders as Inventors: An Action Research Examination of Public Information Work

Thesis directed by Associate Professor Leysia Palen

The development of information and communication technologies (ICTs) has expanded the ways that people communicate and share information with one another. In the context of disaster, this has disrupted and reshaped the nature of the communication of emergency information and public participation in the emergency response process itself. Members of the public have been much quicker at adapting and improvising solutions in this new communication ecology than emergency response organizations. This difference in adoption reflects key differences in the formal constraints and responsibilities faced by emergency responders in comparison to the ability in the public sphere to improvise and organize more fluidly. My research focuses on the design and ongoing development of sociotechnical solutions within a community of emergency responders interested in integrating social media into emergency response practices. I look at both the solutions emerging across this community and the sociotechnical arrangements that support ongoing communication and the evolution of new ideas in a continual process of invention. My research spans four years, starting with an initial case study and progressing over time into a collaborative role that leverages my skills and knowledge of crisis informatics in the joint exploration of data analysis strategies and communication strategies.



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I would also like to acknowledge and thank my friends and colleagues in the Virtual Operational Support Community. They welcomed me as a member of their innovative community from the very beginning, generously sharing their ideas and giving me an insider's view of the challenges of integrating

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## **SECTION ONE. Introduction, Background, & Research Design**

### **CHAPTER 1. Introduction**

#### **1.1 Public Information in Disaster**

Understanding the role of public information requires a broader understanding of the social context of disaster. Fritz (1961) was one of the first scholars to define disaster in social terms as “*an event concentrated in time and space, in which a society or one of its subdivisions undergoes physical harm and social disruption, such that all or some essential functions of the society or subdivision are impaired*”. The key element here is that disaster is a social phenomenon disrupting normal societal function and resulting in the threat or realization of some form of physical harm. The role of public information work within formal emergency response is to provide accurate and timely information to those impacted by the hazard so that they can make informed decisions and organize in response to often volatile and uncertain circumstances. Research shows that citizen response to disaster is typically calm and organized rather than panicked and chaotic. In sudden impact events, citizens are often the first responders and often continue to play a critical role even after formal response arrives on scene. In large scale events citizen-led emergent organization often fills important gaps in response and plays a vital role in the transition to recovery. One of the most persistent and challenging problems for emergency response is managing the convergence of people, supplies and information at the site of disaster. Fritz & Matthewson (1957) suggest that accurate and authoritative information, coordinated and adapted to the specific information needs of various groups involved in the response is critical for managing these issues.

A more detailed summary of related sociology of disaster literature is provided in background section 2.1.

#### **1.2 The Impact of Social Media on Public Information Work**

Advancements in information and communication technologies offer new ways to share information and organize in disaster. Members of the public have used these channels to organize

grassroots efforts at the community level, to break down geographic barriers and connect with people outside the impacted area, and to communicate and share information at a level not seen before (Palen & Liu, 2007). Research in crisis informatics looks at the sociotechnical solutions emerging in the aftermath of disaster. Across this body of literature there is evidence that people are able to assemble information across a wide variety of sources both online and off, official and unofficial when constructing understanding of current circumstances. In this new informational landscape, personally produced content exists alongside information from official sources and mainstream media. Within this complex information space we see evidence of complex, socially distributed problem solving and collective sense making that redefines prior notions of citizen involvement.

The public information work of emergency response serves a vital role in keeping the public informed, but emergency responders are challenged to figure out how to evolve formal response practices to make use of these new channels while still aligning with formal protocols. The challenge is two-fold: first to figure out how to communicate emergency updates effectively across this complex information space, and also how to effectively gather situational awareness and engage in new ways with the public in this visible public space. To answer these questions, my research looks at the innovative practices emerging within emergency response, and at public communications for insight into how emergency responders could move towards better alignment within these channels.

A detailed summary of related crisis informatics literature is provided in background sections 2.2 and 2.3, followed by a discussion of emergent organization in section 2.4.

### **1.3 Why Action Research?**

Over the course of the five studies contained within this dissertation I will show how action research (AR) supported a deeper understanding of virtual operational support practices and how collaborative analysis led to new strategies for supporting public information work within this complex information space. These studies serve as both references for the virtual operational support community moving forward and as a general exploration of public information work within the context of disaster.

Action research (AR) is discussed in background section 2.5.

#### **1.4 An Overview of the Studies**

There are five studies contained within this dissertation that collectively address my research questions. The study in Section One (Chapter 4) takes a broad look at online social media communications across a bounded population of first responders during a wide scale event. It provides an important baseline assessment of both patterns of use and dis-use across this population. These broad patterns paint a general picture of the use of social media use in emergency response. Qualitative analysis of high engagement reveals the highly situated nature of social media communications in disaster. Section Two contains two studies examining a new organizational structure developed within the emergency response community to extend the social media capacity of an emergency response team through the use of trusted digital agents. The first study in this section (Chapter 5) looks at the first emergency trial of this concept during the 2011 Shadow Lake Fire and the second study (Chapter 6) looks at the evolution of practices within this community as it has grown into a global community of teams. Section Three contains two studies looking at different strategies for integrating social media into emergency response practices. The first study (Chapter 7) looks at development of an Integrated Social Media Strategy used by the Jefferson County Type III Incident Management Team during the 2013 Colorado Floods, helping them to provide high level of coverage when they fell outside of the media spotlight during a widespread disaster event. The final study (Chapter 8) looks at public information from the social media monitoring perspective. This study details a series of experiments using aggregated data to refine a strategy for identifying information coming from local and individual sources on Twitter.

## **CHAPTER 2. Background Literature**

### **2.1 Sociology of Disaster**

#### ***2.1.1 Individual Response to Disaster***

Disaster has been analyzed from different perspectives ranging from the description of the physical hazard itself, the physical consequences of the hazard and the social disruption and social changes caused by the hazardous agents. I will focus my summation on what is known about individual social response and social organization in disaster.

Much of the early sociological research on disaster was fueled by US anxiety during the Cold War. It focused on understanding the social psychology of populations impacted by and involved in disaster in anticipation of potential mass casualty events. Sociologists working at this time surveyed accounts of disaster across a wide range of hazards. Rather than finding evidence that people behaved in a panicked or erratic fashion and fled the scene, one of the key findings in this early research was that individuals on scene tended to mobilize and begin responding in a rational, organized manner from the onset. Consistent across the research literature, bystanders on the scene of a disaster are the true first responders (Dynes, 1970; Curtis & Aguirre, 1993; Fischer III, 1998), organizing search and rescue efforts for victims and coordinating initial relief efforts (Fritz & Mathewson, 1957; Kendra & Wachtendorf, 2003a; Kendra & Wachtendorf, 2003b) and members of the impacted community continue to help even after formal response arrives.

Despite research to the contrary, mythology persists regarding how people behave in the aftermath of a disaster. Culturally, we expect that there will be widespread panic and hysteria in which people lose the ability to behave rationally and that norms governing our behavior will devolve into more base instincts. This brings to mind images of people fleeing in panic, property looting, and martial law. Fischer III (1998) explores some of the ways this mythology is perpetuated through media coverage providing the basis of what we consider to be the factual coverage of the event. He compares this to organizational response to disaster and points out that, contrary to popular belief, it is formal

organizational response that is often quite chaotic. It is often difficult for response organizations to communicate effectively and to get accurate information.

### **2.1.2 Convergence Behavior**

Fritz and Mathewson (1957) studied disaster reports and accounts across numerous events. They observed that one of the most striking aspects of human behavior was the spontaneous movement of people, messages, and supplies toward the disaster area. They concluded that this tendency towards convergence, created congestion and was responsible for much of the organization and control issues faced by emergency response. To understand this behavior further, they analyzed the motivations of people converging on a disaster scene and identified five primary roles played by the population converging on scene: the returnees - residents of the impacted area, the anxious – people indirectly affected through their identification with victims or the community, the helpers – people wishing to volunteer material or physical resources to the response, the curious onlookers, and finally the exploiters – those with selfish motivations. Examples of exploitation were rare in the literature.

In response to these issues of convergence, they conclude that the most immediate and crucial need is for “*speedy, accurate, authoritative information, coordinated and adapted to the specific needs of various groups concerned with disaster*” (p.61-62). They also cite other research that ambiguity of information is more of a stimulator of convergence than falsity of information (Williams, 1955) and they suggest that regardless of accuracy, information may be too ambiguous or ill suited to the various audiences responding to it. They identify the failure to provide a central clearinghouse for public information as a key factor that increases internal convergence. They also identify the importance of using local persons within a planned information and communication network and state that the advantages are obvious but often ignored “*familiarity with the local residents and area’s facilities and resources increases speed and efficiency with which the needed information can be gathered and evaluated...many of the problems of identification can be solved readily.*” The key players within a communication network are members of the communities involved. (Fritz & Mathewson, 1957) I would like to emphasize

these findings because it highlights how important the brokerage of information is for dealing with issues of convergence. It also points out that information is not a one-size-fits-all proposition and that tailoring information to different audiences is also a critical part of the process.

### ***2.1.3 Organized Behavior in Disaster***

In the 1960s, the research emphasis in disaster sociology shifted from focusing on individual response to the study of the impact of disaster on communities and how social organization changed or new forms of organization emerged in response to the social disruption. Barton (1963) focused on studying what he referred to as the “emergency social system.” This social system is composed of the existing organizations, primary groups and masses of individuals who mobilize in response to the disaster. What emerges is an improvised system that evolves and adapts to needs created by the disruption. Barton (1963) proposes a series of propositions to explain altruistic social response to disaster. Dynes (1970) consolidated these propositions into what he refers to as the redefinition and expansion of the citizenship role in disaster. After impact, citizens are called upon to do anything they can to help their community. He points out that unfortunately existing organizations are often still organized based on pre-disaster motivations and that they seldom create opportunities to use these citizen resources effectively.

Dynes (1970) focused on the study of organized activities and in particular on the impact disaster has on formal, complex organizations. He proposes that crisis provides a rare opportunity to study how organizations are structured, how they maintain stability, how they adapt, and how they fulfill their functions [p4]. Rather than using existing conceptualizations of organizations that are focused on stable, formal organizations with limited objectives, he proposes a new typology that better reflects adaptation of organizations to disaster. He proposes four types of organized behavior classified by two variables. The first variable relates to the familiarity of the tasks taken on by these organizations: are the tasks routine and familiar or are the tasks new and unfamiliar to the members of the organization. The second variable relates to post impact structure of these organizations: did they maintain their existing structure or did the

organizational structure change in response to the disaster. The chart below summarizes how each of these types of organizations relates to the variables.

	Regular Tasks	Nonregular Tasks
Old Structure	Type I - Established	Type III – Extending
New Structure	Type II – Expanding	Type IV – Emergent

**Table 1: Dynes Four-Fold Organizational Typology.**

The types of organizations range from the most formalized (Type I - *Established*) to the least formalized and dynamic (Type IV - *Emergent*). Type I organizations are typically complex organizations with a bureaucratic structure that attempt to adhere to strict policy and procedure even in extreme circumstances. These organizations are typically formal response organizations such as police and fire that are trained to respond to disaster. They typically depend on full-time, vetted personnel. Emergency circumstances often cause changes to the internal structural arrangements within these organizations such as forcing decision-making lower in the hierarchy than would occur in non-emergency times. Most of the organizational stress in these organizations appears when they take on nontraditional tasks outside of the institutionally defined processes. Type II - *Expanding* organizations are generally, although not exclusively, voluntary organizations trained in disaster response (VOAD) (e.g. American Red Cross). They typically have a team of core personnel with established core activities. They expand through volunteer or additional staffing to meet the demands of the emergency and take on tasks that can be seen as traditional, but often shift to the priorities demanded by the circumstances of the emergency. These types of organizations are often the most stressed because they change both how they are structured and how they function to meet demands of the emergency. In addition, there is often little structure in place to keep track of and monitor the efforts of expanded personnel. Type III – *Extending* organizations exist prior to the disaster but take on new functions in response to the emergency. These organizations can be divided into two types: emergency-relevant organizations and community-relevant organizations. The emergency-relevant groups exist with some non-emergency function, such as a fleet of delivery trucks but may be asked to move materials as part of the disaster response. Community-relevant groups are social

organizations such as church groups that participate based on membership within this group. These organizations are internally cohesive, but there may be problems coordinating efforts with other groups because of their orientation toward their particular affiliation. Type IV - *Emergent* organizations do not exist prior to the disaster and form in response to gaps that are not being filled by other organizations. These types of organizations tend to form under two primary circumstances: when segments of the population are isolated from established emergency service organizations and when there is a lack of coordination and control among the groups involved in the response. There is also a progression in terms of the types of organizations based on the scope of the emergency or disaster. Organizational involvement tends to progress along a spectrum of organizational involvement. If it is a localized emergency, it may be possible to handle it with just the established response organizations. If the scope is large enough, it may be necessary to expand to Type II - *Expanding* and Type III – *Extending* organizations to meet the demands. As scope and complexity increase, there are more opportunities for gaps to develop where Type IV - *Emergent* organizations come together to meet these needs.

#### ***2.1.4 Organization as Structural Enactment in Disaster***

Kreps and Bosworth (1993) were interested in explaining the differences in formal organization and collective behavior emerging in the post-disaster social system. They were specifically interested in finding a way to define both within the same conceptual framework and to account for the variety of forms observed across the research literature. Drawing on the work of Giddens (1984), they conceived of organization as a continual enactment between organizational structure and individual role-making and role-playing.

To this end, Kreps (1978) developed a structural code that describes the structural evolution of post-disaster organization. It expands upon the four-fold typology defined by Dynes (1970), except rather than falling into four discrete organizational types, the code produce a range of organization forms from formal at one end and emergent/collective at the other. The structural code includes four elements: domains (D), tasks (T), human and material resources (R), and activities (A). All four elements are



necessary and collectively sufficient to fully constitute an organization. According to their theory, “*each element as observed in time and space is a unique expression of social structure; that their mutual corpulence points to the existence of organization; and that no pattern of their emergence is necessarily more frequent, important, or effective than any other.*”

#### 2.1.4.1 Interpreting the Structural Code

Domains (D) and tasks (T) define the structural “ends” of an organization. Domain is defined as *the collective representation of bounded units and their reasons for being*. It identifies an organization that has power and external legitimacy. Tasks are defined as *the collective representations of a division of labor for the enactment of human activities*. Resources (R) and activities (A) serve as the structural “means” of an organization. Resources are defined as the *individual capacities and collective technologies of human populations*. Resources are present throughout process of structure being defined, but the actual mobilization of resources may precede or follow any element in the structural code. Activities are defined as *the conjoined actions of individuals and social units*. Activities both enable and are constrained by the other elements within the structural code. An organization is represented by the order the elements appear and it’s preceding forms (e.g. D, D-R, D-R-T, D-R-T-A).

Kreps and Bosworth conceive of the ordering of elements as representing a continuum of forms with the D-T-R-A form (social order) at one end and A-R-T-D (social action) on the other (Saunders & Kreps, 1987). The D-T-R-A end of the spectrum represents formal organization where the domain and resources of the organization are defined up front. The A-R-T-D end of the spectrum represents collective behavior and the spontaneous formation of emergent organizations where the tasks and activities resulting from emergent situations in the aftermath of disaster eventually formalize into an organizational entity. One of the powerful aspects of this structural code is that it recognizes partial and intermediate forms of organization. Partial forms may meet their organizational needs and dissolve or evolve into fully realized organizations. Any of these forms could exist indefinitely or dissolve if the need is fulfilled.

## 2.2 Crisis Informatics

Crisis informatics is an interdisciplinary field of research that integrates technological, sociological, and informational perspectives into the study of crisis response. The term emerged within roughly the same timeframe from the work of both Christine Hagar (2006) and Leysia Palen (Palen, Vieweg, Sutton, Liu, & Hughes, 2007). Hagar defines crisis informatics as a term used to broadly define *“the interconnectedness of people, organizations, information, and technology during crises. It examines intersecting trajectories of social, technical, and information matters in crises/disasters and explores the full life cycle of a crisis: preparation, response, and recovery”* (Hagar, 2010). In the years that followed, Leysia Palen developed this research area and she has come to define it as *“The study and design of ICT in relation to actual or potential mass emergencies, with a particular focus on the role of social computing in such situations”*. The latter definition is simple and concise and it gets at the phenomena of social computing in disaster without getting fixated on specifics of social media use. In this review of crisis informatics literature, I would like to focus on what we know about how people leverage the affordances of new technology to communicate with one another, share information, problem solve and organize response to disaster through technologically-mediated communication tools with a focus on the implications this has for public information work and the processes of formal emergency response.

As the Internet evolved to allow more dynamic information seeking and sharing, social use of the Internet grew and the emphasis shifted from the Internet as a source of static information to a space of social interaction. The timing of this technological shift coincided with the September 11<sup>th</sup> terrorist attacks and other subsequent large-scale emergencies that reminded many people of our responsibilities as a member of a larger global community. A number of early researchers in crisis informatics began to look at examples of sociotechnical adaptations to crises and disaster as an indicator of what was to come and the implications for both technology design and the future of public participation in emergency response. Palen and Liu (2007) analyzed persistent forms of communication both online and off across multiple hazards with different spatial and temporal characteristics for insight into how these aspects affect communication.

They observed a heightening level of public participation and three new channels of communication enabled by ICTs. First, it supports the sharing of information within the impacted population, resulting in a high level of readily available information within the disaster zone. Second, it is breaking down geographic barriers, allowing communication between the impacted population and the outside world. Finally, it creates the possibility of a direct communication channel between the public and emergency response. They conclude that members of the public have always played a vital role in disaster response, but technology is enabling this self-organizing behavior to occur on a much larger scale and to be more visible. They predict that emergency response organizations will have to figure out how to align with, support, and leverage public participation in disaster. In order to do that, they also suggest that emergency response will have to find ways to reconcile the incompatibility of informal social media communication with the formal protocols of the command and control model of emergency response.

Palen, Hiltz, and Liu (2007) look at online forums created in response to multiple disasters. They make a case for the important role citizens play from stepping up as the true first responders through ongoing efforts to meet the needs of their communities. They argue that online forums allow the sharing of information and coordination on a scale not seen before with much broader audience. Forums create the possibility for online gathering spaces. They argue that if we appreciate the role historically played by members of the public in emergency response then we need to plan for public inclusion in emergency response.

A later visionary paper (Palen, Anderson, Mark, Mark, Sicker, Palmer, & Grunewald, 2010) outlines a preliminary research agenda for computer science and technology design that puts the needs of the public first and recognizes the powerful, self-organizing, and collectively intelligent force capacity of citizen contributors. The paper outlines a new communication model that enables communication between citizens and formal response and provides for integration of publicly provided information into situation awareness provided by emergency response organizations. The paper identifies a number of technological and social hurdles that need to be addressed and defined in order to make this happen.

### **2.2.1 Online Forums: New Sites for Grassroots Participation**

The earliest research in crisis informatics looks at the use of online forums and other Web sources in disasters and anticipates the role that such tools and technologies could play both in terms of information sharing and organization surrounding a disaster. One of the earliest (Schneider & Foot, 2002, 2004) looked at how individuals and organizations used online structures of the Web to support new processes for obtaining and providing information, sharing reactions to the September 11<sup>th</sup>, 2001 terrorist attacks, and as a vehicle for conveying policy preferences. A later set of studies (Hagar, 2001; Hagar & Haythornethwaite, 2005) look at the use of a community networking initiative, *Pentalk*, during the 2001 UK Farming Crisis and how this tool supported information exchange and provided a vital channel of support between members of a farming community isolated by quarantine regulations. Another (Torrey, Burke, Lee, Dey, Fussell, & Kiesler, 2005) look at spontaneous organization through blogs and online forums after Hurricane Katrina emerging as a result of the American Red Cross halting “in kind” donations. The authors looked at sites that arranged for “connected giving” between individuals in need and privately provided supplies, comparing the short-term success achieved by blogs versus online forums that tended to persist in the longer term but had more communication difficulties. Qu, Wu, and Wang (2008) analyzed communication threads in a popular online forum after the 2008 Sichuan Earthquake. They identified four important roles within these threads: information exchange, opinion-related communications, action-related communications, and exchanges of emotional support. The forum served as an important feedback mechanism for individuals and for government organizations. During the 2007 Southern California Wildfires, citizens responded to the dearth of timely, relevant, localized information by creating online forums focused on information needed by the dispersed population during the fires (Shklovski, Palen & Sutton, 2008; Sutton, Palen & Shklovski, 2008). A final study, Hughes, Palen, Sutton, Liu, and Vieweg (2008) looks across disaster-related web sites from the perspective of convergence behavior (Fritz & Mathewson, 1957; Kendra & Wachtendorf, 2003a) and conclude that the communications represent bits of activity without context and so it is difficult to frame in the role-based

tradition of prior research. They develop a classification based on the online interaction, finding examples of interactions that fit within traditional convergence roles.

### ***2.2.2 Citizen Journalism***

Another important technological advancement has been tools for producing, refining and sharing new forms of content. Smart phone technology and standard ‘apps’ make capturing photos and videos easy and accessible in the moment. Sites for sharing this information have proliferated as well. The ability to capture and share newsworthy information has cast citizens in a new role as ‘citizen-journalist’, but this also points to an important implication for emergency response – people have the ability to capture and share information that contributes to situational awareness. Photo sharing sites like Flickr have made it possible for people to organize around and participate in the collation of photos for a particular disaster event (Liu, Palen, Sutton, Hughes, & Vieweg, 2008; Liu, Palen, Sutton, Hughes, & Vieweg, 2009). These studies draw a comparison between visual based online ‘photo-blogging’ and traditional text based blogging. They observe how the metadata stored with these photos and videos allow for organization, and support a sort of immediate, visual conversation and collective sensemaking around them. The availability of new sources of ‘open data’ and new tools for creating data ‘mash-ups’ of this information has resulted in another important form of information exchange in disaster. Map-based mash-ups have been a particularly useful form for the visualization of disaster or crisis information and often serve as a visual rallying point for response and reporting. Crisis information “mashed up” and represented on a map serves as a map that can be monitored or acted upon by others (Liu & Palen, 2009; Liu & Palen, 2010). A particularly successful example of this is the map created by Ushahidi following the 2007 Kenya Elections that allowed the reporting of election violence following the 2007 (Okolloh, 2009). The crisis map made election violence visible to the rest of the world despite a lack of media coverage. The developers of Ushahidi released the software as an open source solution where the idea of crowd-sourced crisis mapping took hold.

### ***2.2.3 Microblogging in Disaster***

Twitter, a microblogging platform, has been one of the most widely used and rapidly adopted tools for sharing information in disasters. Although Twitter can be viewed as another form of computer-mediated chat, there are a number of differences in the conventions and mechanisms built into Twitter that make it uniquely suited to the communication and sharing of information in mass convergence events and disaster. Twitter functions as a large informational ecosystem, allowing the broadcast and propagation of short messages across a network of followers or individuals listening for specific content. The more timely and relevant the content of a tweet, the more the information is propagated and the larger the potential audience it reaches. Any member within the Twitter network has the ability to follow or be followed by any other member and follower relationships can shift fluidly in response to changing events or interests. A number of linguistic conventions and features within Twitter have evolved to allow members to share information with their followers, converse publicly with one another (Honeycutt & Herring, 2009) and to contribute to a broad conversation surrounding a topic or event (Messina, 2007). One of the key differences pointed out by Starbird, Palen, Hughes and Vieweg (2010) is that there are no formal curation mechanisms built into Twitter. Interaction in Twitter occurs within and on the data itself through the distribution of information, manipulation of previous content, and the redistribution of material within the broad social network. Twitter is oriented towards the latest information. Without regular retransmission, Twitter communications die off and other topics of conversation emerge (Starbird, Palen, Hughes, & Vieweg, 2010). Microblog posts related to disaster or mass convergence events are more focused on information broadcast and information brokerage when compared with a general sample of tweets (Hughes & Palen, 2009; Qu, Huang, Zhang, & Zhang, 2010). This orientation towards the sharing of concise information, in the moment, across a broad range of sources is what makes Twitter such a valuable communication forum during disaster when timeliness of information is critical. A

number of studies look at both the content of disaster-related tweets and the mechanisms of tweeting for insight into how tweeting helps shape the information space during an event.

Starbird, Palen, Hughes, and Vieweg (2010) looked at social interaction on Twitter during the 2009 Red River Floods, a time-critical event that affected a broadly populated area, to identify the mechanisms of production, distribution, and organization supporting the social life of microblogged information during a disaster. They identified three types of microblogging behavior. Generative activity refers to the creation of information that is the source material for downstream activity. They observed two types of generative behavior: introduction of information from other sources into the discussion or autobiographical narratives such as first-person observations and status updates. Generative tweets accounted for less than 10% of the overall sample, but local tweeters produced over 80% of these. They observed that organization of this new material took place through a highly distributed, decentralized and diffuse central cognition process. Synthetic information production occurs when knowledge from outside sources (including other tweets) is integrated into the tweet. This type of behavior helps to shape and organize the information space by processing and adapting information to fit within the 140-character format. Over 25% of tweets in the general sample synthesized information from outside sources. This was done most commonly by media sources introducing media coverage to the conversation. They conclude that much of this synthesis activity functions as an informal, end-user driven filter for the mass of information surrounding an event. Derivative information production (retweets, recommendations, and re-sourcing) occurred in over 75% of tweets in the sample. Acting on existing information helps to organize an unwieldy information space by filtering and providing a personal recommendation to others. A number of Twitter features support derivative information production: retweeting pushes information to a broader audience and provides endorsement of content, recommending sources through the @mention feature indicates an endorsement of sources as trustworthy, and re-sourcing – the act of pointing to other sources or copying information from external sources – directs people to new sources of information. Re-sourcing introduces new information that requires further organization of the information space. The final method they considered was innovation where certain individuals used their technical knowledge to generate new

information through automated processes. Each of these mechanisms acted as part of a socially distributed process of curation that determines what is valuable or what is not in a time-critical fashion. The authors conclude with recommendations for emergency management: people have the capacity through social cognition and individual motivations to produce content for their perceived audience and to re-use data for their local needs. Understanding this relationship is key to releasing control over information.

Later research looks specifically at what can be learned from analyzing retweet behavior. A study done by Starbird and Palen (2010) builds on the findings from Starbird, Palen, Hughes and Vieweg (2010), they found that during an emergency retweets containing keywords and retweets from geographically-local Twitterers are more likely to pertain to the event. Contrary to the perspective that retweets are noise to be filtered from a dataset, focusing on retweets may serve as a recommendation filter surrounding an event. A comparison of the tweet content for local and non-local users points to a difference in how information is differently valued between these two audiences. The retweets for non-local users tended to pass on information related to high-level or journalistic accounts of the event whereas local users were more likely to pass on information that was directly related to the emergency. A later study by Starbird and Palen (2012) explored the relationship between retweeting behavior and identifying citizens on the ground during the uprisings of the 2011 Arab Spring. They found that a combination of information about follower growth and retweets could be use to identify tweeters who were likely to be tweeting from the ground.

One final topic I'd like to discuss in the context of microblogging is rumor propagation. It is a common perception that rumors spread unchecked through social media channels and it is a reason that some emergency managers are reluctant to incorporate information gathered through social media into their decision-making processes (Hughes & Palen, 2012; Hiltz, Kushma, & Plotnik, 2014). On Twitter, the path of the rumor propagation is readily observable and a number of researchers have analyzed this phenomenon and looked for strategies to understand the process of rumor propagation and to define strategies for predicting the credibility of a tweet. Mendoza, Poblete, and Castillo (2010) compare the



propagation of confirmed information versus unconfirmed rumor following the 2010 earthquake in Chile. They observed that the unconfirmed rumors were questioned more than confirmed information. The same researchers explored the use of manual evaluation of tweets combined with machine learning techniques to see if credibility of a tweet could be determined from the aggregated information about a tweet (Castillo, Mendoza, & Poblete, 2011). They found that newsworthy topics tend to include URLs and have deep propagation trees. Within this, credible tweets tended to come from users who generated a large number of messages. In addition, these tweets originated from a single user or a few users with large number of followers with numerous reposts. This is consistent with the earlier findings of (Hughes & Palen, 2009) that disaster-related tweets were more likely to contain URLs and to be retweets from media or response-organizations, representing information from sources that are perceived to be credible. Another study (Maddock, Starbird, Al-Hassani, Sandoval, Orand, & Mason, 2015) takes a more in-depth look at the propagation of rumor through a recursive analysis of that combines both quantitative and qualitative methods to provide a nuanced, multi-dimensional signature to describe the social life of a rumor on Twitter. They argue that understanding how rumors develop and spread should be an important first step before designing automated process for identifying them.

#### ***2.2.4 Information Seeking and Collective Sensemaking***

Understanding the information seeking practices of citizens in time- and safety-critical situations and their capacity for socially distributed problem solving is essential for the design of solutions and strategies that support and align with these behaviors. ICS protocols place a high value on the release of only officially verified and approved information and concern about controlling the message and stopping the propagation of rumor and misinformation (Buck, Trainor, & Aguirre, 2006). A number of researchers suggest that this high standard of accuracy is an unrealistic and counterproductive ideal (Palen, Vieweg & Anderson, 2010; Tapia, Moore, & Johnson, 2013; Tapia, 2014) and it doesn't fit well with the decision-making practices of "everyday analysts" in crisis situations (Palen, Vieweg, & Anderson, 2010). Disasters by their nature disrupt the predictable nature of our environment and flow of our lives, creating

incomplete and volatile assessments of the current status. It is often impossible to have a fully complete and accurate picture at any given moment. In this complex environment, we must rely on a strategy of satisficing where decisions are made with the best available information (Simon, 1996, p. 190). Palen, Vieweg, and Anderson (2010) go on to argue that in this sort of situation, confirmed accuracy is not the key factor, rather it is the “helpfulness” of the information. Recipients of information are adept at evaluating source-level credibility of information and providers of information often anticipate the need to establish credibility quickly, providing information with the recipient in mind. People gather pieces of information from a multitude of sources that can be used in relation to local circumstances to form a clearer picture and provide the basis for individual decision-making. Just as we saw in the examples in the previous section, as digital sources expand, people assemble information across a variety of sources both online and off, official and unofficial, and through information gathered from both people they know and trust and complete strangers in a process that is increasingly socially distributed (Palen, Vieweg, & Anderson, 2010).

Studying distributed decision-making processes in a diffused environment presents many challenges and is often too complex to capture except in small, observable exchanges. Palen, Vieweg, Sutton, Liu and Hughes (2007) discuss the challenges presented by this type of research and how they used quick response research (QRR) techniques during the 2007 crisis at Virginia Tech to capture the process more completely. The circumstances of the tragedy created a problem that was bounded both in scope and time. Between the time that the number of victims in the shooting was announced and the time that officials released the names of the victims, members within the Virginia Tech community began communicating with one another in a process that evolved into a socially distributed quest to identify the victims evidenced across multiple sites. To capture and analyze this social phenomenon before it disappeared, the research team worked both interviewing students on location and a remote team surveyed activity across over 500 Facebook groups where there was discussion of the shootings. What started as safety and welfare checks among students expanded into a problem space where students coordinated with one another to pool and cross check information and account for members of their

community. The researchers observed parallel problem solving across several sites of study and social arrangements that established norms of participation in terms of fact-checking and source identification to help them reach agreement of who could officially be included on a list of victims. In the end, across each of the list of victims, they were able to accurately identify victims and collectively to arrive at a complete list in advance of the official announcement with errors. This example gives insight into how this sort of collective problem solving space evolves and the collective potential that exists through new social structures and activities supported in this virtual communication space. Vieweg, Palen, Liu, Hughes, and Sutton (2008) extends this research by applying an ethno-methodological lens to a particular discussion thread where a list of confirmed victims was compiled to understand the dynamics of how a loosely connected group of individuals worked together. What they observed were social norms for sharing sources of information so that they could collectively evaluate and verify the accuracy and authenticity of names on the list with a sense of gravitas. A later study (Palen & Vieweg, 2008) examines communications on a group page of a popular social networking site in the aftermath of shootings ten months later at Northern Illinois University on February 14<sup>th</sup>, 2008. They observed how features of the social networking site allowed two geographic communities that shared a common experience to come together in a public, online setting. The researchers observed instances of collective sensemaking between the two communities and the opportunity for the two communities to ally with one another, express empathy, and to offer support, guidance and instruction about how to navigate the experience. In the aftermath of the second shooting, the contributors seemed more aware of the lack of privacy and drew clearer boundaries about the release of information than after the Virginia Tech shootings. The findings about the care with which the information about the victims was attended to, supports a general picture of information sharing in disaster or crisis that favors information accuracy and verification over propagation of rumor or misinformation.

### ***2.2.5 Emergent Citizen-Led Organization in Disaster***

Self-organized groups can take many forms in disaster from members of an impacted community pulling together to help each other out to distant strangers banding together around a cause. Examples of these often spontaneously formed citizen-led organizations exist throughout disaster research literature, but in the past contributing money was the primary form of participation for individuals at a distance from the disaster. The diffusion of ICT has afforded new possibilities for geographically distributed involvement in disaster. In some instances this organization is temporary and lasts until the work is complete. In others, emergent organizations evolve into longer term organizational efforts with a core set of contributors (Starbird & Palen, 2013; Soden & Palen, 2014; Morrow, Mock, Papendieck, & Kocmich, 2011). The role of technology follows a wide spectrum as people adapt to and organize around the circumstances created by a disaster. In some instances technology plays a minimal role such as in the organization of watercraft after the 9/11 terrorist attacks coming together to transport people stranded in lower Manhattan to safety (Wachtendorf & Quarantelli, 2003). A radio call-out from the Coast Guard resulted in mass convergence of vessels to the shoreline of lower Manhattan. Many of them heard the radio call, but others joined in based on observation of the ongoing operations - resulting in a well-orchestrated and orderly evacuation. We see instances where individuals on the ground use social media to gain visibility for the issues and activities they face (Sarcevic, Palen, White, Starbird, Bagdouri, & Anderson, 2012; White & Palen, 2015). A study by White and Palen (2015) provides a rare opportunity to observe the relationship between the online and offline coordination that occurred in the rescue of a herd of horses stranded during the 2013 Colorado Floods. What started as a Facebook post from a distressed ranch owner evolved into a gathering of expertise coordinated both online and off. Technology helped mediate their organizing efforts and social media communications also provided coverage for the community. In some organizational efforts, communications between members are primarily technologically mediated and their collective work helps them to bring together and organize information needed by those on the ground (Soden & Palen, 2014; Morrow, Mock, Papendieck, & Kocmich, 2011;

Starbird & Palen, 2011). In many cases, it is hard to know exactly what the relationship is between online efforts and work happening on the ground (White, Palen & Anderson, 2014).

As the visibility of sociotechnical innovations in crisis response grew, groups began to gather and brainstorm about the potential to join ethically motivated technical experts with humanitarian causes for “civic hacking” efforts. The potential for using distributed expertise in disaster response was one of the topics of conversation. The first Crisis Commons event was held in May 2009 (Zuckerman, 2010). Other events followed and a number of groups formed including The Random Hacks of Kindness group, and crisis mapping groups. Members of Ushahidi were exploring ideas for how their platform could be developed and used for other humanitarian applications and there was growing interest within the OpenStreetMap (OSM) Community for the value that the platform could provide in crisis response (Soden & Palen, 2014). All of this organizing set the stage for what happened after the earthquake in Haiti. On January 12, 2010, a 7.0 magnitude earthquake occurred near Port-au-Prince, Haiti. A combination of factors including the shallowness of the earthquake, proximity to a densely populated area, and weak infrastructure resulted in catastrophic damage. It resulted in approximately 13.9 billion dollars in damage (Cavallo, Powell & Becerra, 2010) and up to a quarter of a million people lost their lives (New York Times, 2010). The magnitude of the earthquake inspired an unprecedented worldwide humanitarian response. I’d like to highlight three efforts that evolved from the response in Haiti: Tweak the Tweet (TtT) (Starbird & Stamberger, 2010), crisis mapping and the formation of the Standby Taskforce (Morrow, Mock, Papendieck, & Kochmich, 2011), and the formalization of the Humanitarian OpenStreetMap Team (OSM) (Soden & Palen, 2014).

Tweak the Tweet (TtT), a micro-syntax for disaster tweeting, was an idea that grew out of a discussion in November 2009 at a Random Hacks of Kindness (RHOK) event (Starbird & Stamberger, 2010). Messina (2007) formalized the idea of using the hash character to identify keywords following the 2007 California Wildfires to make relevant tweets more searchable. Messina (2009) went on to establish a forum for sharing other ideas to allow more content to be meaningfully embedded within the 140-character limit of a tweet. Starbird and Stamberger (2010) refined this idea further and proposed a micro-

syntax for disaster tweeting using the hashtag character ‘#’ to identify key pieces of information in machine-readable form thus aiding response. The TtT syntax was formally deployed in the first days after the earthquake using prescriptive tweets, a formal press release, a tweet editor that made generating the syntax easier, and how-to videos. It did end up being used, but not in the way expected (Starbird & Palen, 2011). Rather than being detected and used by citizens on the ground, twitterers outside of the earthquake zone picked up on the syntax and began acting as translators. They picked up on actionable information coming from the ground, translated it into the TtT syntax and retweeted it. As this activity gained momentum, they started to recognize others participating in the same activity and began to work collectively. Over time, two primary roles emerged: some twitterers continued to act as translators while a second group acted as remote organizers performing more complex organizational tasks through a variety of tools. The TtT syntax evolved during the event to meet new circumstances and volunteers began organizing and improvising their response based on necessary tasks and collaborating with one another. Numerous connections formed between the volunteers and they referred to themselves collectively as ‘voluntweeters.’ After the Haiti response, they went on to form the non-profit Humanity Road. The organization provides support to communities impacted by natural disaster by monitoring social media for actionable tweets and amplifying official information. A later paper (Starbird & Palen, 2013) looks at how this entirely virtual organization based on volunteerism has formed over time and how they maintain their organization through a core group of virtual volunteers.

When Patrick Meier, a member of Ushahidi, first heard about the earthquake in Haiti, he set up an Ushahidi crisis map for Haiti without a clear idea of exactly how it would be used (Nordheim-Hagtun & Meier, 2010). What evolved over the first days following the quake was a lesson in how quickly and effectively people can come together through technologically mediated communications and organize around a cause. Numerous people with technical expertise and connections came together to enable SMS capability within the Ushahidi platform (Munro, 2013) so that Haitian citizens could text information directly to the crisis map. As needs arose, people stepped in and filled the gaps. A map that started as a small group of volunteers in Meier’s living room, evolved into a team of approximately 1000 translators

and approximately 300 volunteers helping to create the reports that helped to connect those that needed help in Haiti with responders. They used a variety of tools including wikis, Skype group chats, and shared Google documents to resolve issues, communicate and improvise their response (Nordheim-Hagtun & Meier, 2010 p. 86). The Ushahidi platform has continued to evolve as a free and open software solution and is used in a variety of crisis and disaster events. There are some conflicting reports about the true impact of the Ushahidi crisis map during the response in Haiti (Morrow, Mock, Papendieck, & Kochmich, 2011), but few can argue that a high level of spontaneously coordinated work that was achieved. Ushahidi formalized their volunteer efforts in the formation of The Standby Task Force a team of virtual volunteers on signed up and managed by a designated team of core members at the International Conference on Crisis Mapping 2010 (Heinzelman, Sewell, Ziemke, & Meier, 2010).

The Humanitarian OpenStreetMap Team (HOT) is another citizen-led group that actively participated in the response in Haiti. OpenStreetMap (OSM) is a volunteer-based project that provides free and open access to geospatial data and a simple set of map editing tools. Interest in using OSM for humanitarian purposes was growing movement within the OSM community, but was not fully formalized until its use in Haiti. Soden and Palen (2014) report on how HOT formalized their efforts in the immediate aftermath of the 2012 earthquake in Haiti and then worked for the following year and a half to support international response organizations and establish a citizen-based effort in Haiti. OSM data was used first for humanitarian purposes during the 2009 Tropical Storm Ondoy in the Philippines as part of situation reports and damage assessments (Maron, 2009). At the time of the quake, OSM and other sources only had a portion of road information and there was an immediate demand for accurate and up-to-date maps to help guide logistics and response efforts. Over the next three weeks, a small local team and over 600 remote volunteers built a base layer map nearly from scratch that became the most detailed map of the quake-affected area. They drew on numerous imagery sources to support their efforts to map roads, building footprints and to identify damage to infrastructure and impromptu camps being set up by displaced Haitians (Keegan, 2010). They provided rapid data extracts in formats for consumption by the traditional tools and numerous response organizations relied on information made available by OSM

(Batty, 2010). Members of the Ushahidi Crisis Mapping effort relied on the OSM as a base map and to aid geotagging of incident reports (Munro, 2013). After the Haiti response, HOT has gone on to promote community-based mapping efforts in seismically at-risk populations (Soden, Budhathoki, & Palen, 2014) and they have added functionality and refined their data model to improve collaborative coordination during a disaster (Soden & Palen, 2014).

### **2.3 Social Media Use in Formal Response**

Researchers predicted that as public social media use increased, emergency responders would need to find ways to incorporate these new channels of communication into their response (Palen & Liu, 2007; Palen, Vieweg, Sutton, Liu, & Hughes, 2007; Palen, Vieweg, & Anderson, 2010). There has been increased pressure both to share emergency information through these channels and to monitor public communications for relevant information that needs to be incorporated back into the response (Palen & Liu, 2007; Palen, Vieweg, Liu, & Hughes, 2009). Despite these pressures, the use of social media within formal emergency response is a fairly new phenomenon, lagging behind public adoption for a number of reasons (Hughes & Palen, 2012; Hughes & Palen, 2014; St. Denis, Hughes, & Palen, 2012). One of the primary barriers is the incompatibility between formal emergency response procedures as defined by the National Incident Management Systems (NIMS) Incident Command System (ICS) and the informal nature of social media communications. According to ICS protocols, formal approval is needed from the incident commander before any information is released to the public. This time-consuming approval process is fundamentally incompatible with the fast-paced, up-to-the-minute style of social media. In addition to this, responders tasked with communicating with the public may lack the organizational support they need. This can come in the form of policies that restrict social media use, concern about liability risks, or organizational indifference that limits the availability of necessary resources and training. In addition, the learning curve for social media is steep and the social media landscape is in a constant state of flux making it unclear what tools to adopt and how to use them. Additionally, tools for capturing social media information and tracking monitoring efforts are limited making it difficult to



incorporate into a formal process. Palen and Liu (2007) predict that the pressure to incorporate social media information from these new public streams will necessarily result in fundamental shifts in the formal institutions of emergency management.

### ***2.3.1 Criticism of the NIMS/ICS Framework***

A number of researchers have taken a critical look at the NIMS/ICS framework and concluded that it contains a number of flaws that make it ill-suited to generalized emergency response and that it does not support public engagement well (Crowe, 2010; Buck, Trainor, & Aguirre, 2006; Dynes, 1994). ICS was developed by the US Forest Service in the 1970s to standardize procedures across wildfire response teams, making communications across organizations and handoffs between wildfire teams easier. It works well for the tactical nature of fighting wildfires where each response follows a predictable pattern. It does not work well for incidents that occur infrequently, incidents that require more improvisation on the part of the response team or incidents that involve more complex social communication (Buck, Trainor, & Aguirre, 2006). Dynes (1994) points out that ICS doesn't really accommodate coordination the communications across the range of existing organizations, emergent groups and converging volunteers that characterize major disaster responses. Crowe (2010) looks specifically at the incompatibility of formal ICS message protocol and the informal communications of social media. He points out that people are often distrustful of formal government communications, serving as a further barrier to sharing information with the public through traditional channels.

### ***2.3.2 The Role of Improvisation and Creativity in Emergency Response***

Disasters are inherently ambiguous situations that require improvisation, especially during the immediate response phase (Tierney, 2002; Mendonca, Beroggi, & Wallace, 2001; Kendra & Wachtendorf, 2002, 2007). Researchers examined specific examples of improvisation following the 9/11 terrorist attacks in New York City (Kendra & Wachtendorf, 2002, 2003a; Wachtendorf & Quarantelli, 2003) and the 2005 Hurricane Katrina (Wachtendorf & Kendra, 2005). Kendra and Wachtendorf (2007) discuss the importance of rethinking our perspective on improvisation within emergency response as not a

failure to plan, rather as an important part of responding to the unknowable circumstances created by the unpredictability of the hazard, the social arrangements on scene, and conditions of the scene. Emergency planning develops strategies for dealing with “what ought to be done” in certain scenarios, whereas improvisation develops a plan for dealing with “what needs to be done” in an emergent situation. They propose that we use ICS as a starting point, but we need to find a ways to extend it to allow both improvisation and the expansion of resources to include community organizations and community-based participation. Ideally these resources and their role would be planned for before an emergency. Mendonca, Beroggi, and Wallace (2001) look at defining a framework that would support improvisation as part of the response process.

### ***2.3.3 The Evolving Role of the Public Information Officer***

The impact of public social media use is felt most strongly in the public relations function of NIMS. In particular it directly impacts the work of public information officers (PIOs) responsible for managing communication with the public. Their primary responsibility is to communicate correct up-to-date information regarding the status of emergency incidents to the media, members of the public and any other stakeholders who are directly or indirectly affected. They are responsible for monitoring public communications, quelling false rumors, and correcting misinformation. They also act as mediators between incident command and mainstream media. Prior to social media, their primary communications were with the public through scheduled press releases and public meetings. They played the role of “gatekeeper” managing the message between incident command and the media.

A study conducted by Hughes and Palen (2012) analyzes the challenges and the shifting roles of the public information officer in this new communication ecosystem. The study combines the results of interviews with 25 PIOs across different types of organizations and summarizes some of the key ways that social media is reshaping their work practice. Most of the PIOs in the interview used at least one form of social media and they report feeling a pressure to figure out how to balance the formal protocols of their job with these new channels of communication. What they found was that the incorporation of social

media expanded not only the scope and type of work activity, but also created new “information pathways” between PIOs the media and members of the public. PIOs see their role shifting from one of “gatekeeper” officially releasing information coming from incident command to one of “translator” coordinating information between the formal and informal space. They take the formal messages from emergency response and translate them into a meaningful format for their stakeholders and they take information from the public sphere and translate it in terms of emergency response. Social media has opened up a direct two-way channel of communication with stakeholders. As media outlets cut back resources, PIOs report feeling and increased pressure to provide media content themselves. They often have equipment that was purchased specifically for this purpose that removes their dependence on mainstream media to provide coverage. The authors argue that these big shifts in work practice represent a shift in how emergency information itself is conceptualized. They call for a rethinking of the Office of Public Information and advocate for the decentralization of the ever-increasing job functions of the PIO to other parts of the institution and a refocusing of the responsibilities of the PIO to the informational front lines of the organization.

#### ***2.3.4 Innovators and Evangelists***

As public social media use gained popularity, emergency responders began to ask how social media might apply to emergency management. One of the earliest documented studies (Sutton, 2009) looks at social media monitoring practices within the Joint Information Center (JIC) at the 2008 National Democratic Convention. The study concludes that personnel made initial attempts at monitoring social media, but fell back on standard operating procedures partly because they did not have a strategy in place for social media monitoring and partly due to the lack of significant developments for this event. We would also point out that the JIC was not responding to an actual emergency and so the operations do not reflect the use of social media in emergency. Another early study looks at the role of the social media evangelist within emergency response (Latonero & Shklovski, 2011). Brian Humphrey, a Public Information Officer (PIO) at the Los Angeles Fire Department (LAFD) pioneered the use of social media

within his department and established communication practices that paved the way for others to follow at the LAFD. In another study, a PIO on a national incident management team trialed the use of a team of trusted digital volunteers to help her extend the social media monitoring capacity and to coordinate social media communications on the 2011 Shadow Lake Fire (St. Denis, Hughes & Palen, 2012). The volunteer team refers to themselves as a Virtual Operational Support Team (VOST) and the concept has continued and expanded within the United States and internationally. As social media adoptions continue, we see a shift from social media evangelists and individual innovators to more examples of organizations with an established a social media presence. One study looks at the online communication of police and fire during the 2012 Hurricane Sandy (Hughes, St. Denis, Palen, & Anderson, 2014). Results from this study showed that nearly half of the departments (46%) had no social media presence at all. Among the departments that did use social media to communicate with their constituents, we see moves on both sides to work out the details of this new information pathway. Another such study looks at the social media practices of two police departments during the August 2011 UK Riots (Denef, Bayerl, & Kaptein, 2013) contrasting the “instrumental” style of one police department operating at the center of the riots with the “expressive” style of another department operating outside of the riot zone. Finally, a later study looks at the development of a sophisticated social media communication plan that critical for reaching constituents during the 2013 Colorado Floods (St. Denis, Palen, & Anderson, 2014).

## **2.4 Emergent Organization**

Organization can be understood as a continually enacted process with communication acting as the essential modality (Weick, 2012; Taylor & Van Every, 2000). It takes place through the ongoing interplay between two essential forms: conversation and text. Conversation is the total universe of shared interaction-through-languaging of the people within the organizational context and text is a coherent, understandable piece of language (Taylor & Van Every, 2000 pp. 35-37). Borrowing from Atlan (1979), Weick (2012) describes the relationship this way: “*Organization resides between smoke and crystal just as it resides between conversation and text. Organization is talked into existence when portions of smoke-*

*like conversation is preserved in crystal-like texts that are then articulated by agents speaking on behalf of an emerging collectivity. Repetitive cycles of texts, conversations, and agents define and modify one another and jointly organize everyday life”* (Weick, 2012). Communication facilitates the ongoing process of making sense of the circumstances in which people collectively find themselves and the events that affect them. Through interactive conversation, situations are talked into existence and the basis is laid for how to deal with it. As circumstances are resolved, new issues or goals are identified and dealt with, making it continually emergent.

Organization is a socially distributed process realized as an interlacing of many local interactions that get knitted together or *laminated* (Boden, 1994) as connections are made across conversational sites. Within this, local understanding is continually adjusted and renegotiated as part of a larger whole with the ongoing conversation looking both retrospectively at steps that led to the current state and futuristically at what is needed to push current circumstances forward. During disaster, social media captures digital traces of these laminated conversations as individuals on the ground connect with a broader audience and members of the virtual community organize around this information in new ways. Localized conversation takes on a new meaning as geographically dispersed populations come together across virtual spaces with a common goal of making sense of emerging information and organizing response efforts. Section 2.2 describes ways that members of the public have adapted social media and ICTs to expand the conversation and organize across these new virtual sites of communication. The studies within this dissertation expand upon Section 2.3 looking specifically at how social media conversation is reshaping emergency response and some of the innovative ways that practitioners are stepping into this conversational space.

## **2.5 Action Research**

Action research (AR) has been described as a research approach rather than a methodology as traditionally understood. It is a multidisciplinary, multi-method, contextually based approach to social research where research is undertaken as a collaborative effort between researcher and participants over

an extended period of time. Hayes (2014) captures the essence of AR when she states: *The cornerstone of AR is that these two cannot be disentangled: the doing and the knowing, the intervention and the learning.* The end goal of action research is the generation of knowledge that benefits both researcher and participants within an everyday context. Participants are considered co-researchers, operating with equal but different knowledge within the given context. The underlying belief is that individuals, action researchers included, accumulate, organize and use complex knowledge in their everyday life and the best way to get at social knowledge is through practical reasoning engaged in through action within social context (Greenwood and Levin, 2006).

Greenwood and Levin (2006) identify three primary components to AR: action, research, and participation. *Action* must be taken to alter current circumstances as part of the collaborative effort over time. The action researcher must apply knowledge of theories, models, and rigorous analysis methods to the generation of new research knowledge. Finally, both researchers and collaborators must be active participants in this process, each taking responsibility for affecting change over time. They go on to define core characteristics that make up action research as follows. AR is context bound, addressing real-life problems holistically. Researcher(s) and participants engage in ongoing collaborative communication as they co-generate knowledge with the contributions of all participants taken seriously and on equal level with researcher. Thus, no party in the process is considered privileged. Diversity of experience and capacity is seen as an opportunity to enrich the process, fueling more creative approaches and insights to problems. The process of constructing new meanings and social action is cyclical with new meaning resulting in new definitions of social action and vice versa. As a consequence, meaning is always considered provisional and a reflection of the current stage of discovery. The ultimate measure of credibility or validity of action research is measured by whether knowledge generated through this process increases participants' control over their own situation.

Action research takes a holistic view of the world. Humans exist as part larger social systems that are not merely structure but constituted through *processes in continual motion*. Within these systems, individuals possess detailed and complex knowledge about their lives, the world and their goals. This

knowledge is different but no less important than scholarly knowledge. Ultimately, the goal of AR is to combine the world of practical reasoning with that of scholarly knowledge in a dialectical relationship meant to draw deeper meaning and affect tangible change.

The action researcher takes on the role of the “friendly outsider” building trust and rapport with the participants over time. Being immersed within the context of the research allows the researcher to experience “knowing how” in addition to the scholarly perspective of “knowing what”. This combination of rapport and knowledge guides collaboration and design of interventions based on the belief held by all involved that better solutions are possible than what currently exists. The action researcher must balance external perspectives and expertise with a substantive appreciation for the circumstances, challenges, and goals of the participant community. AR is method agnostic, with the researcher free to choose whatever analysis methods yields new knowledge. It is a highly reflective process taking skill to draw out results as they unfold within the research process, challenging the researcher to document this process so that others outside the results for transferability to other contexts.

## CHAPTER 3. Research Design

### 3.1 Primary Research Question

**How can we better understand and support the development of solutions within emergency response that make use of new and expanding channels of public communication?**

To this end, I specifically ask a series of related questions:

Most of what we know about the use of online tools in emergency management comes from case studies focused on the innovative use of social media. What remains unknown is how emergency response organizations in general are online tools and social media for emergency communications.

RQ1 What does online tool and social media use look like in general across emergency response organizations during a widespread emergency? Are there differences between emergency and non-emergency use?

The remainder of my research focuses on analysis of examples of high public engagement and my involvement with members of the social media in emergency management community. To this end, I specifically ask,

RQ2 What lessons can we learn from the innovations within the emergency response community that are helping to bridge the gap between formal organizational constraints and informal social media space?

My involvement with the VOST community and experience on numerous activations highlighted some of the key challenges teams face when monitoring public social media communications. I wanted to explore if there was some way to use my experience as a researcher and access to the Project EPIC data collections to develop new monitoring strategies based on the aggregation and analysis of this information. The research questions were development in collaboration with several teams over the course of multiple incidents. I will list them in the order they evolved over time.

RQ3 How can aggregated Twitter data be used to support the social media monitoring practices of emergency response teams?

RQ4 In high volume incidents, could aggregated information be used to identify a subset of tweets more likely to contain individual and local information?

RQ5 How does identifying and connecting information at the individual and local level affect social media monitoring practices?



Work with the PNW VOST team highlighted that circumstances change the focus of what is important within a data set. To that end, we ask:

RQ6 Can aggregated Twitter data be used to provide flexible views of the data? Secondly, which views are most useful across variable circumstances?

These questions are answered through five major studies that explore the ways that social media is reshaping public information work across a variety of contexts and emergency response teams.

## **3.2 Overview of Studies Used to Answer the Research Questions**

### ***3.2.1 Overview of Study in Section Two***

#### ***3.2.1.1 Study One: Online Communications of Police and Fire During 2012 Hurricane Sandy***

Study One (Chapter 4), an analysis of the online communications of a bounded population of police and fire departments during 2012 Hurricane Sandy, addresses RQ1 and RQ2. This study looks at patterns of use and dis-use across this population during a large-scale event and provides a bigger picture view of the use of social media in emergency response. Over half (54%) of the police and fire departments were actively using at least one form of social media to communicate with their constituents, but a quarter of the overall population quit using their accounts during the storm. We believe these results indicate both a growing interest in using social media as a form of communication, but the dis-use during the storm is a reflection important challenges that may have prevented social media use as part of an emergency communication plan. Analysis of departments where there was evidence of high engagement reveals how public information is shaped through ongoing communications with constituents within a visible public stage. Most interesting are examples when we see fundamental shifts in communication that reveal how situated practice trumps pre-planned policy as emergency responders and members of the public calibrate their expectations to shifting circumstances.

### ***3.2.2 Overview of Studies in Section Three***

#### **3.2.2.1 Study Two: Trial by Fire**

Study Two (Chapter 5), an analysis of a new sociotechnical arrangement developed within the emergency response community and first trialed during the 2011 Shadow Lake Fire, addresses RQ2. In this study we look at the tools and processes used by a team of trusted digital volunteers used to coordinate their activities, monitor social media communication, and to establish communication with the public surrounding this event. Finally, we discuss the potential merits and limitations of extending the social media capacity of an emergency response team through the use of a team of trusted volunteers and identify issues that would need to be addressed in the long term.

#### **3.2.2.2 Study Three: “V” is for Virtual**

Study Three (Chapter 6), an analysis of the tools and practices evolving within the growing virtual operational support (VOS) community since the 2011 Shadow Lake Fire, addresses RQ2. This study first looks at how virtual operational support has been adapted to work within a variety of cultural and operational settings worldwide. I then look specifically at the formation of the VOST Leadership Coalition (VLC) and the practices established within this community to support the ongoing evolution and continuity of an idea. I look at how formal training in emergency response and orientation towards social media and communication technology shapes their construction of a globally distributed virtual community of teams. I then look in detail at the tools and practices within an individual VOST team to align with a formal response organization, facilitating communication across a virtually distributed team, and supporting the emergency public information practices across social media channels. Finally, I discuss some of the challenges of balancing a growing and increasingly diverse community of teams with pressures to standardize and formalize practices so that VOST can be more readily utilized as a typed and orderable resource.

### ***3.2.3 Overview of Studies in Section Four***

#### **3.2.3.1 Study Four: Mastering Social Media**

Study Four (Chapter 7), an analysis of the social media communication and work practices of the Jefferson County Type III Incident Management team during the 2013 Colorado Floods, addresses RQ2. This study examines flood-related communications across three social media platforms for insight into how this innovative team has adapted their work practices to communicate and share information effectively during an event where they fell outside of the media spotlight. Using a mixed methods approach of interviews and content analysis, we describe their online behaviors in relation to the emergency, and the adaptations to work practice that allowed them to extend traditional communication practice with social media. Finally, we look at the team's experiences for implications this strategy has for the use of social media in emergencies more generally.

#### **3.2.3.1 Study Five: Evaluating the Use of Aggregated Twitter Data**

Study Five (Chapter 7), a summary of experiments exploring the use of aggregated Twitter data to identify individual and local tweets during an incident, addresses RQ3 through RQ7. The first phase of this research began following the 2014 Carlton Complex Wildfire where the PIO team identified a critical need to identify tweets coming from local and individual sources. After the fire, I used the aggregated source information from the 2014 Carlton Complex Fire to define a strategy for filtering out approximately eighty-eight percent of the overall tweets, with approximately 50% of the remaining tweets coming from individual and local sources. Quantitative analysis showed that remaining tweets were strongly biased towards locally relevant information and an informal narrative style. Qualitative analysis of this data set showed how local information is shaped across social media sources and related tweets produce narrative background over time. The filtering strategy was repeated the following summer during the 2015 Wolverine Fire and the 2015 Chelan Complex where results indicated that filtering was most useful during the most active phases of the fire, but a catastrophic event at the end of the fire demonstrated that the manual filtering was not enough and additional methods would be needed. Finally,

several data views were provided to the VOST team during the 2015 Kettle Complex Fire and I observed how they used the data and gathered feedback about what steps would be needed to make a filtered view effective in real-time response.

### **3.3 Methods and Reporting**

#### ***3.3.1. History of Involvement with Virtual Operational Support (VOS) Community***

##### ***3.3.1.1 The Shadow Lake Study***

My research began in the fall of 2011 when I attended a meeting in New Mexico with members of Crisis Commons, a digital volunteer organization, and a group of emergency managers from Los Ranchos de Albuquerque, New Mexico. The meeting was held at the office of emergency manager, Jeff Phillips, the creator of the concept of a virtual operational support team (VOST). I attended the meeting as a representative of the University of Colorado's Project EPIC team to learn more about digital volunteerism and the crisis camp idea. The discussion revolved around ways to leverage digital volunteers effectively, crisis commons efforts, and an after action review of the first trial use of a VOST on the 2011 Shadow Lake Fire. It was at this meeting that I was first introduced to the concept of using a team of trained and trusted volunteers as an extension of an official on-site emergency response team. They were already very familiar with the crisis informatics research literature from University of Colorado's Project EPIC Team and were very interested in sharing ideas. By the end of the meeting we had an informal agreement that I would conduct a case study of the use of a VOST during the Shadow Lake Fire and that I would produce a white paper documenting this and the core concepts of virtual operational support.

In the months that followed, I interviewed each of the members of this team and analyzed archives of their backchannel communications and public-facing social media communications. The product of this research is contained in Study 2 – Trial by Fire. This study furthered my understanding of the variety of challenges emergency responders face when trying to incorporate social media into their formal emergency communication plans. After this study, I was keenly interested in seeing how VOST

would evolve over time and how other emergency response organizations would address the challenges they faced. For the members of the Shadow Lake VOST, my study became a document that could be shared within emergency management detailing the concept and the results of this first implementation. It is posted as a reference document on the Virtual Operational Support Group Website (Lane, J., 2012). Many of the members of the Shadow Lake VOST later became leaders of their own teams. I have stayed in contact with each of these members throughout my research and I belong to three teams led by members of the Shadow Lake VOST.

### 3.3.1.2 Becoming a “VOSTie”

Following publication of *Trial by Fire* (St. Denis, Hughes, & Palen, 2012), I continued to participate in discussions and was added to the chat rooms for VOST activations across several newly active teams. During the first summer, this including multiple wildland fire activations and infrastructure projects. In 2012, Colorado experienced a severe wildfire season and I had an opportunity observe the Portland NIMO PIO team coordinating information across these fires. During this first summer, I would describe my role primarily as a participant observation, but as I gained comfort, I began to lend a hand, especially when circumstances were the most volatile.

Over the course of the next few years, as I gained skill and knowledge, I gradually took on a more active role and I now belong to a total of eight teams, shown in Table 2 below. This experience allowed me to observe differences in style and practice across these teams, but it was challenging to balance the demands of these teams with my workload as a student and research. Fortunately, the bulk of the work falls over the summer months and so each summer I dedicate much of my time to volunteering across these teams.

Team Name	Official Response Team Supported	Year
Eriksen's VOST	Portland NIMO, a Federal Type I Incident Management Team	2012
Pacific Northwest VOST (PNW VOST)	Pacific Northwest Team 2, a Federal Type I Incident Management Team	2012
Pacific Northwest 3 VOST (PNW3 VOST)	Pacific Northwest Team 3, a Federal Type I Incident Management Team	2012
Colorado VOST (COVOST)	Colorado Department of Homeland Security and Emergency Management, Colorado State Level Resource	2014
Oregon VOST (OR VOST)	Oregon Office of Emergency Management	2015
Henrico VOST	Henrico County Office of Emergency Management, Virginia	2015
Jeffco VOST	Jefferson County Type III Incident Management Team (no longer active – replaced by COVOST)	2013
Santa Fe VOST	Santa Fe Office of Emergency Management, Santa Fe, New Mexico	2012

**Table 2: VOST Team Membership Summary.**

If there are multiple activations occurring simultaneously, I go where I am most needed and monitor activities across the other teams as time permits. I have participated in over twenty-five activations over the last four years. Most of these activations have involved supporting Federal Type 1 teams for wildland fire response, but I also supported the JeffCoVOST for the 2013 Colorado Floods, support for several non-emergency activations, multiple line of duty death memorials – including the 2013 Granite Mountain Hotshots Memorial, and the 2015 Umpqua Community College Shootings. Experience across these events has helped develop my sense of how public communications takes shape across a variety of events and circumstance and it has developed my judgment of emergency and response relevance within this context.

### 3.3.1.3 Research Focus

My primary focus has been on building relationships within three teams: Eriksen's VOST (an extension of the original Shadow Lake VOST), PNW VOST, and JeffCo/COVOST. I have maintained contact with Kris Eriksen, Public Information Officer for the Portland NIMO Team. I am particularly interested in a recent shift in her practice to provide updates directly through local response organizations and community led efforts – empowering the organizations that will be there after the federal team leaves, rather than pushing information only from the official federal accounts. This research was not far enough

along to include in my dissertation. Second, I have worked closely with the leader of the PNW VOST team since 2012, immersing myself in the work practices of this team and developing a strong rapport with this small but dedicated team. Over time, I have gained enough trust with this team to function as a co-lead when needed. A summary of hours spent on this team is provided in Table 3. Finally, I worked with the Jefferson County VOST (JeffCo VOST) during the 2013 Colorado Floods resulting in Study 4 – Mastering Social Media.

<b>Incident Name</b>	<b>Year</b>	<b>Hours Logged</b>
Arapahoe	2012	27.13
Barry Point	2012	22.22
Wenatchee Complex	2012	27.65
Table Mountain	2012	52.03
Owyhee	2013	11.68
Logging Unit Fires	2014	20.63
Chiwaukum Complex	2014	18.00
Deception Complex	2014	33.86
Sockeye Fire	2015	15.50
Wolverine Fire & Chelan Complex	2015	178.20
Kettle Complex	2015	27.5
Total Hours Logged		434.40

**Table 3: Hours Worked on PNW VOST.**

In March, 2014 the Colorado Division of Homeland Security and Emergency Management (DHSEM) took over management of the team and rebranded it as the COVOST, a state level team. Project EPIC and COVOST have a partnership agreement and I have been working with as part of Study 5 – Evaluating the Use of Aggregated Twitter Data. I provided summaries of aggregated data across two non-emergency activations, but COVOST did not have an emergency activation during the timeframe of my analysis. I will touch on this research in the reflections section, but this analysis did not make it into the chapter.

#### 3.3.1.4 Other Involvement

I am a participating member of the Virtual Leadership Coalition (VLC) and I belong to the *All Things VOS* chat room detailed in Study 3. Membership in both these forums allows me to keep up with

what is happening across the VOST community. These forums and involvement across teams have helped me to foster new relationships and to converse with members of other groups. It has also provided valuable perspective on how this community shares experience, fosters new ideas and provides support to each other through these virtual channels. My analysis of cross-team coordination is included in Study 3.

The administrator of the Virtual Operational Support Group Website (VOSG.us) works closely with members of the international community and she has been instrumental in keeping me informed about new developments, but I have not had the opportunity to work directly with these teams. My summary of the developments within these teams is based on published information and lacks the same richness as the material generated through action research.

#### 3.3.1.5 Aggregated Analysis

Over the course of my participation in VOST activations, I have spent countless hours monitoring public social media communications and comparing monitoring results with other team members. Immersion in this environment has taught me how challenging it is to sift through social media content for emergency relevant information, especially in high volume events or when circumstances intensify. This was the initial motivation for pursuing the aggregated analysis described in section 3.2.3.1.

#### 3.3.2. *Evolution of My Role as Action Researcher*

This dissertation represents four years of collaborative research, building relationships and working alongside members of the virtual operational support community. With the exception of Study One, the census, the studies contained in this dissertation are focused on the co-production of knowledge traced through a series of experiments. My direct involvement with this experimental process has evolved over time, but there has always been a strong element of collaboration.

Members of the Shadow Lake VOST sought out my involvement because they wanted help from a member of Project EPIC evaluating and publishing the results from the first emergency trial and framing it within the larger context of crisis informatics. Although I wasn't a participant during Shadow Lake, the publication of the *Trial by Fire* paper positioned their experiment within the crisis informatics



literature and allowed them to share the idea across a broader audience. Study Three expands upon this initial study, combining my ongoing knowledge of evolving practices with a breadth of experience across teams and the larger community that allowed me to produce a comparative overview of the evolution of this idea as adapted across contexts. Similarly, it was my breadth of experience across teams and within crisis informatics research that allowed me to recognize the practices of the Jefferson County Type III IMT as height of practice for Study Four. Across these studies, I participated in the discussion and implementation surrounding the evolution of practices across this small but diverse community. Part of my contribution as collaborator and knowledgeable outsider has been to document this ongoing process of innovation. These documents serve as reference material both inside and outside of the VOST community for the discussion of new ideas in an area that is struggling for fresh perspective.

After two years of active involvement in VOST, my focus shifted to exploring ways to using support social media monitoring efforts. In the summer of 2014 I began a series of experiments to see if aggregated data related to an incident could be used to define more effective strategies for identifying response relevant information during an incident. This analysis was done in collaboration with multiple teams across multiple incidents. It was trialed on both emergency and non-emergency events. A subset of these trials is described in detail in Study Five. The first three rounds focused on identifying the commonly occurring sources and then providing aggregated summaries to the activating agencies (see description 8.3 for analysis during 2014 Carlton Complex). Based on feedback from these, my focus shifted to defining a strategy for filtering out sources that were unlikely to be from individual and local sources and providing an aggregated analysis. This strategy was trialed across multiple fires during the summer of 2015. The results from these trials led to further refinements of the process, allowing the teams to tailor the configuration dynamically to fit the resources and needs of the individual teams and the current circumstances surrounding an incident.

This process has followed my involvement across the teams defined in Table 2 above. Trialing the analysis across multiple teams and across both emergency and non-emergency incidents has shaped the evolution of this process. Across teams, I have observed how teams differ in terms of information

needs. When I work with COVOST and Eriksen's VOST, the information is provided directly to the response team and both prefer the filtered version. When I work with PNW VOST, the information is used within the VOST team itself. There the preference is for the full version unless circumstances dictate filtering. In non-emergency events, the filtering is far less effective and spam is a much larger problem. During emergency response, the need for filtering fluctuates with circumstances, with the current process adapting well to circumstances where tweet volumes exceed the resources available to perform the social media monitoring. It doesn't work well in circumstances where there are sharp spikes related to an outpouring of emotional support. The results from analysis have been reviewed across the teams that I work with. The results of my analysis have been shared across the teams that I work with and feedback from each round has been incorporated into the next phases of development. I am scheduled to present the most recent results in an upcoming session of the VOST Leadership Coalition so that the larger VOST community has a chance to learn from our experience.

### ***3.3.3. Methods Employed Across Studies***

Action research is method agnostic and I used whatever analytical tools were useful for the given context. Each study contains a detailed discussion of methods, but this is a high level summary of techniques that I have used throughout my research.

#### ***3.3.3.1 Quantitative Analysis***

Quantitative analysis methods have been applied to public facing social media content. Quantitative results point to general trends in the use of social media by the emergency response organizations under study and provide a high level summary of the content of emergency communications. The content categories used in Study 1 were developed in collaboration with Amanda Hughes using an iterative pair-coding process. These content codes were the starting point for the content categories used for Study 4. The data coding categories used in Study 5 were developed over the course of the incidents under study and evolved to measure important qualitative differences in the content.

### 3.3.3.2 Qualitative Analysis

Qualitative analysis of social media content and archives of backchannel communications often reveals important characteristics of the evolving practices under study and the situated nature of social media communication in disaster. Throughout my research I have focused on qualitative analysis, looking for insight into how emergency responders are translating and transforming public information work within virtual and social media channels, and in turn how public involvement in these channels reshapes and influences emergency response. This for me is the most interesting and rewarding aspect of my research.

### 3.3.3.3 Interviews

For Study 2, Study 3, Study 4, and Study 5, I conducted interviews with the PIOs and VOST team members related to each of these studies. These interviews were semi-structured and each interview was recorded and transcribed. This allowed me to gather relevant information about work practices, individual memories of events, opinions, and personal reflections on their experiences.

### 3.3.3.3 Document Analysis

Wherever possible, I analyze documents and published content related to whatever I am studying. This includes information such as team websites, after action reports, published reflections, meeting minutes, and published articles related to SMEM and VOST.

### 3.4 Collaborative Research and Inclusion of Published Work

This dissertation includes previously published research: the research and analysis for Study One, Study Two, and Study Four. I was the lead author for Study 2 and Study 4 and second author for Study 1.

My co-authors are indicated as follows:

- Study One, which appears as Chapter Four, is a reprint of Hughes, A. L., St Denis, L. A., Palen, L., & Anderson, K. M. (2014, April). Online public communications by police & fire services during the 2012 Hurricane Sandy. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1505-1514). ACM.
- Study Two, which appears as Chapter 5, is a reprint of St. Denis, L. A. S., Hughes, A. L., & Palen, L. (2012). Trial by fire: The deployment of trusted digital volunteers in the 2011 Shadow Lake Fire. In *Proceedings of the 9th International*.
- Study Four, which appears as Chapter 7, is a reprint of St Denis, L., Palen, L., & Anderson, K. M. (2014). Mastering Social Media: An Analysis of Jefferson County's Communications during the 2013 Colorado Floods. In *Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM 20014)*.

All reprinted, previously published research appears in this dissertation with the permission of my co-authors, Leysia Palen, Amanda Hughes, and Ken Anderson.

## **SECTION TWO. Putting Innovation into Perspective**

### **Section Introduction**

Before examining the innovative use of social media in emergency management, it is important to understand what the full spectrum of social media use looks like. The study in this section looks at the online communications across a bounded population of emergency responders during a wide scale disaster. It fills an important gap in the research in that it looks at both use and disuse during an event. If the study of innovative practice provides insight into future trends, looking at online communications across a population provides a frame of reference for understanding current social media use in general, a measure of how frequently social media communication broke down during a disaster, and where there are signs of innovative use.

## **CHAPTER 4. Online Public Communications by Police & Fire Services during the 2012 Hurricane Sandy**

### **4.1 Study Summary**

Social media and other online communication tools are a subject of great interest in mass emergency response. Members of the public are turning to these solutions to seek and offer emergency information. Emergency responders are working to determine what social media policies should be in terms of their “public information” functions. We report on the online communications from all the coastal fire and police departments within a 100 mile radius of Hurricane Sandy’s US landfall. Across four types of online communication media, we collected data from 840 fire and police departments. Findings indicate that few departments used these online channels in their Sandy response efforts, and that communications differed between fire and police departments and across media type. However, among the highly engaged departments, there is evidence that they bend and adapt policies about what constitutes appropriate public communication in the face of emergency demands; therefore, we propose that flexibility is important in considering future emergency online communication policy. We conclude with design recommendations for making online communication media more “listenable” for both emergency managers and members of the public.

The text contained within Sections 4.1 through 4.6 is a reprint of Hughes, A., L. St. Denis, L. Palen, and K. Anderson. (2014). Online Public Communications by Police & Fire Services during the 2012 Hurricane Sandy. In the Proceedings of the *ACM 2014 Conference on Human Factors in Computing Systems (CHI 2014)*, Toronto, 10 pages. This reprint appears here with the permission of my co-authors, Amanda Hughes, Leysia Palen, and Ken Anderson.

**This study addresses research questions RQ1 and RQ2.**

### **4.2 Study One Introduction**

With their need to quickly reach and engage with a diffuse target audience, emergency service workers are reportedly adopting social media and other online communication tools to connect with the public they serve (Denef, Bayerl, & Kaptein, 2013; Hughes & Palen, 2012; Hughes & Palen, 2014;

Latanero & Shklovski, 2011; St. Denis, Hughes, & Palen, 2012). Based on our ongoing research in this area, however, we see that use is uneven, and policy and practice with respect to such use are not always aligned. Studies have documented how members of the public use online communications like social media in a variety of emergency contexts (Hjorth & Kim, 2011; Hughes & Palen, 2014; Mark, Bagdouri, Palen, Martin, Al=Ani, & Anderson, 2012; Palen & Liu, 2007; Qu, Wu & Wang, 2009; Starbird, Palen, Hughes & Vieweg, 2010; Zook, Graham, Shelton, & Gorman, 2010), and emergency workers appear to be attending to that demand though seem uncertain about how to respond. The 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.

What remains empirically unknown is how widespread online media use is for emergency public information communication, and what the nature of that use is. Existing studies in this area have been limited to examining emergency workers who are heavily engaged in these communications (Denef, Bayler, & Kaptein, 2013; Latanero & Shklovski, 2011) —mostly because it is easier to find and study traces of their activity—rather than examining the absence of online communications.

This research attempts to provide a more comprehensive description of how and why much emergency services use online media to communicate with the public during mass emergencies by examining fire and police departments' use during Hurricane Sandy. In a disaster event like Hurricane Sandy—one that affected millions of people and required a massive coordinated response and recovery effort—information needs are great. We examine the activities of fire and police agencies during this event because both play significant roles in the distribution of emergency preparedness, response, and recovery information to the public during and after large-scale disasters (Wenger, Quarantelli, & Dynes, 1989).

#### ***4.2.1 Background Literature***

A small but growing area of crisis informatics research (Hagar & Haythornthwaite, 2005; Palen, Vieweg, Liu & Hughes, 2009) examines online media use by emergency responders, and reports on their typically slow adoption of such tools (Hughes & Palen, 2014). Emergency 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 (Crowe, 2010; Hughes & Palen, 2012). Additionally, organizational support for online communication with the public is often lacking, with limited resources, insufficient management support, poor tools, and no training (Hughes & Palen, 2012; Latanero & Shklovski, 2011). Further, the volume of public information surrounding an event can be challenging to monitor and online sources can be difficult to identify and verify, especially in large-scale events (Hughes & Palen, 2012).

Prior work has expounded upon some of the features of online communication by emergency personnel. Early adopters of social media in some organizations are seen as evangelists: A public information officer (the public relations representative of an emergency response organization) from the Los Angeles Fire Department (Latanero & Shklovski, 2011) has influenced how his and other fire departments might use online tools like social media to retrieve intelligence and communicate with constituents. Other research examines how a wildfire response team incorporated vetted virtual volunteers to help offload the work required to deal with a fairly high volume of social media activity by the public (St. Denis, Hughes, & Palen, 2012). Another study (Sutton, Spiro, Butts, Fitzhugh, Johnson, & Greczek, 2013) examined how state and federal organizations used Twitter around the 2010 Deepwater Horizon oil spill and discovered that social structures created through Twitter affected the way information spread. More recently, Denef, Bayerl and Kaptin (2013) examined Twitter use of two police departments during the 2011 London Riots, and described the different styles of public engagement that each assumed—one more formal and detached (instrumental) and the other more informal and personal (expressive) (Denef, Bayerl, & Kaptein, 2013). Though these studies reveal particular uses as well as uncertainty about how to



incorporate social media into emergency practice, they do not provide a representative picture of how online communications like social media are used in a general emergency response context.

In this paper, we seek to fill this knowledge gap by studying fire and police public communications before, during, and directly following Hurricane Sandy. Specifically, we examine the communications across four types of online media by departments in the path of the storm.

### **4.3 Study Site and Data Collection**

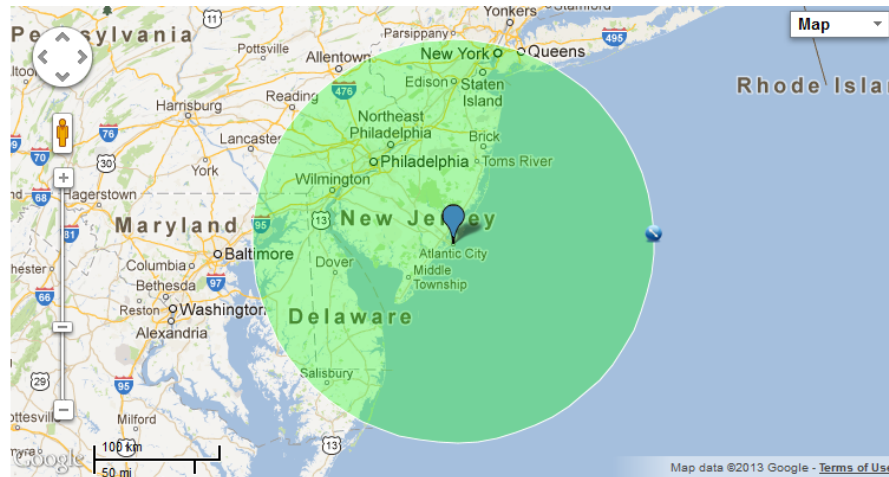
#### ***4.3.1 Hurricane Sandy***

On October 29, 2012 Hurricane Sandy made landfall at Brigantine, New Jersey, in one of the most densely populated regions of the United States (US). Hurricane Sandy was the deadliest hurricane (with 72 direct deaths) to strike the east coast in over forty years, and the second-costliest hurricane (estimated at \$65 Billion US dollars) (National Climatic Data Center, 2013) in US history (Blake, Kimberlain, Berg, Cangialosi, & Beven II, 2013). The storm displaced approximately 776,000 people (Yonetani & Morris, 2013) and damaged or destroyed over 650,000 homes (Blake, Kimberlain, Berg, Cangialosi, & Beven II, 2013). During the storm, nearly 8.5 million people lost power with outages lasting weeks in the more heavily impacted areas (Blake, Kimberlain, Berg, Cangialosi, & Beven II, 2013).

Several factors complicated the response to Hurricane Sandy. First, the impact of the hurricane was intensified by an existing winter storm system: a phenomenon known as the Fujiwhara effect (Fujiwhara, 1923) that caused the two storms to merge into one “superstorm.” Second, despite dire predictions from forecasters of extreme weather and a potentially lethal storm surge, a survey conducted after the event indicates that approximately 63% of residents in coastal areas chose not to evacuate (Gibbs & Holloway, 2013). Finally, a large winter storm—termed a Nor’easter—moved into the affected area a week later, causing additional difficulty for Sandy recovery efforts, especially for those still without shelter and/or power.

#### 4.3.2 Data Collection & Analysis Methods

The data collection began with specification of a geographical boundary that included those hardest hit by the storm, with a scope that allowed for analytical breadth: we included coastal counties within a 100 mile radius of where Sandy made landfall as the target (see Figure 1). This made for a total of 26 counties located across 5 US states.



**Figure 1: 100-mile radius centered on Brigantine, NJ, where Sandy made US Landfall on October 22, 2012.**

##### 4.3.2.1 Fire and Police Department Identification

Next, we identified all fire and police departments within the 26 counties. We extracted a list of fire departments from the National Fire Department Census Database. Unfortunately, the US Fire Administration reports that only 88% of departments participated. However, we discovered that counties sequentially assign numbers to fire departments. This rule of thumb helped identify gaps in the census data, and revealed an additional 75 departments—bringing the total sample to 568 fire departments.

The police departments exist at three levels: state, county, and municipality. Each of the 5 states has a state police department, and each of the 26 counties has a sheriff's office. Additionally, every municipality (e.g. township, city, and village) can potentially have a police department. We found online lists of all the municipalities in the 26 counties, and performed a web search for their respective departments, identifying a total of 272 police departments.

#### 4.3.2.2 Data Retrieval from the Four Online Communication Media

For each fire and police department, we looked at four online communication media: a website, a subscriber-based notification service (Nixle), a microblogging service (Twitter), and a social networking service (Facebook). Though we found occasional references to other online communication tools such as Google+ and CodeRed, these were rarely used and not included in the study.

We searched for a website for each of the departments; if found, we captured the URL and then examined its content for references to social media accounts. In addition, we then looked for Nixle, Twitter, and Facebook accounts using their search interfaces. In Nixle, searching by municipality returns all accounts in that area. In Twitter and Facebook we searched using the departments' names and variations. If through due diligence we did not find an account, we assumed it either did not exist or could not be found easily by members of the public either, thus defeating any purpose of its use as a communication medium.

To narrow the scope to those online communications most likely to be about Hurricane Sandy, we restricted the data collection window to October 25-November 9, 2012. On October 25, the first online Sandy communication appeared in our datasets. By November 9, most of the immediate hurricane recovery efforts had completed and the number of online communications that were not about Hurricane Sandy began to outnumber those that were.

##### *Website.*

Because each fire and police department website is unique and the information is presented in different ways, we were unable to collect data in a format that would allow for comparison to the other types of online communication. However, we visited and made notes for 676 websites; these sites often linked to the other media, described next.

##### *Nixle.*

This online service offers both free and paid notification services to fire and police departments as well as other emergency management and municipal government agencies. Users can search for agencies by location and subscribe for notifications. We found 128 Nixle accounts and extracted the post

information for each of these accounts using web-scraping methods. In a few cases, some of the older data for these accounts had been deleted. The *Fire & Police Nixle Collection* contains 930 posts.

#### *Twitter.*

We found 114 Twitter accounts and retrieved the full message streams for each of these accounts using the Twitter REST API. The *Fire & Police Sandy Tweet Collection* contains 3033 tweets.

#### *Facebook.*

We identified 556 public Facebook accounts and retrieved the full set of posts for each of these accounts using the Facebook Graph API. The *Fire & Police Sandy Facebook Collection* contains 4652 posts.

#### 4.3.2.3 Content Coding

We coded the data for on/off-topicness and content. The final coding scheme contains 19 categories (see Table 4) and was developed through an iterative pair-coding process. The first coding pass was done with two researchers working together to establish a consistent coding scheme on the Twitter data. After this first pass, we consolidated and refined the categories and then took a second pass on the data to correct and verify the coding scheme. Next, we divided the Facebook and Nixle coding tasks between the same two researchers. To check the validity of this independent coding process, both researchers coded a subset of 200 messages. For this subset, Cohen's kappa across the 19 coding categories averaged 0.87 (SD = 0.24).

Category	Description
cleanup	Clearing of hurricane debris
closures	Closure/re-opening of public offices, transportation services, access routes, and scheduled events
damage	Storm damage information
donations	Donations of time (volunteering), money, or supplies to relief efforts
engagement	Invitations to engage with department on social media or direct responses to public posts/tweets
evacuation	Evacuation order and shelter information
preparation	Storm preparation information
protocol	Formal response protocol information (e.g. when to call 9-1-1 versus 3-1-1)
reassurance	Reassurance to the public that first responders are prepared for or actively monitoring the storm
reference	Reference to an external information source
relief	Storm assistance or relief information
response	Specific incidents or response efforts during the hurricane
resources	Information about supplies needed or available
rumor	Misinformation and rumor
safety	Safety precautions or conditions
services	Power , phone, internet, or cable services information
status	Changing storm condition information
support	Expression of gratitude or support
weather	Weather updates

**Table 4: Nixle, Twitter, Facebook Content Coding Scheme.**

#### 4.3.2.4 Level of Engagement

Lastly, we developed a coding scheme to compare engagement levels for each department across Nixle, Twitter, and Facebook (Table 4). We did not code websites for engagement because data collection occurred months after Hurricane Sandy, at which point it was difficult to know what information the website had contained during our data collection window.

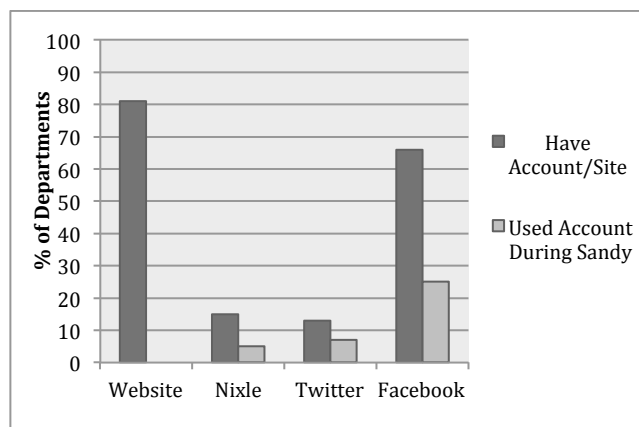
Level	Description
Inactive	No account found OR account found but not used
Non-Sandy Active	Account used to share information, but not used to share information about Hurricane Sandy
Sandy Active	Account used to communicate information about Hurricane Sandy

**Table 5: Engagement Level Coding Scheme.**

## 4.4 Quantitative Descriptions of Use

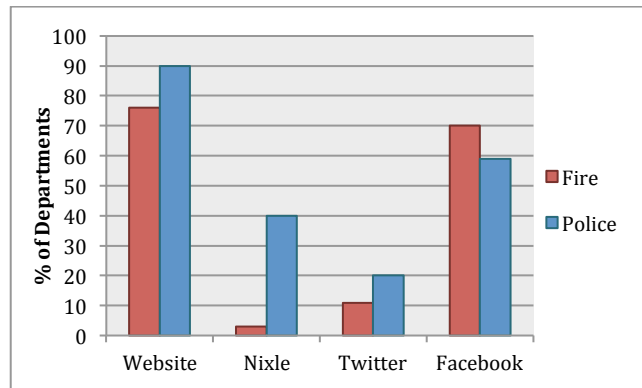
### 4.4.1 Overall Online Communication Use

Results indicate (Figure 2) that the majority of departments have a website (81%) and/or a Facebook account (66%). Twitter use, however, was much less common (13%) and Nixle differs greatly by type of department (police: 40%, fire: 3%, combined: 15%). In general, the percentage of departments that have a website or social media account was higher for police than fire (Figure 3), with the exception of Facebook: 70% of fire departments and 60% of police departments have Facebook accounts.



**Figure 2: % Departments with Accounts/Website versus the % That Used Their Account during Sandy.**

Even though a fire or police department may have a website and/or a social media account, they did not necessarily use it to communicate during Hurricane Sandy. Figure 3 shows the smaller percentage of departments that used each communication medium to engage in storm-specific communication with the public: Facebook (25%) is the most popular, followed by Twitter (7%), and finally, Nixle (5%). We do not report website use because we could not collect reliable data around its use during Hurricane Sandy.



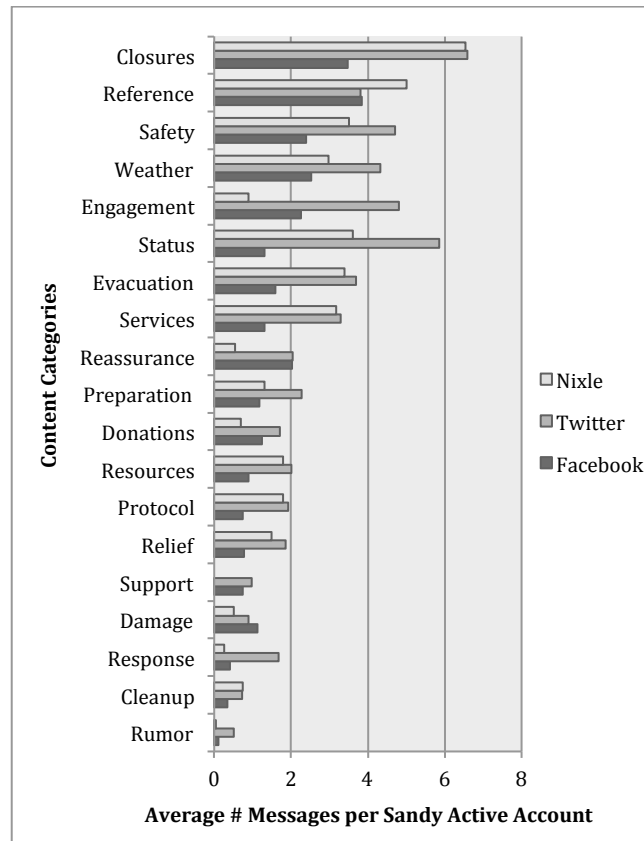
**Figure 3: % of Fire and Police Departments Using Each Communication Medium.**

Figure 4 shows how frequently each content category occurs in the Facebook, Twitter, and Nixle message collections. The number of messages is averaged across the number of active accounts for each communication type. Twitter averages are higher overall for each of the categories except *reference*. The opposite is true for Facebook where the averages are mostly lower. The most frequently occurring categories are information about *closures*, *reference* to other official sources of information, *safety* instructions, and *weather* updates.

The *reference* category, which describes those cases when third party sources are discussed, is important because it shows that emergency managers operating social media accounts often play an information vetting role, sifting through available information and sharing what they think is relevant with their constituents. Usually these references point to sources from other agencies, especially those with a broad jurisdiction or scope of interest such as a state governor’s office, the Federal Emergency Management Agency (FEMA), or the US National Weather Service.

Interestingly, we found few instances of *rumor*, where departments corrected misinformation through their online communications. A frequent concern that emergency response organizations have with the public’s online communication is with the credibility and accuracy. These findings suggest that the presence of online rumor is not as much of an issue as some may fear.

Each of the four online communication media have characteristics that make them suited to different styles of communication and different ways of sharing information during an emergency. We now turn our attention to how fire and police departments used each.



**Figure 4: Average Number of Message per Sandy Active Account for Each Content Category for Nixle, Twitter, and Facebook.**

#### ***4.4.2 Website-Specific Communication Behavior***

Fire and police departments primarily used their websites as a place to provide information about themselves and information relevant to their community, but with little to no means for two-way engagement with their constituents. The information most commonly found on fire and police department websites includes employee rosters, phone numbers, links to other local agency websites, surveys of equipment and resources, and a narrative about the department's history. Sandy-relevant information on these websites includes warnings to prepare for the storm, fundraising activities, long-term recovery information, and accountings of department response efforts (e.g. number of calls or number of rescues). One feature used for posting information about Sandy was a blog or a blog-type feature with time- and date-stamped updates. Often these updates provided a feedback mechanism where members of the public can comment, but this feature is rarely used.



#### ***4.4.3 Nixle-Specific Communication Behavior***

Even though Nixle is free to both fire and police departments, it was primarily used by police departments: 40% of the police departments in our sample had a Nixle account whereas only 3% of fire departments had an account. This disparity may be due to differences in role for these two organizations during an emergency event. The police communicate with the public about evacuations, closures, and safety conditions, whereas firefighters tend to focus on response to highly-localized circumstances such as administering emergency medical services or responding to a structure fire—activities that may not need to be shared with a wide audience.

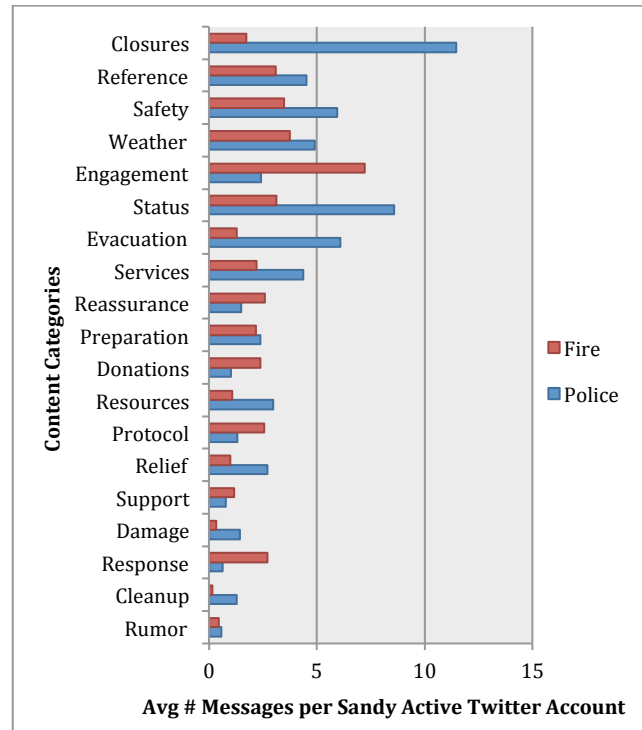
Nixle provides a subscription-based, one-way channel to members of the public who want to receive notifications. Unlike a website, Facebook, or Twitter account, Nixle accounts are authenticated before creation, so members of the public have a reasonable expectation that emergency notifications they receive are from real agencies. Because Nixle can only distribute information (with no means for the public to comment or respond), the notification messages tend to read like formal press releases—carefully crafted using official and more impersonal language.

#### ***4.4.4 Twitter-Specific Communication Behavior***

Twitter is the least frequently occurring account type. Of the 88 Twitter accounts, we found only 58 communicated information about Hurricane Sandy. The percentage of use among police departments is higher than fire departments both for having an active Twitter account (15% for police vs. 8.3% for fire) and for using it during Hurricane Sandy (10% for police vs. 5% for fire).

The majority of tweets broadcast information to the public and 66% of these messages contain links to information sources such as National Weather Service bulletins, official disaster declarations, status updates, evacuation maps, and internally compiled information. Also appearing are retweets (17%) that originate from other official sources, such as high-ranking political officials (e.g., a governor or mayor) or emergency response organizations (e.g., FEMA). Through these (re)tweets, departments performed an information vetting role during Hurricane Sandy.

Figure 5 shows the average number of categorized Twitter messages per Sandy-active account. Here we see that police departments report far more *closures*, *status* messages, and information about *evacuations* than fire. These categories seem to speak more directly to the nature of police work, where they are expected to manage the population and maintain order during and after a disaster. The broadcast nature of Twitter can help distribute information as circumstances around an event change.

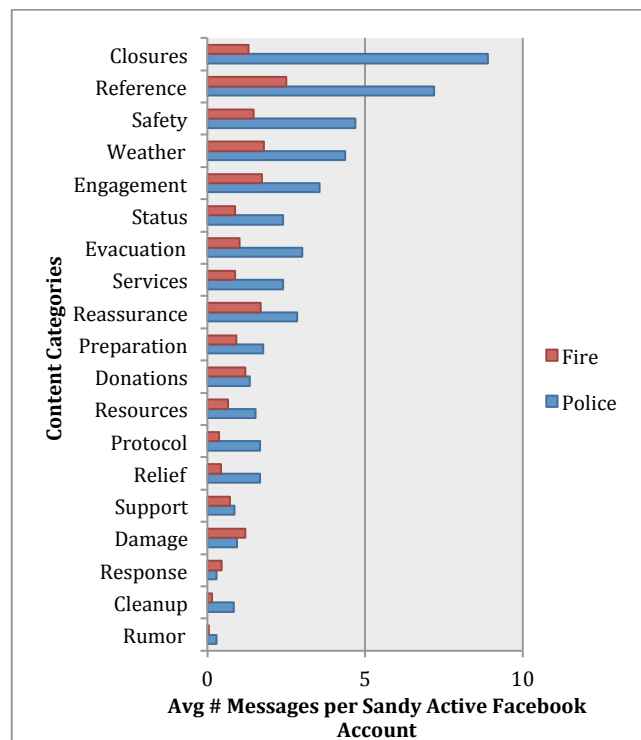


**Figure 5: Fire and Police Department Tweets by Category.**

Surprisingly, only 9% of on-topic tweets in the *Fire & Police Tweet Collection* contain hashtags related to Hurricane Sandy (e.g. #Sandy, #frankenstorm, #HurricaneSandy). We expect to see heavier hashtag use as it is known to improve the searchability of tweets. This low incidence of common hashtags suggests that fire and police departments may depend more on Twitter's follower relationship to reach their constituents, rather than on providing searchable terms for a general audience.

#### 4.4.5 Facebook-Specific Communication Behavior

Facebook is the most widely used online medium to share information with the public about Sandy. Twenty-five percent of the departments in the sample used Facebook, which is 3.6 times the number of Twitter accounts, and five times the number of Nixle accounts. Facebook differs from the other tools that we studied in that it allows for direct and visible interaction with the public. People can post relevant questions, share information, and provide feedback. The format also allows for direct and readily visible replies, and it collates a lot of information in one place and over time. These qualities seem to make Facebook an effective tool for managing public conversation and maintaining a visible presence with the communities that fire and police departments serve.

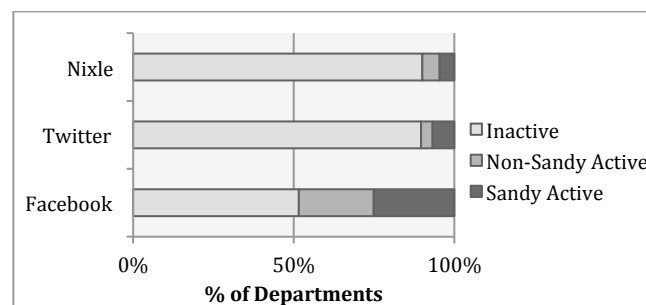


**Figure 6: Average Number of Facebook Message for Each Category for Fire and Police.**

Facebook has a similar category distribution to that of Twitter (Figure 6). The main quantitative difference is in the number of departments that replied directly to the public. With respect to the departments that used Facebook to communicate Sandy-specific information, 39% replied directly to the public whereas only 10% of the departments that used Twitter replied directly to Sandy-specific tweets and all but one of these replied sparingly (3 or less replies).

## 4.5 Online Engagement

To better measure and compare the varied use of online communication during Hurricane Sandy, we assigned each department an engagement level (*Inactive*, *Non-Sandy Active*, *Sandy Active*) for Nixle, Twitter, and Facebook. Figure 7 shows that departments were least engaged with Nixle: 90% were *Inactive*, 6% were *Non-Sandy Active*, and only 4% were *Sandy Active*. Engagement with Twitter was only slightly higher, with 89% *Inactive*, 4% *Non-Sandy Active*, and 7% *Sandy Active*. The highest levels of online engagement were found on Facebook, with 52% *Inactive*, 23% *Non-Sandy Active*, and 25% *Sandy Active*. When we calculate the percentage of *Sandy Active* accounts in all Active accounts (*Non-Sandy Active* and *Sandy Active*), Nixle is again the lowest (40%), but Twitter (63.6%) and Facebook (47.9%) are reversed. These percentages indicate that of the departments with active accounts, those that used Twitter were most likely to use it during Hurricane Sandy.



**Figure 7: Department Engagement by Media Type.**

Next, we divided the departments into three groups based on the highest level of engagement each had. Departments at the lowest level, the *Inactive Group* (387 departments, 46.1%), include those that were *Inactive* across all three communication media. Departments in the *Non-Sandy Active Group* (207 departments, 24.6%) used at least one online medium, but did not use any media to share Sandy-specific information. The *Sandy Active Group* (246 departments, 29.3%) used at least one online medium to share Sandy-specific information. Table 6 captures the number of active accounts per department within the *Non-Sandy Active* and the *Sandy Active* groups.

Engagement Groups	Number N of Online Media			% of Depts
	N=1	N=2	N=3	
Non-Sandy Active	88.4%	11.1%	0.5%	24.6%
Sandy Active	77.6%	19.1%	3.3%	29.3%

**Table 6: Breakdown of Non-Sandy and Sandy Active Groups By the Number of Media with that Level of Engagement.**

#### ***4.5.1 Inactive Group***

The majority of departments in this group (232 departments, 60%) had no Nixle, Twitter, or Facebook account. Past studies report (Hughes & Palen, 2012) that common reasons for emergency responders not to use online media include feeling inexperienced or lacking the time, resources, and/or approval from management. Other emergency responders perceive that online media do not meet the communication needs of their organization and community (Hughes & Palen, 2012). We suspect these reasons explain much of the lack of activity by departments in the *Inactive Group*.

The remainder of departments in the *Inactive Group* (155 departments, 40%) had at least one online account, but the account was clearly in disuse. This lack of account activity may be explained by departments that started to use an online account only to discover that it did not meet their needs, or they found that they did not have the time or other resources to maintain it.

#### ***4.5.2 Non-Sandy Active Group***

These departments showed frequent and recent activity over at least one online communication medium, but curiously this did not translate into use during Hurricane Sandy. One likely reason may be that departments were so busy responding to the disaster event that online communications were not possible given the circumstances. For instance, some of the departments most affected by the storm were incapacitated with severe flooding, power outages, and loss of vehicles, equipment, and even life. Unfortunately, the data collected in this study cannot answer questions about *why* departments did (or did not) use online communications; answers to these questions requires further data collection and study.

#### **4.5.3 Sandy Active Group**

Even though the percentage of department type in the *Sandy Active Group* is about the same (28% fire and 32% police), we saw a clear difference in the average number of messages when comparing police and fire. Police departments post more actively on average across all three platforms. This difference is the most pronounced on Facebook where the average number of Sandy-specific posts is 2.66 times higher for police compared to fire (32 posts versus 12). The average number of relevant tweets is 1.75 times higher when comparing police to fire. The results for Nixle are inconclusive because there are so few fire departments (4) using Nixle to which we could compare police departments.

All the online communications we collected come from those departments in the *Sandy Active Group*, so naturally we can report more on their activity and online communication practice. We now turn our attention to the departments in this group for insight into the adaptability of online tools to meet the needs of emergency response.

#### **4.6 High Engagement is a Situated Practice**

When examining departments in the *Sandy Active Group*, we find a mix of communication strategies and behaviors, but most interesting are those moments when we see fundamental changes in communication that show how situated practice trumps pre-planned policy and greatly affects the shaping of public information. What constitutes appropriate online interaction evolves as both emergency personnel and the public calibrate their expectations. We illustrate this point through two examples: one excerpt taken from the activity of the Long Beach Township Police Department Facebook account, and another from the @FDNY (Fire Department of New York) Twitter account.

Long Beach Island (LBI), New Jersey, is a barrier island that suffered extensive damage during Hurricane Sandy. Residents were evacuated prior to the storm surge, and the island remained closed to residents for 13 days except for a few brief periods when they were allowed to retrieve personal belongings. These circumstances produced a situation where the LBTPD was left to protect the property interests, safety, and information needs of a displaced and often frustrated population.

The LBTPD's Facebook page served as a public forum for displaced residents to comment on the response efforts. Posts from residents fell across several themes: questions and comments about re-entry details, requests for information about damage to particular neighborhoods and properties, concerns about protection of property, and expressions of gratitude. For example:

(November 2 13:04): Any information from on the first street Loveladies Bay side ?

(November 4 14:42): When will access to north beach be allowed?

(November 2 14:42): thank you so much for keeping us informed. Can we bring any food, water, etc to donate to those who are working on the island?

By posting to a public and persistent forum like Facebook, residents hold the LBTPD publically accountable—and the LBTPD allows itself to be held accountable in turn.

LBTPD answered questions in succinct messages using formal language and without referring directly to the posters, sometimes with multiple answers in one reply. For instance, LBTPD responded to residents' questions with the following post:

LBTPD: There is no time frame for access to north beach. Any donations would be graciously accepted! Contractors can register at [WWW.LBIEOC.org](http://WWW.LBIEOC.org)

They did not publicly respond directly to posts that criticize evacuation procedures or that were not beneficial to the larger population. This is another behavioral feature of mutual accountability on a public stage.

Despite LBTPD's impersonal posting style and carefully crafted responses, it was clear that the LBTPD monitored comments. For example, residents post:

(October 29 12:22): Our home is in Loveladies 117c LBB. Are there any photos from that area or news? Thank you

(October 30 8:27): Does anyone have any information about conditions in North Beach Haven @ 18th Street? Thank you first responders!

In response, LBTPD provided before and after photos for each of the neighborhoods in the township and surrounding areas. Numerous requests would have been time-consuming to respond to individually, but by posting aerial photos, the LBTPD was able to respond to broad area concerns.

As recovery efforts continue, increasingly frustrated residents offered public commentary about restricted access to their homes:

(November 5 15:23pm): No one knows my property better than I do, so why the hell am I going to call some contractor or plumber that I don't even know to enter my house to winterize or enter my house! Plus they don't have keys! To make matters worse my house is in north beach and not allowed to enter today. I want answers! Additional damages are now the townships responsibilities!

Even in response to concerns like these, the LBTPD continued to communicate in highly visible and documentable ways. In these examples, we see how the responsibilities of public communication shift in response to the situation at hand and toward mutual accountability on a public stage.

Another exchange we learn from comes from FDNY's Twitter communications. The @FDNY account generated far more tweets than other accounts and responded to members of the public more as well (179 replies to 239 accounts). The disproportionately high level of public engagement found in the @FDNY Twitter account seems to be due to several factors. The @FDNY has a potential audience of 8,175,133 people (US Census Bureau, 2012), which is much larger than any other fire department we examined. This account is also staffed with full-time social media personnel and has a history of replying to public inquiries. In addition, at the height of the storm surge when there were widespread power and phone outages as well as a large neighborhood fire (the Breezy Point fire) the 911-dispatch system became overloaded. Members of the public began tweeting requests for emergency assistance when they were unable to reach 911 dispatch (Khorram, 2012). We detail these exchanges below.

On October 28, a day prior to Hurricane Sandy landfall, @FDNY sent several (re)tweets notifying the public of evacuation orders and procedures for emergency assistance:

@FDNY<sup>1</sup> (Oct 28 11:56): RT @NotifyNYC: NYC orders MANDATORY EVACUATION Zone A, Rockaways, Hamilton Bch, City Is. due to dangerous storm <http://t.co/D10EV04p> or 311

@FDNY (Oct 28 16:11): RT @NYCMayorsOffice: Mayor: If you can't evacuate yourself and need assistance, please call 311. #Sandy

The next day, on October 29 as the storm surge reaches its peak, we see the first direct response to twitterers who provided emergency information and made requests:

@Lochald (Oct 29 20:03): IDK address. And he's not replying right now (probably saving his cell battery). He had said others were aware & getting help. @edaro @FDNY

A reply from @FDNY redirected him to make a 911 call:

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<sup>1</sup> Individual usernames are anonymized while public entities' names remain unchanged.



@FDNY (Oct 29 20:06pm): @Lochald @edaro Please don't tweet with emergency info. We want to help everyone as soon as we can. Please ask him to call 911.

A tweet about the protocol for how to request help and report other information followed soon

after:

@FDNY (Oct 29 21:32): PLEASE NOTE: \*Do not\* tweet emergency calls. Please call 911. If it is not an emergency, please call 311. #NYC #Sandy

Shortly after this message, however, @FDNY sent numerous replies indicating that they were attempting to contact dispatchers on twitterers' behalf. In the exchange that follows, we begin to see @FDNY change its stance about what constitutes appropriate Twitter protocol under these emergency circumstances:

@Dynb (Oct 29 22:12): @FDNY my sis family at 78th St155-22 Howard Beach Queens NY 11414, water risinig 12 ft need help 7186745977,1st floor drowned, kids scared

@FDNY responded:

@FDNY (Oct 29 22:16): @Dynb Please keep trying to call 911. I will try to reach dispatchers now.

A status update from @FDNY:

@FDNY (Oct 29 22:32): @Dynb Please note dispatchers are aware and are trying to send help.

From @Dynb a few hours later the following is posted:

@Dynb (Oct 30 0:08): @FDNY Thank you , water rescding but help required many many kids in neighborhood very scared & stranded 155-22 78th st, Queens 11414

A reply from @FDNY provided reassurance:

@FDNY (Oct 30 0:11): @RSDynb I understand. Dispatch was notified. I know it's difficult, but please be patient. Units working to respond to all calls safely.

In reaction to these types of exchanges, a flurry of tweets from the public appeared with expressions of concern that @FDNY was bypassing official protocol. @FDNY replied:

@FDNY (Oct 30 0:23): @Bleymor @Lisar @twitter @rass Don't want NYC to rely on this as an alt to 911. But notifying dispatchers of all emergencies tweeted

These conversations continued throughout the storm and the Breezy Point fire. Replies went back and forth as @FDNY gathered information and relayed it to dispatchers. Numerous @FDNY tweets provided reassurance that information had been received and that help was on the way. At the same time,

@FDNY keeps reinforcing the use of official channels, making it clear that Twitter as dispatch was not a permanent solution but one that had become necessary given the extenuating circumstances. This observed activity had a deeply engaging quality because of implicit admission that mass emergency response is a largely improvised (Kendra & Wachtendorf, 2003; Mendonca, Beroggi, & Wallace, 2001), or situated (Suchman, 1987), activity.

It is unclear how this bypass of official protocol affected dispatch work or how those who “kept to the rules” and reported their emergencies through 911 were affected. However, we believe that this *public* adaptation of online communication technology is novel, and shows how protocols in disaster response are often overruled (Kendra & Wachtendorf, 2003; Mendonca, Beroggi, & Wallace, 2001). Rarely are such overrides so visible to the public, which is a new contribution of the online world. It is highly doubtful that this behavior will be isolated to this one emergency and to these accounts. That such popular accounts for a populous region made these moves sets a precedent and indicates what is likely to come in future events.

## **4.7 Conclusion**

In this paper, we provide quantified evidence of both the presence and absence of online communications by fire and police departments during Hurricane Sandy. Results show that relatively few of these departments used online media in their public communications during this event, and that there was a high degree of variance across the different media under study. Among those departments that used online media during Hurricane Sandy, discursive moves signal creative adaptations and set meaningful precedents for the future of emergency management.

### **4.7.1 Procedures & Policy**

Emergency responders strive to implement common organizational structures and procedures to streamline coordination in multiagency response. However, no current standardized procedures exist for online media use and we argue that this is just as well. Given this research, we believe that implementing universal, and therefore likely restrictive, online media policies is premature and possibly even dangerous

at this point of time in the socio-technical evolution of disaster response. Not only do online media support different kinds of interaction and purpose, emergency managers need to be free to improvise their practice in relation to the situations they and their constituents face. High-level policy decisions may prematurely mandate and restrict which media emergency groups use and how they use it.

Though some regularity is helpful—particularly in the case of warning messaging—the fluctuating needs of the public and the capacities that responders have as disasters then ensue must be matched by the communications media that support informational exchange—whether or not that includes online media. Future policies must provide flexibility that allows emergency organizations to employ strategies that best fit the needs of their organization, community, and response effort.

#### ***4.7.2 Transparency & Public Accountability***

In the data, we see regular reminders of emergency response’s accountability to the public. Throughout the hurricane event, *reassurance* messages assert that response efforts are under control, and that professionals are in place to do the jobs for which they are trained. Evidence of this accountability is found in the information that departments provide about the status of the storm, recovery, and relief efforts. Cases of rumor correction appear, although not frequently, indicating that the amount of rumor that people mistakenly take seriously is not high; nevertheless, attention to rumor demonstrates a commitment to both social media as a meaningful communication venue that the public attends to, and to ensuring that its contents are accurate. Making good use of this transparency through public communication and the accountability that follows can be challenging, but has the potential to foster trust and lead to better decision-making by affected constituents.

In the past, reports of emergency response activities were not as freely available (e.g. they were filtered through the media, or reported in press releases every 12 hours). Communications enabled by online media can provide a greater sense of transparency, one where emergency service workers can directly communicate with the public and one where the communications of these workers are visible to the public in ways not previously possible. Both the LBTPD and FDNY adjusted their information

strategies in response to members of the public. Yet, in the case of LBTPD, this transparency also exposed the department to increased public scrutiny and criticism.

#### ***4.7.3 Design Recommendations & Future Work***

Based on this research, we offer several design recommendations. First, to make online media streams more “listenable” for on-the-ground emergency managers, new features and/or tools are needed that allow emergency managers to better track, respond to, and document public information. For example, no automated means exist for tracking the status of online queries from the public (e.g. whether a reply was given, what the the reply was, how and when the reply was sent, who sent it, and to whom the reply was sent). Without tracking this kind of information, questions from the public can easily slip through the cracks, especially during a large-scale crisis event. Second, there is also a need to make online media streams more “listenable” for members of the public. In Twitter and Facebook, the data showed that replies by emergency managers to questions from the public were often buried within response threads to individual messages. Unless one knows what to search for or wades through many potentially irrelevant conversations, he or she may never find the information they seek, even though it is publically available. If emergency managers and members of the public could better “listen” to online media streams, value of the online media and therefore their use would likely increase during times of crisis.

To complement these technology design efforts, emergency management practice will need to create better capacities for departments to use online media. This involves finding a balance between a department’s desire to communicate online (by virtue of establishing accounts and audience following during non-disaster times) and their (in)ability to act on those relationships when personnel resources become taxed during disaster.

Low overall use of online media by fire and police departments during Hurricane Sandy suggests that emergency management use of these media is not well understood. Indeed, little research exists around the features and affordances of online media and how each can fit into an emergency management

communication strategy. The research presented here lays a foundation for future applied and basic research in this area by reporting actual online media use during a large-scale crisis event.

#### **4.8 Reflections on the Action Research**

This study fills a gap in the research literature and provides a broad perspective of online tool and social media use, but because it is based solely on the online communications, it leaves important questions unanswered. There is no way of knowing why 25% of the population stopped using social media during the storm. Identifying the key factors that prevented use could be used to identify possible solutions for the future. On the other end of the spectrum, our analysis of high engagement was based on interpretations of both the public and emergency response communications. Knowing what happened behind the scenes and the reflections of these organizations after the fact would have added depth to our analysis. Without that, it still provides valuable information about more general social media use in a wide-scale event.

#### **Section Epilogue**

The previous study looked across a population of emergency responders and their online communications during a large-scale event. Although there was low overall use of online tools to share storm-related information during Hurricane Sandy (29%), indicating there are still significant challenges to be addressed. However, among those that did we observe discursive moves that signal creative adaptations and set meaningful precedents for the future. I will turn now to studies that look at sociotechnical innovations that have emerged from within the emergency response community to try to address some of these important challenges.

## **SECTION THREE. The Invention of a New Organizational Structure**

### **Section Introduction**

This section contains two studies looking at a new organizational structure developed from within the emergency response community. This community represents a grassroots movement led by a small group of emergency responders interested in finding a way to align the formal protocols of emergency response with informal social media channels and readily available information and communication technologies (ICTs). This group was motivated not only by the growing popularity and use of social media by members of the public in disaster (section 2.2) but a belief that these same tools could be used to extend the resources of an emergency response organization through the use of trained and “trusted digital agents”. Chapter 5 looks at the first emergency trial of this idea on the 2011 Shadow Lake fire and how a this team of trusted agents came together, organized and enacted the first VOST in support of the response team. Following the Shadow Lake Fire, the virtual operational support community has grown into a global community of teams continuing to adapt and evolve the core concepts from this first trial to fit a variety of sociocultural and organizational contexts. Chapter 6 explores both the evolution of practices that supports continued growth and sharing of ideas and adaptations of practice that have allowed individual teams to align themselves closely with formal response organizations.

## **CHAPTER 5. Trial by Fire: The Deployment of Trusted Digital Volunteers in the 2011 Shadow Lake Fire**

### **5.1 Study Summary**

We report on the use of a team of trusted digital volunteers during the 2011 Shadow Lake Fire that occurred in the US Pacific Northwest to extend the social media capacity of a Type I incident management team. In this case study, we outline the tools and processes used by this virtual team to coordinate their activities, monitor social media communication and to establish communications with the public around the event. Finally, we discuss the potential merits and limitations of implementing a team of trusted volunteers and explore how this idea could be incorporated into emergency management organizations.

The text contained within Sections 5.1 through 5.6 is a reprint of St. Denis, L. A., Hughes, A. and Palen, L. (2012). Trial By Fire: The Deployment of Trusted Digital Volunteers in the 2011 Shadow Lake Fire. In *Proceedings of the Conference on Information Systems for Crisis Response and Management (ISCRAM 2012)*, Vancouver, BC. This reprint appears here with the permission of my co-authors, Amanda Hughes and Leysia Palen.

**This study addresses research question RQ2.**

### **5.2 Introduction**

Information and communication technology (ICT) provides a means for emergency response organizations to communicate quickly and widely within their units as well as with external stakeholders. However, ICT advances have been rapid and have far outpaced emergency management's capacity to adapt. In particular, forms of ICT known as social media have introduced new ways for members of the public affected by a disaster event to communicate with friends and family, seek information and help, and provide assistance to others (Palen & Liu, 2007; Shklovski, Palen, & Sutton, 2008; Palen, Vieweg, Liu, & Hughes, 2009; Qu, Wu, & Wang, 2009; Heverin & Zach, 2010; Starbird & Palen, 2011; Perng, Büscher, Halvorsrud, Wood, Stiso, Ramirez, & Al-Akkad, 2012).

As social media use in the public arena increases, pressure placed on emergency managers to use these communication channels for information distribution is also rising. Additionally, emergency managers are experiencing new pressure to monitor and evaluate the public's online activities and incorporate the useful and relevant information back into emergency response efforts (Palen & Liu, 2007; Palen, Vieweg, Liu & Hughes, 2009). A recent survey reports that US citizens have higher expectations around official emergency information being available over social media streams, and they expect emergency managers to monitor and respond to requests for help over these streams as well (American Red Cross, 2011). However, studies have shown that, to date, few emergency response organizations are equipped to do this kind of social media monitoring and communication at scale (Latonero & Shklovski, 2011; Hughes & Palen, 2012).

Accompanying the demand from the public to use social media, emergency managers are recognizing social media's potential benefits. Information can be distributed quickly and to large audiences using social media. Further, emergency managers can bypass traditional media by sending information directly to the public. How social media will evolve emergency management (EM) communications is still in question, but practitioners are realizing that such arrangements carry the potential to allow conversational interactions with the public, in contrast to the traditional one-way communication procedural model (Sorensen & Sorensen, 2007; Latonero & Shklovski, 2011; Hughes & Palen, 2012).

In response to these new expectations and possibilities, some emergency managers are beginning to incorporate social media into their communication plans. However, the road is not easy. Emergency managers sometimes lack the support of their organization to use social media. This might come in the form of policies that restrict social media use outright; or in the form of fear about assuming new risk; or in the form of indifference that limits the availability of resources and cooperative relationships that could support an effective social media communication plan. Further, the structures and procedures supporting EM organizations have been described as bureaucratic and rigid (Britton, 1989; Neal & Phillips, 1995; Buck, Trainor, & Aguirre, 2006). These qualities can make it difficult for emergency organizations to



fully incorporate social media communication with its loosely organized and emergent nature (Palen & Liu, 2007; Crowe, 2010).

In addition, social media presents challenges in its adoption, specifically with respect to the learning curve required to use social media tools and operate in an evolving information space. The many different types of social media are constantly changing, with new services appearing regularly. With all this heterogeneity, emergency managers find it hard to know what social media services they should incorporate into their practice. The temporal resources of emergency managers are already heavily taxed, and social media, though they carry the aura of a convenience technology, nevertheless require an investment of time to employ effectively (Latonero & Shklovski, 2011; Hughes & Palen, 2012). Although social media supports the sharing of information, tools are not yet available for reliably capturing social media postings or tracking the new professional work activities that arise from the presence of social media.

### ***5.2.1 Supporting Work with Virtual Teams***

Increasingly, emergency managers in all capacities are aware of these concerns, and are seeking solutions to accommodate a changing landscape while simultaneously attending to the already demanding work of emergency response. In such a domain, it is crucial to look to practitioners themselves to see what mechanisms of adaption they innovate. One such recent innovation is a method for expanding an organization's resources through the use of a "virtual," remotely located team. Social media exchanges by definition cross geographies. With respect to emergency response work, Starbird and Palen (2011; 2012) have shown how distributed participants and the crowd that encircles them perform "work" over social media that is intended to aid response. However, the innovation of using social media to enable a designated virtual team which itself supports social media communications with the public—and, critically, to have that all incorporated into the *practice* of EM—is new, and one that needs examination.

A recent research review (Hiltz, Fjermestad, Ocker, & Turoff, 2006) on virtual teams provides insight into these matters and concludes that size, project duration, and leadership contribute strongly to

team success. Results from a survey of globally distributed teams (Bradner, Mark, & Hertel, 2003) indicate that members of smaller teams (of 4-9 members): 1) participate more actively; 2) are more committed to team members; 3) are more aware of team goals; 4) are better acquainted with other team members' characteristics, and 5) report higher levels of rapport than larger teams (of 14-18 members). Additionally, virtual team relationships strengthened over time with more positive relationships correlating to longer project durations (Walther, Boos, & Jonas, 2002). Leaders of what were deemed successful virtual teams were able to communicate information effectively, communicate roles and responsibilities among team members, and assert their authority in a way that members perceived as positive (Kayworth & Leidner, 2002).

In this paper, we examine a recent instance of a virtual team of trusted volunteers designed to manage and monitor social media communications in support of emergency incident response. The Virtual Operations Support Team (VOST) experiment—designed by emergency managers themselves—speaks to the need for EM participation in the social media “channel” during a crisis, while also having that activity support but not interfere with on-the-ground operations. The VOST concept in these early trials bridges notions of volunteer and professional by including people who are experienced in EM elsewhere but who are operating as volunteers in the current response.

### ***5.2.2 Virtual Operations Support Team (VOST): Origins and Innovation***

Early in 2011, emergency manager Jeff Phillips developed the VOST concept. As Phillips describes it, the VOST concept integrates ‘trusted agents’ into EM operations by creating a virtual team whose focus is to establish and monitor social media communication, manage communication channels with the public, and handle matters that can be executed remotely through digital means such as the management of donations or volunteers. In times of need, the support of a VOST can be enlisted to extend communication capacities and provide operational support. They feel that, ideally, an emergency manager who hopes to use a VOST would establish their team well in advance, so they are ready to be deployed when needed.

When Kris Eriksen, the Public Information Officer (PIO) for the National Incident Management Organization (NIMO) Portland Team, was called to the Shadow Lake Fire on August 31, 2011, she was aware of Phillips' idea and wanted to implement a VOST to help overcome some communication challenges she was facing. Through Twitter she put out a call for volunteers, to which Phillips was one of the initial respondents. Phillips then worked remotely to quickly assemble a team for Eriksen.

## **5.3 The Study**

### ***5.3.1 Shadow Lake Fire***

Ignited by lightning, the Shadow Lake Fire began on August 28, 2011 in the Mt. Washington Wilderness—15 miles northwest of Sisters, Oregon (USA) and seven miles west of Black Butte Ranch. The Portland NIMO Team, a Type I team, took over management of the fire on August 31. Type I incident management teams are the most highly trained federally certified teams. Comprised of members through interagency agreements, these teams are called to manage the most complex and threatening wildland fires. On August 31, the fire, though serious, was still relatively small at an approximate 364 acres. The team used an indirect suppression strategy common in remote wildfires; they monitored the fire closely and confined it to the Mt. Washington Wilderness. This reduced the area's burn risk in future wildfires and offered the safest option for firefighters rather than placing them in a remote area with no roads, heavy downed wood, and no readily available safety zones. Despite precautions however, the conditions were such that the fire grew to over 10,000 acres in size, and resulted in the evacuation of the Big Lake Recreation Area on September 3. Firefighters gained the upper hand on September 14, and the fire was reduced to smolder and smoke by September 18.

### ***5.3.2 Method***

Seven of the eight VOST members agreed to be interviewed: federal PIO Eriksen, four emergency managers (one of whom was Phillips), the president of the regional Voluntary Organizations Active in Disaster (VOAD) and one citizen volunteer. Eriksen was the only member with official

responsibility for the fire while the others were affiliated with the fire only as VOST members. Interviews were conducted over the phone or Skype. Those participants identified in this paper gave written permission to do so while the others remain anonymous.

We organized interview questions into four sections, each tailored to the role participants played in the VOST. Section I covered background information that led to the formation of the Shadow Lake Fire VOST and explored interview participants' motivations for joining the team. Section II focused on the technical implementation of the Shadow Lake Fire VOST, in which participants were asked what tools they used to manage communications both within the VOST and with members of the public. Section III asked participants to outline the VOST in-practice organization. Section IV asked participants to reflect on their experiences and how the VOST concept might operate in future events.

In addition to the interviews, we collected copies of supporting documents and obtained access to online resources used by the VOST (Table 7).

Resource	Description
InciWeb Incident Information System	The online incident information system used for official communication between the incident management team and the public
ORfireinfo Blog	Blog maintained by the VOST team containing latest information, photos, maps and videos during fire (orfireinfo.net)
ORFireInfo Facebook Page	Postings for the Shadow Lake Fire
ORfireInfo Twitter Account	ORfireInfo Twitter activity during the Shadow Lake Fire
ORFire Business Card	Used by PIOs with printed information and QR code with links to online sources
VOST Team Document	The Google document containing team information, operational objectives and daily activity log
VOST Group 'Skype Chat' Archive	An archive of the Skype Chat communication between members of the VOST team during the Shadow Lake Fire
Facebook Analytics File	Facebook Analytics File for ORFireInfo
Keepstream Archive	File archive of media monitoring activities and communication

**Table 7: Documents and online materials about the Shadow Lake Fire collected for analysis.**

Each of the public-facing media forms used in the Shadow Lake Fire were examined to understand content and how and to what degree they linked to one another, to official printed materials and to mainstream media sources. A diagram was created to visualize relationships between these public

interfaces. An initial scan of each interface identified representative entries from each and characterize how they were used by the VOST.

The content of the Keepstream file, which is where the media monitoring activities were archived, was analyzed in detail, with each entry coded by source type (e.g. citizen, mainstream media, community organization), the type of social media used, and the media form of the content (e.g. link to mainstream media, video, text). Intra-team Skype chat was analyzed in depth to understand how members coordinated activities and organized themselves. The Skype chat was the primary form of communication during the fire. All this was compared to the Twitter and Facebook @ORFireInfo accounts to develop a posthoc overview of the coordinated work. Once completed, this stage of research generated a second round of questions to the VOST members that were answered through email.

## **5.4 Findings: Shadow Lake VOST**

### ***5.4.1 Motivations for VOST Implementation***

PIO Eriksen saw the Shadow Lake Fire as an opportunity to trial the VOST concept during a real event to see if and how it could help overcome obstacles when communicating with local communities. As a federal EM employee, her use of social media was restricted. Policy allowed her to take advantage of existing social media accounts in the surrounding communities or through the Forest Service, but she could not create new accounts to target a larger, affected set of communities. The official online site for federal teams is InciWeb, which PIOs must use to post press releases, images, contacts, and relevant links, yet it has limitations. The system is frequently down; when this happens there is no official backup or alternative place to post the latest information. Additionally, file size is restricted to 2MB, which means that detailed topographic maps, images, or videos cannot be posted. Furthermore, there is no means for comments on InciWeb, making it a unidirectional information source.

An increasingly tech savvy population, restrictive policies and limited official tools created the conditions for trialing a VOST given the limited risk to the public. In addition, community leaders from Sisters, Oregon made it clear that information-sharing with the public was a priority.

### 5.4.2 Startup Logistics

Selected VOST members had a combination of strong technical skills, social media savvy, and EM experience. Volunteers resided in different locations across the US, and consequently they relied on ICT for all interaction. These ICT are described above (Table 1), and also included Rondee Internet conferencing (voice conferencing), a gmail account (press releases) and a Dropbox account (file sharing). The Google document was modelled after ICS Form 204, a federal EM form, and summarized team objectives, contact details, availability, and activity. Skype Chat was the primary means of communication, but they used Internet conferencing when they needed to collaborate synchronously as a group over an audio connection. If something needed immediate attention they communicated by phone or through Twitter direct messaging. The team established a social media presence on Facebook, Twitter, and Wordpress using the identity *@ORFireInfo* (short for “Oregon Fire Information”).

Both the team and tools were in place by August 31, when Eriksen finished her first briefing on the status of the fire. Afterwards, the VOST<sup>2</sup> met as a group for the first time to discuss how they would work as a team and determine team objectives, tasks, and assignments. Throughout the fire, Eriksen provided direction while Phillips coordinated VOST efforts.

Team size was intentionally kept small due to the sensitive nature of the project, but the three week duration of the fire and individual commitments put a strain on scheduling. During the fire, several members of the VOST left their roles to attend to other matters; two had limited availability throughout. As a result, one person joined the effort toward the end of the event. Though other members of the team provided mentoring and brought her up to speed quickly, she expressed how challenging it was to jump into an operation that had been underway for several weeks. VOST members recognized that adding depth to the team roster to cover instances where members become unavailable and detailed procedural documentation would have helped.

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<sup>2</sup> During the fire, Eriksen changed the name of the VOST to Virtual Information Operations Support (VIOS) so it would not be confused with her internal operations team. For consistency and clarity, we choose to refer to the team as a VOST throughout the paper instead of a VIOS. She sees VOIS as an instance of a VOST.

### ***5.4.3 Work Practice***

Though Eriksen and the VOST knew they had to work flexibly, they began with a vision of the work that would include classic PIO activities of media monitoring, management of the public's concerns, communication of the fire fighters' progress, and representation of the public's concerns (Table 8).

Over the course of the three weeks they were active, members of the VOST reported falling into a routine. In the evening, PIO Eriksen would draft a press release based on information from the evening briefing with her NIMO Type 1 team. Before releasing it the next morning, she checked with the VOST for new information. From her office, Eriksen or someone on her PIO team monitored the VOST Skype Chat throughout the day. As new information became available, they updated the ORFireInfo blog and Facebook page, and used Twitter to send public messages and link information. Social media and mainstream media monitoring was documented through Keepstream. Occasionally they would use Internet conferencing for a voice discussion, but typically they found that Skype Chat worked best for communicating as a group and also directly with one another.

To most members of the VOST, management of the project appeared to run smoothly, but Eriksen reported that it was difficult to know how to manage a volunteer team that could not be officially recognized. No member of the internal PIO team, besides Eriksen, interacted directly with the VOST. Therefore, the PIO team was informally extended to include VOST efforts but the VOST was not formally integrated into the official response.

<b>VOST Objectives/Tasks/Assignments</b>
<ul style="list-style-type: none"> <li>• <i>Follow social media and traditional media trends and report back what you are seeing</i></li> <li>• <i>Communicate issues and concerns being expressed by the public</i></li> <li>• <i>Identify misinformation or angry postings that need to be corrected or dealt with</i></li> <li>• <i>Provide a supportive voice for the NIMO team and its efforts through social media</i></li> <li>• <i>Push out key message each day (via personal and official Twitter accounts)</i></li> <li>• <i>Post and tweet messages from private accounts with information from @ORFireInfo accounts</i></li> <li>• <i>Represent the citizen's perspective</i></li> <li>• <i>Compile media coverage (traditional and non-traditional) by date</i></li> <li>• <i>Document the social media conversation – especially if something big happens</i></li> <li>• <i>Take this opportunity to learn new tools and try new things</i></li> <li>• <i>Document the experience of participating as a VOST member</i></li> </ul>

**Table 8: Shadow Lake VOST Objectives/Tasks/Assignments.**

#### 5.4.3.1 Social Media Monitoring

The team reported using a range of tools to “watch and listen” while at the same time trying to maintain an archive. Any information they found was added to the Keepstream file and was referenced like a virtual file cabinet by the NIMO team. Eriksen was interested in capturing as complete a record as possible; duplication was not a concern. The VOST was instructed to communicate with her directly if they identified any negative coverage, irritated stakeholder groups, or citizen concerns that required her attention.

The Keepstream archive contained 121 entries between August 29-September 15, with over 60% of the entries captured between September 2-5. The content of the archive focused almost exclusively on mainstream media coverage of the fire with roughly one third of the entries captured as direct links to mainstream media web sites, one third as links to the ORFireInfo accounts and the remaining entries coming from social media accounts for mainstream media organizations, individuals and community organizations.

#### 5.4.3.2 Communicating with the Public

The VOST used Twitter to direct people to new information as it became available using embedded links. New press releases on InciWeb, updates to the blog, and ORFireInfo Facebook updates



were some of the information links they distributed over Twitter. The latest media reports, community information, and key status updates were also tweeted, with at least a few updates sent each day to maintain a dialogue with the community.

The ORFireInfo blog served as the primary communication interface used by the VOST to communicate with the public. On the blog, they positioned themselves as volunteers with access to the latest information and direct contact with the Type I team (through PIO Eriksen). This was done to establish a separation between content posted on their blog and official fire information posted on InciWeb. Much of the information provided on the blog was the same as that available through InciWeb, but they were able to add additional information that InciWeb could not support, such as full resolution maps, Google Earth tours, videos, photo galleries and community announcements. The blog also contained dynamically updated information such as the latest @ORFireInfo Tweets, and live webcam coverage from a neighboring resort.

In addition, the ORFireInfo Facebook page supported direct conversation with the community. Much of the information between the Facebook postings and the blog overlapped, but on Facebook, members of the public initiated contact with the VOST and in turn the VOST would respond directly to information posted there. Those affected by the fire posted smoke reports, photos and videos. They asked questions, requested specific information, expressed frustration, and extended well wishes and thanks to the firefighters. VOST members then responded directly to the community in a timely manner and relayed important information back to the NIMO firefighting organization. These interactions with members of the public averaged roughly one per day throughout the duration of the fire.

#### 5.4.3.3 Documentation

A required task for PIOs is to compile and document media coverage of an event. As Eriksen explains,

*20 years ago, all we had was clippings from whatever newspapers we could find. 10 years ago we started being able to go to the media websites and print copies of the stories. That was helpful because we could usually get print copies of TV or radio stories which previously had to go undocumented. Now we have all these search engines to help us find stuff.*

However, even though search engines ease the task of finding items, there is greater expectation that things will be found, and today there are more things to be found. This is a time-consuming task that Eriksen reports was a “huge time saver” that the VOST was able to contribute to the response.

The work activities of the VOST were officially recorded in the Activity Log portion of the VOST team document. It provided a high level summary of key objectives and a summary of activities that supported these objectives. In addition, the Skype chat archive provided an informal but highly detailed record of how they accomplished these objectives and coordinated their activities.

Documentation is important, but not all of it needs to be brought to the attention of the responding team on the ground. By *separating the concerns*, as we like to think about it, between what the incident command team must *know* during the emergency and what they need to *document*, the VOST could support the larger requirements of the institution of EM while not interfering with the work of the fire fighters. In providing this documentation service, they acted as a trusted filter for Ericksen:

*...they found a blog by a guy... who was unhappy that some fire vehicles were misrouted and accidentally ended up on the wrong back roads of the community... using small bridges that even school buses didn't drive over because they were historic and/or unsafe. And he didn't have much confidence in our ability to fight a fire when our trucks got lost in the woods. And he posted pictures. But because [the VOST] brought the blog to my attention, I was able to grab the Liaison Officer, show him, talk about it and we sent him out to meet with the man, walk over the bridges, check for damage and basically deal with and defuse a situation that could have caused us community conflict. That's EXACTLY what I need a [VOST] to do.*

Finding good technical support for documentation was harder than the strength of desire to do it, but this trial suggests that the opportunity to outsource such a task to skilled volunteers could helpfully support response teams.

Logging of their work in the activity log was inconsistent, one participant reported. The reasons for this are unclear and require more investigation, but they *could* include the following: 1) traces of the team's actions and decisions were recorded through their social media activity and conversation on the Skype chat, so motivation to log was low; 2) the activity log could not capture the nature of the work well and therefore the tools and processes need to be improved; 3) expectation to log is impractical for the nature of the work; 4) connection to the effort was too removed to generate enough personal incentive to

record. This concern around logging remains an open question that needs to be further explored with direct examination of work practice, which could not be done in this post hoc study.

#### 5.4.3.4 Coordination

Members of the VOST indicated that the Skype chat played a pivotal role in coordinating their efforts. An analysis of the chat revealed rich coordination within this environment. Member presence and availability were communicated here, and ideas about how to conduct themselves were discussed in detail. They also used it to report independent activity. A reading of the chat logs show tightly coordinated teamwork, displays of trust, and camaraderie, as the following excerpt illustrates:

```
[9/3/11 11:31:31] Kris Eriksen: ...Just a heads up to all. We are poised to start
evacuations in Big Lake Camp area. The fire is moving west and pretty windy.
Asking for volunteers to leave now but haven't pulled the trigger yet. But I
need you all to stand by
```

Eriksen makes active use of the VOST, ensuring they are aware of incident command team activities, and the implications they will have on VOST work.

```
[9/3/11 11:32:22] Jeff Phillips: i will text the group as a heads up.
[9/3/11 11:32:44] Kris Eriksen: thanks. Getting a bit ummmmm well you know!!
```

A VOST member responds to the notification in less than a minute, and prepares to activate the rest of the team via SMS, presumably to assure their attention to a common medium. Eriksen acknowledges the confirmation.

```
[9/3/11 12:26:21] Kris Eriksen: IC just told me that. And, not for public yet
but we are recommending to the sheriff that the Big Lake area be evacuated by
1500 today. When thats confirmed i will let you know.
```

Later, Eriksen makes reference to the incident commander (IC), demonstrating much more than superficial integration of VOST with her work, and a display of trust. In the exchanges that follow, we see rapid acknowledgment by Phillips of what is to come, as well as communication of what he intends to do. A third VOST member, over the course of less than 4 minutes, tells the team of his action that resulted from this communication, but also asks for a check on his work:

[9/3/11 12:26:42] Jeff Phillips: copy  
...  
[9/3/11 12:29:26] Jeff Phillips: 2 follow up tweets with specific language from advisory  
[9/3/11 12:30:42] <Vost Member>: I just dropped a piece of text in - can Kris & Jeff come help me shape this so I can make it a PDF and upload for linking?  
[9/3/11 12:32:16] Jeff Phillips: ...best just to link to inciweb page now that it's up <http://inciweb.org/incident/article/2550/12930/> imo  
[9/3/11 12:32:34] <Vost Member>: okay that's great and much easier

Above, the VOST members work out where and how to post information across multiple media venues, providing direct links to get to information rapidly. Despite the work of the last VOST member, the information was already posted to the sometimes erratic InciWeb, and so they expedite their work to make use of that material. They continue to coordinate to make sure the information propagates across the media they support:

[9/3/11 12:33:16] Jeff Phillips: can you place the link and snippet on a couple of the local fb pages?  
[9/3/11 12:36:10] Kris Eriksen: thanks guys.

The text format of chat serves another important function; it provides documentation of decisions and conversations between members of the team. Members of the VOST reported that they used the text as a means to catch up on communication before they began their shifts, without interrupting others. It allowed team members to jump in and contribute without the high overhead of context-setting. The NIMO team used it as a means to “listen in” and scan for new information.

#### ***5.4.4 Integration of VOST Work into Formal PIO Work***

One challenge Eriksen faces as a Type 1 PIO who responds to events across the US, is that every event requires her to quickly determine what existing communication channels are locally in place and how she can integrate with those channels most effectively. As we explained above, the VOST team made sure that information sources were interlinked, so that access to one resulted in audience exposure to others.

Eriksen, in turn, created ways to communicate these sources to local communities. In addition to traditional media, she used information booths and bulletin boards to share information—classic PIO

practice. However, on the back of the business cards she distributed, she printed QR codes that linked directly to both official information sources as well as VOST-created information sources (Figure 8).

In addition to the creativity on display here with the use of QR codes, several other messages are signaled. First, the QR codes signal a high-tech response to the community, something that will likely be an important attribute of future emergency response. In this way, they were probably perceived as additionally *responsive* to the public. Second, Eriksen publicly aligns both the official sources and the VOST-created social media source together (ie., the Twitter account that the VOST put in place, the one she could not). Finally, the last important signal of this action is the high degree of trust the lead PIO put in the VOST. In these actions, Eriksen makes legitimate the VOST as an extension of her PIO duties.



**Figure 8: Front and Back of Business Card Used to Distribute Information about the Shadow Lake Fire.**

#### ***5.4.5 Campaigning for a New Idea***

Members of the VOST and those who supported them understood that this was an opportunity to trial a new idea that would bring the possibilities of social media into EM. For that reason, there was a sense of advocacy about the idea, a sense that comes through in the participant reporting. Nevertheless, participants were self-aware: they conveyed a sense of knowing they were campaigning against resistance that has only recently started to soften. Overall, participants reported the effort going smoothly, and for the scope of the effort, the research concurs that it likely did. However, this is *an important message for practitioners and policymakers*: it is imperative that the institution of EM become open about the possibilities of social media, precisely so we can critically examine its successes and failures. If users of

social media must assume a stance of advocacy in the face of unyielding resistance, then our ability to examine its prospects and problems with a critical eye is limited

## **5.5 Discussion**

Our data show that interviewees frequently identified the ability to extend the support capacity of a local EM team as a key benefit of using trusted volunteers. A team of trusted digital volunteers has the potential to offer additional coverage to what a local EM team can provide. An additional characteristic of this volunteer model is that it is located outside of the impact area, and therefore not affected by power outages, adverse weather conditions or other service disruptions. This was beneficial in the first few days of the Shadow Lake Fire while the Type 1 team worked through connectivity issues with wireless and cell phone coverage when setting up their operations base in a remote area. Further, with team members working from different time zones, they were able to provide an added level of monitoring beyond the waking hours at the emergency site.

Some of the perceived success of the Shadow Lake Fire VOST could be attributed to having qualities of a successful virtual team (Hiltz, Fjermestad, Ocker, & Turoff, 2006): a small team size, extended project duration, and strong leadership. The size of the VOST team was small at a total of eight members. Many members of the team had worked together before in prior exercises so they were familiar with each other's skills and work habits. VOST coverage for the Shadow Lake Fire lasted for three weeks, giving team members an opportunity to establish a shared work practice. Lastly, the Shadow Lake Fire VOST was internally led by Phillips who had a passion to make the team and its work a success.

It is not yet clear that some of these attributes—such as small team size—would be beneficial in all events. For example, the intended VOST design assumes that as resources grow, team members will be organized in small teams with a leader to oversee individual team activities. This may help teams maintain a workable size, but it does not address the logging of increased activity. Practitioners felt that they needed an audit trail; this is perceived as important to the practice of PIO work. In this event we see this value being expressed through concern about using a federal EM form (ICS Form 204) to organize

their activities and archiving of their chat. However this growth is managed, there will need to be a consistent way of capturing and providing a clear audit trail of team activity.

Through the data reported here, we have examined the ways this configuration was made successful. For expansion of the trusted volunteer to a larger deployment, questions, of course, remain. Of particular concern are those surrounding legal liabilities. Who is responsible for information shared by these teams? Would the individual members or the team need to be indemnified or protected from mistakes that will undoubtedly arise? Red Cross volunteers are protected by the agency to whom they belong and from whom they received training. A future formalized digital volunteer workforce and the response teams they support will likely be most successful under similar arrangements.

Logistically, incorporation of trusted volunteers might require an additional layer of management, perhaps one that acts as team lead, as its designer imagined, located remotely. However, this person might not be a volunteer and instead be directly affiliated with the response. This might mitigate the liability issue to a degree, and be conceptualized instead as a remotely located expansion of the PIO team with the lead being responsible for local oversight of tasks. In addition, because mass emergencies have uncertain duration, a plan for rotation and replacement needs to be in place, with minimum duration and overlapping schedules to ensure sufficient organizational learning. Though it is possible in theory to support many volunteers on rotation, continuity through a small, focused operation would likely be the most beneficial, and more likely to be trusted.

Finally, when trusted volunteers are managed by a PIO staff member on the incident management team, the relationship that trusted volunteers have to municipal, state and other area PIOs can become problematic. Is the team an arm of the responding incident management team? Is their information access to the responding team differently privileged from other area emergency responders? Trusted volunteers would likely need to be incorporated into a clear chain of command so they know to whom they are responsible and what their relationships across the response effort are meant to be. It is possible they could be an asset to the entire local system of emergency response, but just as agencies have agreements

about the nature of their inter-coordination, so too must trusted volunteers be deliberately incorporated into the larger ecology of response.

Solutions described here were no doubt successful because they were carefully adapted to the incident. We take this as an important point, and suggest that deployment of VOSTs be conducted in these early days when there is sufficient time and overt commitment to adapt the team to the event. Though we might be able to trial VOSTs in emergency simulations, only real events will deeply stress test the concept. Likewise, real events are more likely to give way to socio-technical innovations and improvisations that show its future promise. It is essential that the VOSTs are successful because the response to the incident must be successful. The means to long-term effective solutions, then, lie not in “proving” viability, but rather in *actively designing interim viable outcomes*.

How to do this? We are now in a situation where we can no longer resist the prospects of social media in EM, but instead determine how best to make use of it; therefore, trials must be closely shepherded and adapted to each situation. Ideally, events like these—serious events that have an audience, but with limited physical risk to people—will be used to scaffold and establish the practice, though it needs to be done rapidly. The demands of the public will likely outpace slow evaluation, and a large disaster is unfortunately the kind of situation for which trusted volunteers could help a strapped formal response. To that end, our ability to provide tools to directly support the work practices of an extended PIO branch—including trusted volunteers—to manage and respond to social media communications is a critical concurrent piece of progress that must be made.

## **5.6 Conclusion**

The attempt to employ a team of trusted volunteers is an example of socio-technical innovation in times of disaster by the emergency management community. This case shows how emergency managers have begun to look within their own communities for help. They appreciate the role of existing remote volunteers, and extend the idea by finding trusted agents who could help when information demands during emergencies outstrip capacity to respond. In this examination, we learn about how a nascent team



of trusted volunteers internally operates, and how the formal response coordinates with it. Their experiences also raise questions that, given this perceived local success, need to be addressed to make it possible to extend the idea of a trusted volunteer network in support of larger emergency management aims.

## **5.7 Reflections on the Action Research**

What struck me now looking back on this first trial are both the simplicity of the solution and how effectively this team of emergency responders was able to translate emergency response practices from the physical world to the virtual and to extend their ranks with trusted volunteers. The tools themselves are ordinary and common, but they were able to quickly formalize their mission, establish an effective backchannel for communication and coordination, and to establish a social media presence across multiple platforms before the official response team took command of the fire. They were also able to link local public information, the physical trap line, with the virtual channels as well. This solution represents nothing short of sociotechnical invention and the emergency responders the inventors of a solution that remade emergency response through virtual channels and effectively engaged trusted volunteers. There was no model for this within formal response and the structure was unique to emergent organization in the virtual world as well.

Although this was conducted as a traditional case study, my ongoing experience as a member of several VOST teams has supplemented this research in a way such that I have a deeper understanding of how this played out for the first time. Much of the processes and protocols established in this first trial have paved the way for future practice. Looking back at the chat archive, I see how the style of ongoing communications establishing camaraderie between members and coordinating work mirrors the familiar yet focused conversation seen across each of the teams rooms today. The team chat is still the primary channel of conversation and information sharing during an incident. When I look back at the *VOST Team Document*, I see within this much of the information documenting activation orders and current objectives that will later evolve into the team workbook. I also see the attempts at capturing analytics, archiving and

curating as part of an ongoing search to identify the best way to capture what happened during an event for future reference. Chapter 6 will look at the practices and organizational structures that have evolved since this initial trial.

## **CHAPTER 6: “V” is for Virtual: A Look at Practices within the Virtual Operational Support (VOS) Community**

### **6.1 Study Summary**

This study extends the research in Chapter 5 to look at how virtual operational support has evolved and grown over the four years since the Shadow Lake Fire. Virtual operational support has expanded into a worldwide community of teams committed to the developing the concept of extending emergency resources through the use of virtual tools and teams. Adopting a practice lens (Orlikowski, 2000), I look at the virtual practices put in place to support the ongoing evolution of VOS and the adaptations made by individual teams to align themselves with the emergency response organizations they support. In turn, I will also look at some of the ways that these virtual practices are reshaping the possibilities emergency response itself.

**This study addresses research question RQ2.**

### **6.2 Introduction**

Since the formation of VOST Osbourne in March 2011 at the National Emergency Management Association (NEMA 2011) Conference (Lane, J., 2012) and the first emergency trial during the 2011 Shadow Lake Fire (St. Denis, Hughes, & Palen, 2012), the use of virtual operational support has continued to grow and evolve as new teams form and adapt their practices in a variety of settings worldwide. There are currently approximately 35 active teams and an additional 19 in different phases of development. These teams operate at the national, state, province, regional and local level to support emergency response organizations in a variety of cultural and organizational contexts. As a community, they have worked to collaboratively define what a VOST is, but there are no explicit rules and no formal governance structure. One of the founding members describes it as a “coalition of the willing” – a community held together by a common vision and certain core concepts. It is these core concepts that distinguish virtual operational support from other forms of digital volunteerism and emergent organization following a disaster.

### ***6.2.1 VOST Teams: Team Composition and Organizational Form***

The key attributes of a VOST as defined prior to the 2011 Shadow Lake Fire continues to be a team of trained and trusted digital resources who operate according to pre-defined processes and protocols in support of an official emergency response organization. One of the senior members of the VOST community (Bledsoe, 2014, May 19) points out that the “V” in VOST stands for “virtual” and not “volunteer”. Although many of the resources on VOST teams are doing so in a volunteer capacity, she notes that these resources may or may not be volunteers. Team members often come from a variety of backgrounds including emergency managers, public information officers, intelligence analysts, college students and social media savvy community supporters. Regardless of specific backgrounds, team members typically have a high level of emergency response knowledge and high proficiency for working social media and social networking technologies.

If we look at the evolving organizational structure of a VOST using the structural framework defined by Kreps and Bosworth (1993) we see another important difference that aligns this virtual organization with formal response and distinguishes it from spontaneous emergent organization. Kreps and Bosworth (1993, p. 44) conceive of organizational structural enactment following a disaster. This enactment is expressed across a continuum with organizations that establish a team [D] and resources [R] first as “ends first” organizations (social order) at one end and those that establish activities [A] and tasks [T] first at the other (social action). The organizational structure enacted by the VOST represents what Saunders and Kreps (1984) would describe as the “ends first” form [D-R-A-T] with the establishment of the team [D] and resources [R] identified up front, followed by a definition of the key objectives and activities [A], and finally the ongoing definition of tasks [T] during an activation. This up front definition of roles, responsibilities, and protocols combined with vetted resources mirror the organizational form closely associated with formal response. In contrast, spontaneous emergent organization can be described by a “means first” organizational structure with activities [A] and resources [R] taking shape first and eventually evolving in to a more solidified form if complexity is significant enough. [See Background 2.1.4 for a more detailed explanation]

### 6.2.2 Technologies-in-Practice

This study makes use of a Orlikowski's practice lens (Orlikowski, 2000) to examine how the background and orientation of the members of the VOST community has shaped their use of technology and practices and how in turn these evolving practices are reshaping emergency response through the use of virtual technologies-in-practice. Orlikowski (1992) proposed an extension of structuration theory (Giddens, 1984) as a useful framework for understanding how as people interact with technology in their ongoing practices, they enact structures that shape their emergent and situated use of these tools. These structures reflect both the motivations of the individual and the institutional and cultural contexts influencing their behavior. She makes a clear distinction about the role of technology, although technology can embody particular symbolic or material properties, it does not embody structures because these can only be instantiated in practice (Orlikowski, 2000). It is through repeated use that these structures emerge. She terms these enacted structures *technologies-in-practice*: the set of rules and resources that are (re)constituted in people's recurrent engagement with the technologies at hand.

The continual enactment of practices within a community often leads to the establishment of consistent *technologies-in-practice* where individuals share similar background, training, social context, work experience, and motivations. But Orlikowski points out that this stability is only temporary and contextually provisional. At any time, an individual or a group can choose to transform these practices and enact new structures. Sometimes these transformations are small, incremental changes and sometimes they reflect major shifts in thinking and innovative leaps. Orlikowski explains, "*Technologies-in-practice can be and are changed as actors experience changes in awareness, knowledge, power, motivations, time, circumstances and the technology*" (Orlikowski, 2000 p. 411).

In *Trial by Fire* (St. Denis, Hughes, & Palen, 2012) we saw how circumstances primed an innovative leap forward for a group of emergency responders. They drew on their experience in formal response to formulate a new set of *technologies-in-practice*, adapting emergency protocols for use in the virtual world, and engaging with a team of *trusted agents*. This solution was strongly rooted and shaped

by their prior experience and training, but also clearly reshaped and redefined through the ongoing use of new technologies and shifts in knowledge and motivations among the individual team members. I will illustrate in this study how the practices initiated during the 2012 Shadow Lake Fire provided a foundation for the ongoing evolution of the current structures that shape how the virtual operational support (VOS) community facilitates communication and interaction across teams and examples of how cultural and institutional forces have influenced the continued evolution of related but varied *technologies-in-practice* for individual teams within this diverse global community.

### **6.3 Method**

This study is based on my experience as a collaborative researcher within the virtual operational support community (section 3.3). I have drawn on my experience as a VOST member and participation in the larger virtual operational support community. Section 6.6 is based on my over four hundred hours of active participation on this team.

#### ***6.3.1 Documents and Online Sources***

I reviewed VOST Leadership Coalition meeting agendas, meeting summaries, and links to related documents. I have also gathered information from online sources including the Virtual Operational Support Group (VOSG) website, and social media accounts and the content and websites produced by individual VOST teams.

#### ***6.3.2 Interviews***

Two formal interviews were conducted for this study. The first was with the facilitator of the VOST Leadership Coalition (VLC) to gather more information about the founding of the coalition, the motivations behind it, the facilitator's personal reflections on how the coalition has evolved over the years, and more information about focus groups and other organized efforts of the VLC. The second was with the team lead for the Pacific Northwest Virtual Operational Support Team (PNW VOST). I have logged over four hundred hours on this team as a VOST member, but I wanted to gather more information

about team history and the evolution of the processes currently in use. Audio for both of these interviews were recorded and transcribed.

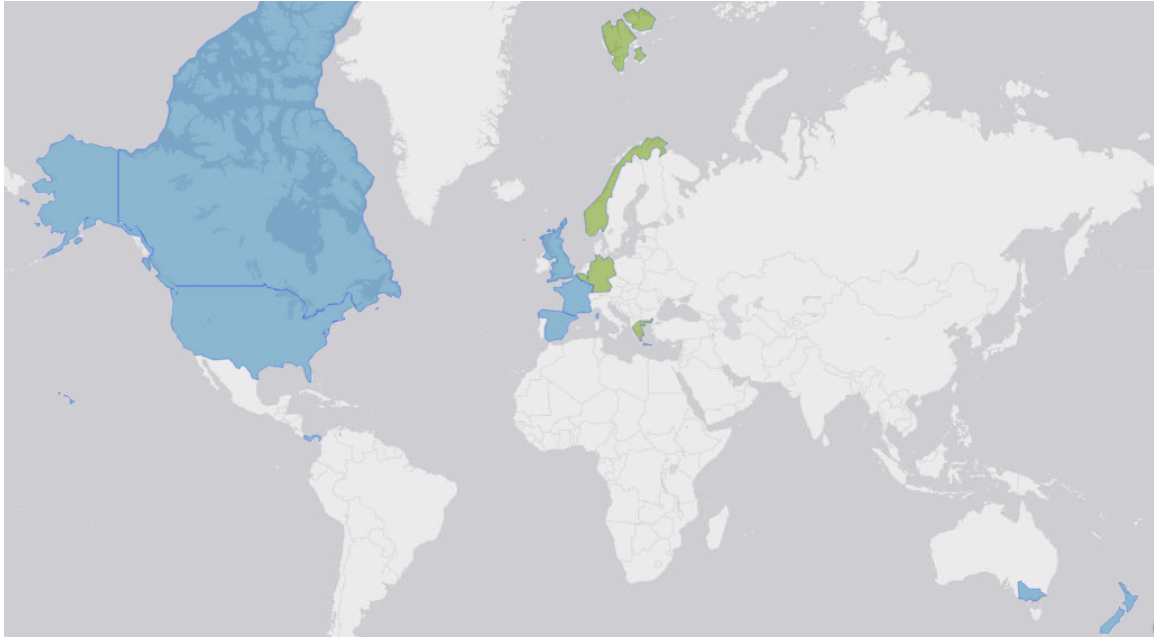
### **6.3.2 Email Correspondence**

I worked with the administrator of the VOSG website (VOSG.us) to gather current status information for all the teams listed in the VLC Participant Roster and on the VOSG website. Working from both of these lists, we emailed team leaders to gather up to date information about the operational status of these teams and any planned changes in status. This information was used to refresh the information on the VOSG website and to produce the maps contained in this study.

## **6.4 Findings**

### **6.4.1 Virtual Operational Support: A Diverse Global Community**

Virtual operational support has grown to include teams in North America, Europe, Australia, New Zealand, and Panama (see Figure 9). The maps represent teams that are currently active (shown in blue), in development (shown in green) or that exist but are on hold for some reason (shown in yellow). The maps capture the teams and their status at the time of publication, for more up-to-date information refer to the VOSG website (Lane, 2015, July, 15). My direct research has been exclusively with teams in the United States and within these teams I observe similar work practices and the frequent sharing of resources and expertise across teams. Important factors that may support this exchange are common language, a common incident command system (ICS), common culture, and access to the similar tools and technologies. There is also an overlap in time zone providing more opportunities for direct communication. All of these factors may influence a level of consistency across US teams and highlight reasons for some of the variability at the international level. I have not had the opportunity to work with any of the international teams directly, but I will highlight examples based on published information to show how differing circumstances has resulted in different organizational structures and work practices within these teams.



**Figure 9: VOST Worldwide Map (November 2015)**

#### ***6.4.2 Virtual Operational Support: A Diverse Global Community***

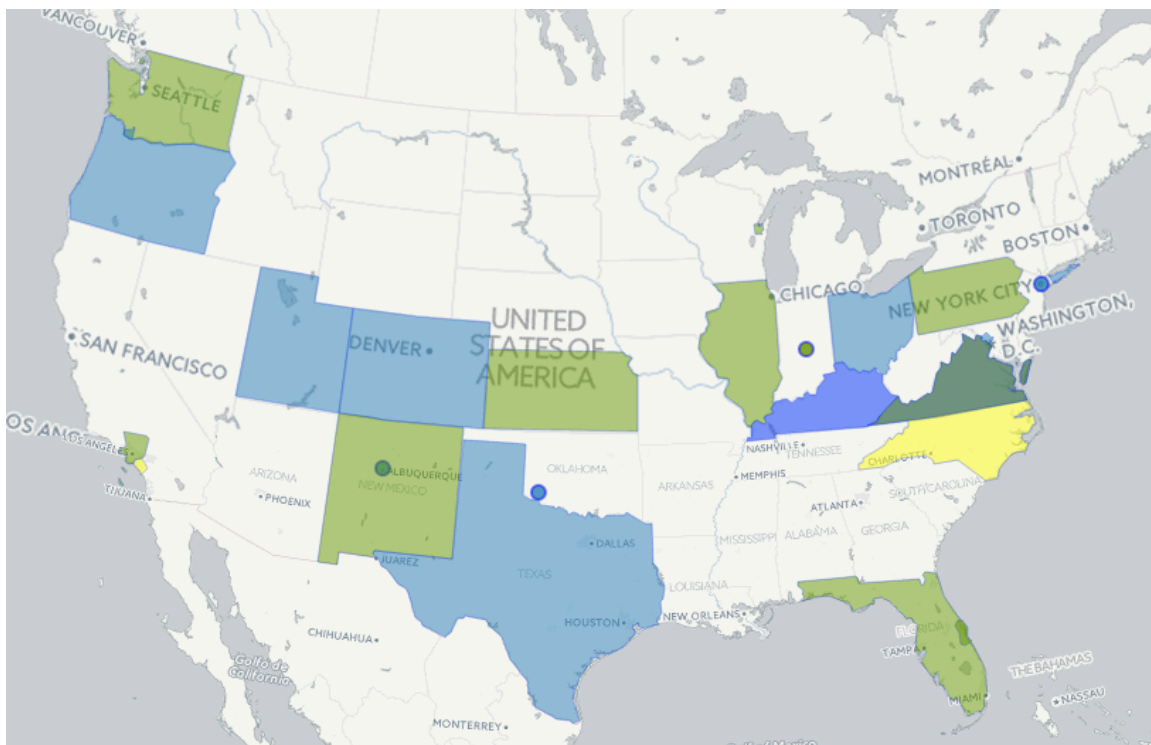
There are fifteen active teams in the United States supporting agencies at the national, state, and local levels. This includes three federal Type 1 incident management teams, including Eriksen's VOST that formed during the 2011 Shadow Lake Fire, and the National Weather Service (NWS) in Texas has used a VOST for extreme weather events (see Table 9). They have also been piloting an idea they call the *NWS Supplemental Assistance Volunteer Initiative (SAVI)* based on VOST concepts. The SAVI model draws on internal resources and expertise during high-impact weather events from offices where the weather is benign (Barry, Boucher, Jones, Smith, Brice, & Pieper, 2015). Volunteers from these outlying offices perform quality control on the information coming in so that the impacted office can focus their efforts on outgoing communications. There are twelve active state and local level teams and eleven more currently in development (see figure 10). The Colorado VOST (COVOST) was one of the first teams to develop a state level model. It grew out of the Integrated Social Media Strategy developed by the Jefferson County Sheriff's Office (see Chapter 7). In March 2014, the Colorado Department of Homeland Security and Emergency Management (DHSEM) took over management of the Jefferson County VOST



(JeffCo VOST) and rebranded the team the Colorado Virtual Operational Support Team (COVOST). The COVOST is specifically designed to be a resource available to local agencies in the state of Colorado to supplement or enhance any existing plans. Several other states are now working on developing a state level model and consulting with COVOST on strategies at this early stage of development.

National Level Team	VOST
Portland National Incident Management Team (Portland NIMO)	Eriksen's VOST led by Kris Eriksen
Pacific Northwest Incident Management Team 2 (PNW Team 2)	Pacific Northwest VOST
Pacific Northwest Incident Management Team 3 (PNW Team 3)	Pacific Northwest VOST3
National Weather Service (NWS)	OK VOST, West Texas VOST, SAVI

**Table 9: US National Level Teams.**



**Figure 10: VOST Teams in the United States (November 2015)**

#### 6.4.3 International VOSTs

Examples in the international VOST community demonstrate how different social and operational contexts have led to new operational models. New alliances and models of support are evolving based on shared borders, geographic proximity, and shared language. In the United States, teams follow a strict

activation model as prescribed by the National Incident Management System (NIMS), prohibiting self-activation. Outside the United States, a number of teams have implemented models and technologies-in-practice that support permanent operational status. These practices evolved out of the need to align with different social contexts, differing relationships with response organizations, and differing resource constraints as detailed in the examples that follow.

#### 6.4.3.1 Canada VOST

The Canadian national VOST (Canada VOST) has official government support and covers all provinces and territories in Canada. They operate with funding from Public Safety Canada, non-governmental organizations, and funding from Canadian fire chiefs (Bledsoe, 2013). In September 2014, Canada VOST and members of U.S. VOSTs participated in the Canada-U.S. Enhanced Resiliency Experiment (CAUSE III), a Department of Homeland Security (DHS) Science and Technology exercise that explored cross-border information sharing. The exercise simulated a hurricane impacting both the U.S. and Canada and explored strategies for providing mutual aid remotely to jurisdictions on both sides of the border (DHS website). They also have an alliance with Association VISOV, the French speaking VOST, to support the French speaking population of Canada.

#### 6.4.3.2 Association VISOV, France: A French Speaking VOST

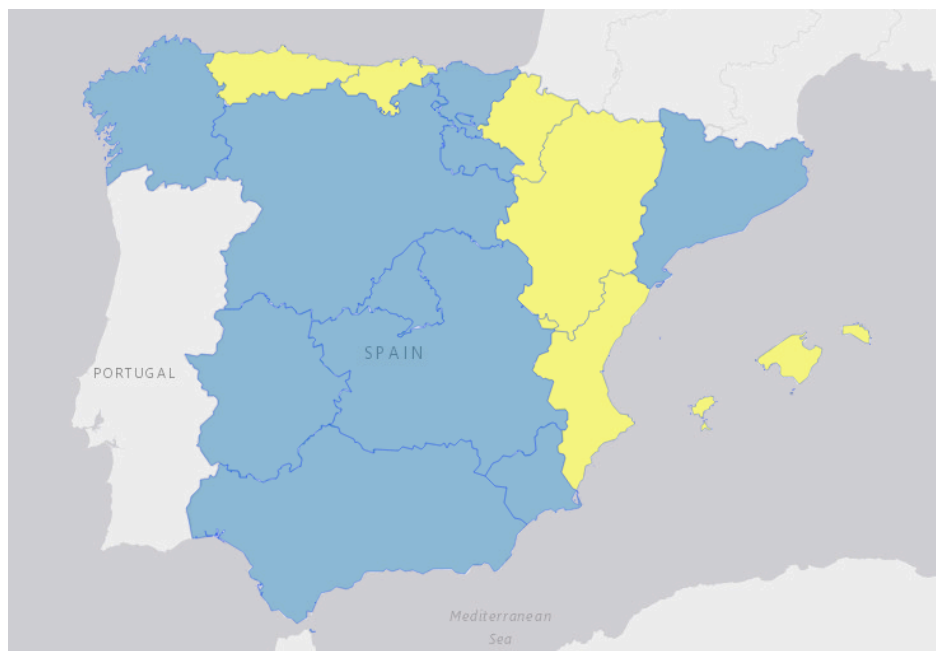
Association VISOV is based in France primarily supporting the Civil Defense Department (COGIC) but has also supported the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). The aim of this association is to use VOST methodology, tools and resources in the support of French speaking populations in disaster (Lane & Tymen, 2015, May 24). The team worked in coordination with a VOST team member in the United States to negotiate the translation of the social media reference “*Using Social Media for Enhanced Situational Awareness and Decision Support*” (DHS Science & Technology, 2014, June) into French for the French-speaking emergency response community (Lane & Tymen, 2015). The team formed in 2012 and is staffed by volunteers experienced in emergency response, crisis management and communication. They are currently working on expanding their

connections to include subject matter experts within the disaster and emergency response community and they recently formed a partnership with *La Radio Météo*, France's first web-based radio station dedicated 24/7 to weather news. VISOV recently receive the *Trophy for Citizenship Award 2015* from the French High Committee of Civil Defense where they were recognized "as a kind of citizen start-up that makes us open our eyes to the structural and organizational changes needed in the field of security and civil protection" (Lane & Tymen, 2015, September, 28).

#### 6.4.3.3 sky VOST, USA: An English-Speaking Multi-National VOST

Another team with a multinational focus is *sky VOST* based out of New York, USA. The team formed in 2015 in support of Team Rubicon following the 2015 Nepal Earthquake much like the Shadow Lake VOST formed in response to a request for help from Kris Eriksen. The skyVOST used their skills and connections to help identify areas where medical help was needed. This team is looking at providing multi-national support for English-speaking populations in the future.

#### 6.4.3.4 VOST Spain: Countering Rumors and Hoaxes



**Figure 11: Spanish Regional Teams Coordinated by VOST Spain (November 2015).**

VOST Spain emerged from a need to counter the mass proliferation of disaster-related rumors and hoaxes that frequently spread across social media in Spain. During the 2012 Valencia Wildfires in Spain, a hoax Twitter account was able to establish itself as an official information source garnering over 400,000 followers and proliferating misinformation. The account went undetected by officials and was not shut down (Lane, J, 2014, February 20). This sort of hoax is a common in Spain and potentially overwhelming for the emergency response system (equivalent to the 9-1-1 system in the United States). To counter this issue, VOST Spain established teams at the regional level (see Figure 11) that monitor and maintain an active presence on social media channels so that rumors and hoaxes can be countered effectively and the impact to call volumes for the emergency response system minimized. According to policy, teams are always actively monitoring and each team tweets daily to maintain an identity as the “go to” source for information.

#### 6.4.3.5 VOST Victoria, Australia:

Similar to VOST Spain, VOST Victoria maintains permanent operational status rather than following an activation-based model. VOST Victoria is an all-hazards team that provides support to multiple agencies within the state of Victoria, Australia. In Australia, the threat of bushfire is ever-present, especially during the summer months from November through May. Fire activity peaks daily from 1pm to 8pm and multiple fires need to be tracked and the risk to populated areas continually assessed. VOST Victoria has developed a unique workflow process that allows them to maximize the efforts of a small team of volunteers. VOST volunteers use their personal accounts to communicate directly with a group of registered clients within the emergency response community. Social media monitoring information is translated into communications they refer to as “job notes”. Their goal is to get this information out to clients in close to real-time. In the case of a catastrophic event, they have plans in place to “upscale” by drawing on expertise and resources within the VOST community and use of the standard workbook (see 6.6.6). They recently expanded their team resources to include volunteers focused on recovery and animal welfare (Lemon, B., 2014, June).

## 6.5 Technologies-in-Practice Across Teams

### 6.5.1 Synchronous Chat

Ease of communication between team members and across teams is a critical aspect of virtual operational support. One of the primary forms of communication is synchronous chat. Historically, this has been Skype chat, but outside of the United States many of the teams have chat rooms in *whatsapp* because it is more popular and less expensive to use in many areas. As mentioned in the Shadow Lake study, ongoing conversations in synchronous chat persist and many VOST members scan these conversations to catch up on what is happening. This feature is particularly valuable in a global community where time differences make it difficult to communicate in real-time.

#### 6.5.1.1 *All Things VOS* (ATV) Chat Room: A Community Forum

The *All Things VOS* (ATV) room is a Skype chat room open to anyone with an interest in virtual operational support. It is a community-wide forum where members can ask questions, share information, socialize with one another, and to keep up with what is happening across the VOST community. Members frequently drop in links to information or tools they find useful. It is also a space where team leaders can put out a call for additional resources if they need help from other teams. One of the senior members of the VOST community reports that this can be an important, especially in sudden onset events where help is needed immediately. She cited an earthquake in New Zealand and tornadoes in Oklahoma as examples of when team leaders reaching out to the broader community for extra assistance, allowing anyone awake and listening to respond. In a worldwide community, it is likely someone is listening on this channel.

#### 6.5.1.2 #SMEMChat

Although not specifically a VOST activity, members of the social media in emergency management community meet every Friday at 12:30 EST on Twitter using the hashtag #SMEMChat. Every week there is a different topic of discussion related to the use of social media in emergency management (SMEM). Typically someone within the SMEM community will host and tweet out

questions to stimulate conversation around a topic. Members of the VOST have used this venue to discuss topics related to virtual operational support. VOST Victoria has also used this venue to host special sessions of #SMEMChat using the hashtag #SMEMau to connect with and share their experiences using social media in Australia and to build connections with members of this global community.

### ***6.5.2 The VOST Leadership Coalition***

The VOST Leadership Coalition (VLC) was conceived of at the National Emergency Management Association (NEMA) Conference in March, 2012 and met for the first time in April 2012. The founding VOST members saw value in bringing team leaders together to talk about their experience working with virtual teams, to talk about emerging situational awareness tools, organize around VOST related topics and to bring vendors in to demo new tools and technologies. The VLC facilitator reports that they conceived of the coalition as a venue for sharing ideas rather than a forum for defining strict standards. They have always believed that individual teams should determine how they function, but that a facilitated conversation could support learning across teams and help define guidelines for what works well. Although they expect differences their hope is that ongoing communication across teams will produce a consistency of message that will prevent wildly different interpretations of VOST.

The VLC facilitator refers to it as a “coalition of the willing” – anyone with an interest in virtual operational support is welcome to join the discussion. Shortly after they met for the first time, they defined the coalition as being *comprised of team leaders, coordinators, administrators and developers, as well as representatives of any group operating or developing digital volunteer programs anywhere in the world* (Lane, J., 2012, May 24). By the second meeting there were twenty-four organizations represented. The VLC hosts an hourly conference call once a month and the agenda is shared ahead of time via an editable Google document. Anyone can add an item to the agenda making the content of the discussions crowd-sourced across the VOST community. Each meeting follows a similar format. It is kicked off with an optional *GroupMe* notification exercise, followed by a short presentation, lessons learned from recent activations, general topics of discussion, and finally what they refer to as *Good of the Order* - topics for

round-table discussion. The VLC facilitator reports that it has been challenging to find a regular time that works for all participants, but they typically have representation from both U.S. and international teams increasing the diversity of discussion both in terms of new ways of organizing teams and exposure to a wider range of tools and platforms.

The primary focus of the meetings is on information sharing and lessons learned. Discussion of recent activations takes priority on the agenda. Recent activations are added to the agenda and Team leaders are encouraged to share about their recent experiences and any lessons learned. This sharing can range from informal discussion to the sharing of detailed after action reports. To illustrate information sharing across teams and the mutual benefit this provides, I have taken excerpts from a document shared by Kris Eriksen, PIO for the Portland NIMO Team and leader of Eriksen's VOST, detailing their experience dealing with negative public posts during the 2012 Barry Point Fire. This document was shared with the VOST Leadership Coalition in September 2012.

#### 6.5.2.1 Lessons Learned from the Barry Point Fire

The 2012 Barry Point Fire started in South-Eastern Oregon on August 6, 2012. Complexity of the fire increased and NIMO took command of the fire on August 13<sup>th</sup> (see Incident A.2). No social media had been put in place by earlier teams and the incoming team made the decision to fully engage with the public through social media. A Forest Service Flickr and Twitter account were created on August 13<sup>th</sup> and a blog and Facebook account were created specifically for the incident later that same evening. The next morning they received the following public response after posting a photo of the incident commander at the morning briefing:

XXXXXX XXXXXX I can hear it now..... "THIS IS BIG DOLLARS MEN AND WOMEN" Your paychecks depend on this fire burning up as much as possible. The longer we can Let'er burn the bigger ALL of our pockets get! So be careful out there, eat a good lunch, be sure you all take your government mandated breaks... Every 15mins whether you need it or not! Ooh and don't forget hacky sac play offs are tonite following directly after dinner, so be sure to practice on that while your standing around watching the fire today! • Yesterday at 6:44am · Like · 1

This post brought an issue into the foreground that is a concern for all teams engaging with the public through social media. Eriksen and her team used this as an opportunity to learn from the

experience and develop protocols for handling negative posts. To share this experience, she archived the related comments and added notes about the thought process they went through along the way. Eriksen explains,

*After this first post (above), we were concerned, but took a pause to try to see this as an opportunity to think about and develop protocols about how to handle people who make these kinds of posts because it's what most PIOs/IC's and agency leaders are concerned about [when using social media]. We talked about if we should respond, what we should say, when to say it and wondered if the community on social media would jump in at some point as we believed it would. It took about 45 min for the first "rebuttal" to appear. ...as you can see they came in pretty steadily.*

She provides an archive of the steady stream of comments from both the angry citizen and related public responses. She identifies several that demonstrate a high level of knowledge and understanding of the firefighting process. Eriksen points out the value that this information has coming from an individual rather than the response team. Eventually, they decide to comment to let people know they are listening. Eriksen explains,

*It was about here, at 9:24 am – 2 ½ hours after the first negative post, and in seeing the community managing the negative person – that we posted our "Policy" statement and pinned it to the top of the page so that it would remain at the top of the page and be the first thing people saw. ... By Thursday the 16<sup>th</sup>, there were 62 likes for that "policy" statement.*

Here is a copy of the policy statement:

Barry Point ORFire  
23 hours ago Wed. August 15, 9:24 am

While we appreciate that sometimes other opinions can be difficult to hear, we create these pages so that everyone can have a voice. There are always strong opinions associated with wildland fires and we believe that people need and want to talk to each other about what's happening.

That said, we do have policies regarding abusive or threatening language, sexist, racist or defamatory comments and we will uphold those policies.

At the end of the archive, Eriksen reflects on the process her team went through and how the situation played out. She admits that it was not as straightforward as it might seem and there are no clear strategies for how best to handle this sort of negative sentiment. Within these conclusions she provides this reflection,



*I read her comments and while they were nasty, mean and misguided, they were not defamatory or racist or any of the other things. She was mostly venting about one issue: that we were only in it for the money and that we were managing it so that we could make a lot of money – therefore it was in our best interest to let it get big. That’s not an uncommon opinion; we’ve all heard it before, just not so unrelentingly. And I knew blocking someone can open a bigger can of worms, so you better be really sure. We got several private messages from people asking us to please block her. I thought, “well we need to let them know that we are not ignoring it” so I drafted the statement (listed above) that I hoped would give a subtle warning that there was a line we would not let her cross – but without addressing it directly to her. Besides, I felt it was something everyone should know.*

As Eriksen points out, dealing with negative public sentiment is not new, but dealing with it on public-facing social media requires careful consideration. Sharing this with other team leaders offers them an opportunity to think through their own strategies for how to handle negative public sentiment in the future.

### **6.5.3 Focus Groups and Outside Efforts**

Over time, various subgroups have formed within the VOST community to tackle projects such as the creation of VOST training materials or to craft clear messaging around virtual operational support concepts. Members of the VLC have also participated in outside events such as attending the White House Innovation Day and other emergency management related events. Several members of the VLC participated as members of the Department of Homeland Security Science and Technology’s Virtual Social Media Working Group.

### **6.5.4 International Coalitions**

As the number of teams has grown, particularly in Europe, new alliances have formed to coordinate regional efforts. The newly formed VOST Europe describes itself as *a coalition of VOST teams located in the European Union to undertake projects and activities within the European Union*” (Lane, 2015, July 15). There are other coalitions in the discussion stage: VOST Americas and VOST Oceania, but not much is known about how these coalitions will take shape.

### ***6.5.5 VLC Special Session***

The VLC held a special session in July 2015 to discuss the evolution of VOST. The purpose of the meeting was to discuss differences in some of the messaging and expectations coming from seasoned team members mentoring new and developing teams. Members of the coalition wanted to discuss whether establishing a level of governance would be necessary to ensure clear messaging, a sustainable internet presence and to move VOST further down the path towards standardizing and credentialing of teams. A majority of participants were opposed to establishing organizational governance and felt that procedures followed by individual teams should be worked out between the teams and their activating agencies rather than imposed from the outside. There was consensus, however, that they needed a better process for onboarding new teams. As a next step, information is being gathered in the form of a survey across all team leaders. This discussion highlights the ongoing contradictory struggle between fostering an organic bottom-up evolution that supports the development of new ideas and adaptation to a variety of contexts worldwide versus establishing the standards and structures necessary for the resource typing and credentialing of teams that would facilitate the integration of VOST with formal response in the United States.

## **6.6 Virtual Work Practices Within an Individual Team: An Analysis of PNW VOST**

As detailed in the previous sections, there are no explicit rules for how to operate and organize a VOST. Team organization and operational protocols are worked out between individual teams and the activating agency. Although there are many commonalities across teams, no two teams operate in exactly the same way. I will now look more closely at the work practices of one team to examine how the team leader has adapted tools and processes to extend the social media monitoring resources of a Type 1 incident management team and leveraging the resources of a virtually distributed team.

### ***6.6.1 History of the Pacific Northwest Virtual Operational Support Team (PNW VOST)***

The PNW VOST formed in 2012 in support of the Pacific Northwest National Incident Management Team 2 (PNW Team 2), a Type 1 National Incident Management Team. Type 1 Incident

Management Teams are the most skilled teams in the nation, responding to any type of incident when the demands of an incident exceed the capabilities and resources at the state and local level. The PNW VOST focuses on social media monitoring, updating public-facing social media channels and the amplification of official emergency information. The team lead works directly with the PIO team to understand current objectives and to manage escalations. She has been a member of this VOST since its formation and has been an integral part of defining and continually refining team protocols.

### 6.6.2 The PNW VOST Team Room: Maintaining Team Preparedness

The team lead maintains a Skype chat that is referred to as the “team room”. This is the place where general information about the team is placed. Membership is restricted to current members of the PNW VOST, members of the incident management team and approved observers. Information such as where the team is in the current rotation and general situational awareness is posted here. The atmosphere of the team room is social. Team members check in with each other frequently and chat.

Every morning, the team lead pulls together information across relevant sources of online information to create the *PNW VOST Coordination Summary* (VCS) and places a link in the team room (see figure 12).



**Figure 12: Daily Posting of the VCS to Team Room.**

The VCS summarizes important information from a variety of sources providing general incident situational awareness. It follows a consistent format and contains information such national and regional preparedness levels, the regional briefing (list of fires), an overview of large incidents, fire potential

maps, weather, drought conditions, and a summary of current news related to these incidents. This type of information is particularly useful for Type 1 teams monitoring current conditions in anticipation of future deployment. Any fires that could potentially be the next up for the Type 1 teams are marked in bold face and important details in the summary are highlighted. Whenever PNW Team 2 is at the top of the rotation, the PNW VOST pays close attention to this information, pulling together any new sources of information that might be needed.

### ***6.6.3 Activating the Virtual Team***

Team activation follows a clearly defined set of steps and there are protocols associated with each of these.

1. Notifying team members: An announcement is made in the Team Room and the official callout to the VOST team members is done via a group-messaging application.
2. Work begins on the incident workbook (see section 6.6.5)
  - a. Team members reply to the callout and mark their availability in the workbook
  - b. Team members update their contact information if necessary
  - c. Pre-activation monitoring begins
  - d. Resource lists are updated with new sources and information from previous incident workbooks
3. Public-facing social media accounts are created for the incident
4. The Incident Room is created

### ***6.6.4 The Incident Room: Coordinating Virtual Response***

At the start of a new activation, a new Skype chat is created with the incident name (e.g. Wolverine Fire VOST) and is referred to as the Incident Room. This room contains all members of PNW VOST responding to the callout, liaisons from the PIO team, and any other contributors approved by the team lead. Once the incident room is created, conversation shifts from the Team Room to the Incident Room. All incident-specific communications now take place in the Incident Room and any general team communication takes place in the Team Room. The team leader explains that from her experience, this makes managing resources and communications much cleaner. After an incident, the Incident Room is *stood down* and any resources that were on loan or temporary get cleaned up automatically.

Daily coordination happens primarily from within the Incident Room. Communications from the team lead help VOST members gauge what is needed and active team members continually check in.

When circumstances are the volatile there is a feeling in the room of “all hands on deck” and when circumstances quiet down people tend to take more breaks and step away. There is a natural rhythm to the day. In the morning, the VCS, information from the 9am update from Inciweb, and updates from the PIO team provide an overview of primary concerns and what is expected for the day. The PIO shares video from the morning briefings when available. Team members check in and let the team lead know what their availability looks like and she in turn notifies the team of any specific support that is needed that day. As the day progresses, team members log results from social media monitoring in the workbook (see section 6.6.5) which serves as the official record of the team’s efforts. Within the incident room there is ongoing conversation about what team members are seeing on social media. If a team member finds something that potentially needs to be escalated, it is logged first in the workbook and then shared in the Incident Room. The team lead takes a look at the information, asks for more information if needed, and escalates.

Conversation in the incident room flows unless there is an escalation. When information needs to be escalated to the PIO Team, casual conversation in the incident room stops. The team lead contacts the PIO Team to let them know there is an escalation along with the line number in the workbook. Once the escalation is complete conversation resumes in the incident room.

#### ***6.6.5 Establishing Common Operating Procedures: The Incident Workbook***

The concept of the VOST workbook originated within the VOST community to centralize incident information in a shared spreadsheet. The PNW VOST team lead further developed this VOST specific tool and released a template version of the VOST Workbook in Creative Commons along with the VOST Deployment Workbook Users Guide containing instructions for its use. This tool has been adopted and adapted by a number of VOST teams and adapted as necessary to meet their individual processes and protocols. This description covers version currently being used by the PNW VOST. The VOST workbook serves as the official record of team activities and an ongoing reference for the PIO

Team. Permissions are managed so that only the active team members and relevant members from the PIO Team have access to the contents.

The workbook is organized into tabs with specific functions (see Table 10 below). The ICS 204 Form is maintained by the VOST lead based on communications with the PIO Team. It contains information about assignments in place for the current operational period. Versions for prior operational periods are archived off to the right in the workbook. The General Availability Table keeps track of team member availability throughout the day. The Check In/Check Out Log keeps track of actual work effort and logs who is currently actively working at any given time. Key Search Terms and Tags documents terms used in social media monitoring.

<b>Tab</b>	<b>Description</b>
Cover	General Incident Information
ICS 204 Form (updated daily)	This is a VOST specific version of the ICS Form 204 – Assignment list It should be updated daily. The previous day’s form copied and moved to the far right for archival purposes.
General Availability Table	Availability by day. Team members mark their availability for each hour
The Check In/Check Out Log	This table keeps track of actual effort from individual team members and who is currently working.
The VOST Activity Log	A record of significant activity
Key Search Terms & Tags	Keeps track of search terms and tags currently being used in social media monitoring by type of information (e.g. fire name, lat/long, geographic areas impacted). This mirrors information set up in Tweet Deck (the Twitter monitoring tool used across the team).
Key Websites and Resources	A list of key sources both internal and
Search Results	Records detailed information for any significant social media monitoring results.
Team Members	Contact Information and social media accounts for team members

**Table 10: Incident Workbook Tabs.**

A copy of the workbook is archived daily, the ICS 204 tab is then refreshed with new information for the day. This document serves as an important record of both official orders coming from the incident management team and a record of the results related to these orders.

### **6.6.6 Standing Down**

At the end of the activation, coinciding with when the incident management team stands down, the VOST team receives their orders to stand down. Any final items are logged in the workbook, and communications are completed. At a specified time, the incident room is stood down and all team members shift their attention back to the team room. The team leader archives off the results across the social media platforms and the workbook. After the incident, team members meet via a chat session for an after action review. Significant results from this session are compiled into an after-action-report (AAR) and information is communicated to the PIO Team.

### **6.7 Discussion**

As reported in Chapter 5, at the time of the Shadow Lake Fire the use of social media in emergency response was a controversial idea and members of Eriksen's VOST reported being aware that they were campaigning for a new idea. They pursued this idea because as emergency managers they felt it was important to explore and plan for the use of social media in emergency management in a world that was becoming increasingly adept and reliant on social media as a means for sharing and accessing emergency information. The VOST concept grew out of a grassroots movement within the emergency response community. They pursued the idea without official sponsorship from a formal response organization and no funding to make it happen. The virtual operational support community is made up of individuals with a background in emergency response and knowledge of social media and information and communication technologies, volunteering their time and energy to redefine emergency response to work within a virtual context. As members of the emergency response community, there is an underlying focus on emergency preparedness. If formal response is about defining and designating resources, procedures, and protocols for use in a variety of circumstances and on any scale, VOST is about redefining these in the virtual world and defining how virtual operational response can align more closely with formal response effectively.

The ongoing evolution of virtual operation support practices reflects the continual adaptation of tools and technologies to meet the continually evolving needs within this unique social and organizational context. Solutions are pieced together from the free or minimal cost technologies readily available, often the same tools being actively explored by their constituents in disaster. Through the use of these tools in combination with their personal social networking skills they have been able to build a community of like-minded emergency responders exploring a new idea and a new organizational structure. Across teams there is a clear orientation towards practices that support collaboration, sharing of ideas, preparedness, and the establishment of community and trust across an increasingly diverse community of teams. Within individual teams there is an orientation towards aligning virtual practices with the protocols and culture of the formal response organizations. Often the tools and technologies being used are the same, but differences in these technologies-in-practice indicate important differences in orientation.

#### ***6.7.1 Cross-Team Technologies-in-Practice: Fostering Collaboration, Preparedness and Consistent Messaging***

##### **6.7.1.1 The VLC and Other Forums**

The practices established by the VLC set the tone within this community as open to new ideas and collaboration: membership and participation is open to all interested, the agenda is crowd-sourced, and the orientation of the discussions are toward the sharing of ideas rather than the establishment of strict rules or governance structures. Equally important, the topics of discussion reflect an orientation towards emergency preparedness in a virtual world: leveraging the lessons learned across activations, keeping up with new tools and technologies, and discussing relevant topics related to virtual operational support a form of cross team awareness and training for a variety of circumstances. The formation of focus groups and side projects also suggests that the forum provides an important support structure for maintaining clear messaging and coordinating efforts within the larger world of emergency response.



#### 6.7.1.2 Ongoing Communication Channels

The various chat rooms and in particular the *All Things VOS* room provides an ongoing, open channel of communication across the VOST community. This 24/7 connectivity is important for several reasons. First, it helps members within the extended community to build familiarity and trust with one another in a virtual environment. This is important in a community where trust is a central requirement for mutual support. It also allows members to communicate and share information with one another regardless of timing. The text-based format allows members to “catch up” when the timing is convenient. Finally, the 24/7 orientation of the room supports an open channel when team leaders need additional support. They can post a callout for help within the room and anyone awake and available within this trusted community can respond.

#### 6.7.1.3 Social Media Accounts

Members across this community are also connected across various social media channels. Twitter is one of the primary ones and members within this community follow each other and team accounts to stay current with what is happening and many participate in the #SMEMChat sessions.

### ***6.7.2 Team Level Technologies-in-Practice: Aligning the Informal with the Formal***

Within teams, many of the same channels and tools are used and teams maintain ongoing communications through the team chat, but the orientation of practice is different. Here the emphasis is on aligning with the formal protocols and procedures of the activating agency and understanding relevant cultural factors. Processes and protocols are clearly defined and consistent. Looking to the example provided, many of the processes and protocols mirror reflect a translation of formal response protocols in a virtual work environment. Members of the team have to officially respond to the callout to “report for duty” and be added to the incident room. The incident room becomes a virtual command post, and membership in this environment signals a shift from general processes and protocols to those corresponding with those that align with formal response. The protocols for recording their efforts in the workbook act as both the official record, and a situational awareness tool that helps members of the

VOST and the PIOs keep track of what is happening in the moment and in the recent past. The Incident Room acts as a shared channel of communication between members of the VOST and the PIO team and also with each other. When the activation is over, the process of standing down provides a virtual set of tasks that signal the shift in virtual terms from on duty to off.

Looking across the VOST community we see how different environments and cultural settings have led to a range of adaptations within the individual VOST teams. Each of these has been necessary to make virtual operational support work across a variety of contexts and to align effectively with the individual response organizations these teams support.

### ***6.7.3 Balancing Innovation and Alignment with Emergency Response***

The current work practices across the virtual operational support community has successfully fostered the growth of an idea and provided space for teams to experiment and share ideas with one another in an organic bottom-up style of development. As one of the founding members pointed out, this bottom-up organic style has succeeded where other top down mandates have failed. But the question remains will this style still continue to be effective as the size and diversity of the community grows? There are inevitably differences in vision and work practices that may challenge underlying assumptions of VOST. How will the democratic work practices established within this community support reconciliation of differences? Secondly, we've seen how adaptations within individual teams supports stronger alignment with the response organizations they support, but does this lack of standardization of processes and protocols prevent other types of alignments with formal response? In the United States, this lack of standardization makes it difficult to clearly define what a VOST is in formal response terms. Some team leaders within the U.S. would like to see establishment of standards that would support the resource typing of VOST teams and credentialing of members. If the special session of the VLC is an indication then some of these topics will soon be tabled for discussion.

## **6.8 Conclusion**

If we take the perspective that organization is a continually enacted process rather than static entity, we see signs that as the virtual operational support community will continue to share ideas and collectively enact structures that strike a balance between the needs of individual teams and the concept as a whole. We may see more of a middle ground where standards are developed that enable the deployment of VOST across a wider variety of settings. Hopefully this will be balanced against continued innovation from a skilled and innovative group of emergency responders.

## **6.9 Reflections on the Action Research**

Within teams, based on my experience, there is a strong focus on training and the implementation of clearly defined processes and protocols. In contrast, across teams the community as a whole gravitates towards the sharing of new ideas and technological practices, but resists imposing rules or governance structures. I believe that it is this culture that supports the generation of new ideas and culture of continual re-invention that has fueled the expansion of teams and evolution of structure across an increasingly diverse environment. It also reflects the history of the founding members of the VOST who had to campaign for the opportunity to explore new ideas in a hostile and somewhat rigid environment. As one of the founding members of VOST pointed out, this “coalition of the willing” has succeeded where top down mandates from within formal response have failed.

It is not an easy balance and as the community grows, along with the diversity of ideas there will certainly be conflicts and disagreements that will have to be worked through. There will be new coalitions and alliances that form in response to gravitation of interest or goals, and these may push the VOST in conflicting directions. Despite all of this, there is a strong sense of camaraderie across this community and a willingness to extend expertise or a helping hand across teams whenever it is needed. The same channels that support ongoing conversation and sharing of ideas also provide infrastructure across a global community in the event of a wide-scale or sudden onset disaster. These channels are likely to reach

skilled community members awake, available to help and willing to able to adapt quickly to what is needed.

## **SECTION THREE. Public Information Work in a Digitally Connected World**

### **Section Introduction**

The growth of social media use in disaster has opened up new channels of communication across a wide variety of information sources on a publicly visible stage. It is now possible for emergency response organizations, official civic agencies, media, private organizations, and both local and geographically dispersed individual to interact with one another in new and often unexplored ways. New models of public information work are emerging as response organizations experiment with strategies for how to integrate social media into formal practice effectively. This section contains two studies that look at public information work from different angles. Chapter 7 looks at the evolving social media practices of a county level incident management team that we consider a “height of practice” case. They are exploring new ways to use social media channels to optimize both media information sharing and engagement with the public. Chapter 8 looks at the complexity of the information space on Twitter and explores a strategy for filtering down to information that is more likely to come from individual and local sources. The study traces through four rounds of analysis where we evaluate different segments of the data as social media communications change throughout the course of these fires.

## **CHAPTER 7. Mastering Social Media**

### **7.1 Study Summary**

We report on the social media communications and work practices of the Jefferson County Type III Incident Management Team during the September 2013 Colorado Floods. In this case study, we examine flood-related communications across three platforms: Facebook, Twitter, and the team's blog for insight into how this innovative team coordinated their communications to meet the information needs of a community outside of the media spotlight. Using a mixed method approach of interviews and social media content analysis, we describe their online behaviors in relation to the needs of the emergency response as a whole. We report on adaptations to their work practice that allowed them to extend traditional communications with social media to create an integrated communication plan. Finally, we look to the team's experiences for direction in how to use social media in emergencies generally.

The text contained within Sections 7.1 through 7.6 is a reprint of St. Denis, L., Palen, L. & Anderson, K (2014). Mastering Social Media: An Analysis of Jefferson County's Communications during the 2013 Colorado Floods. In *Proceedings of the Conference on Information Systems for Crisis Response and Management (ISCRAM 2014)*. This reprint appears here with the permission of my co-authors, Leysia Palen and Ken Anderson.

**This study addresses research question RQ2.**

### **7.2 Introduction**

Information and communication technology (ICT), and specifically social media, provide additional means for people to receive information about emergencies beyond mass media and public meetings. Members of the public use it to communicate and share information with friends and family, gather timely and relevant information, seek assistance, and to provide assistance to others (Palen & Liu, 2007; Shklovski, Palen, & Sutton, 2008; Palen, Vieweg, Liu, & Hughes, 2009, Qu, Wu, & Wang, 2009; Heverin & Zach, 2010; Starbird & Palen, 2011; Perng, Büscher, Halvorsrud, Wood, Stiso, Ramirez, &

Al-Akkad, 2012). However, when emergency response groups establish social media accounts, members of the public attend to them and pass on their posts as credible sources for the latest emergency information (Starbird & Palen, 2010). The public engages directly with emergency responders who are actively online, posing new opportunities and challenges for such groups (Denef, Bayerl & Klaptein, 2013, Hughes, St. Denis, Palen & Anderson, 2014).

However, public adoption of social media has far outpaced emergency management's capacity to adapt to it internally themselves. Relatively few groups use social media, in spite of a demand for "best practices" around social media use for emergency management. Latonero and Shklovski (2011) examine how change happened in a fire department by way of a social media champion. A recent study of the online communication practices of the 840 fire and police departments within a 100 mile radius of the 2012 Hurricane Sandy landfall shows that a little more than a third of the departments (37%) had an account on any one of the online tools studied (Web, Facebook, Twitter or Nixle). Furthermore, use *during* and immediately after the disaster was even dramatically lower: only 7% used Twitter and 25% used Facebook (Hughes, St. Denis, Palen, & Anderson, 2014).

This low level of use is likely due to a number of factors. Emergency management groups may lack official support for the use of social media, and with it, the resources for the necessary staffing. This may take the form of policies and procedures that prohibit the use of social media. It may also be that formal command and control procedures make the use of social media difficult or impractical (Palen & Liu, 2007). Without personnel resources that are free during emergencies, groups may be unable to communicate with the audience following they build up during times of peace (Hughes & Palen, 2011, Hughes & Palen 2014). Additionally, social media practices during emergency response are perceived as sufficiently different than more routine forms of public communication. There are few role models for how to use social media effectively during an emergency. Experimentation comes at a cost when costs are already high.

Furthermore, though such groups are increasingly seeking “best practices” for social media use, we wonder if such an idea is somewhat premature. We question whether “best practices” overconstrains use during a phase of technological change that is inherently experimental. What we saw in Sandy shows how over-determination and rigidity of practice ultimately gets overruled by one’s own experiences: The Fire Department of New York (FDNY) notably changed their practice from first stating a clear policy that social media could not be used for 911-type reports, to conceding the need when 911 was overloaded at the height of the storm (Hughes, St. Denis, Palen, & Anderson, 2014). Other emergency practitioners are experimenting with use of Virtual Operational Support Teams (VOST) to help manage the demands of social media interaction and monitoring during an emergency (St. Denis, Hughes, & Palen, 2012). These teams are formed through a flexible structuring of a distributed, skilled, pre-qualified often volunteer workforce.

We continue to explore these issues in recent events that affected the Denver Metro Front Range region of Colorado in September 2013, when the region was afflicted by dramatic rain storms and subsequent flash flooding. We focus in on how one county—Jefferson— somewhat outside the worst affected region conducted their communications work: though the county had damage, the amount was not nearly that of its neighbors. As an experienced county-level team for the fourth largest county in the state, they were able to put their communications expertise to a rather new problem: reaching their afflicted constituents and seeking mass media attention to then secure the state and federal level attention they also needed to get a formal disaster declaration. Because other counties were far more affected, the mass media attention was not on Jefferson County. These demands, their existing experience, and that their risks for flood damage were somewhat reduced created a set of conditions under which they could carefully experiment with new forms of social media use. In the end, they and others have described their communications practice, which included a fairly deep integration of social media, as highly effective, and this situation, though considered critically, is one we approach as a “height of practice” case.

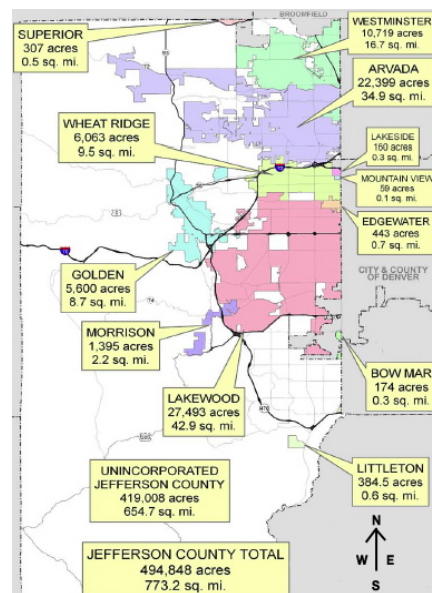


## 7.3 The Study

### 7.3.1 The Jefferson County Type III Incident Management Team

#### 7.3.3.1 Overview

Jefferson County is the fourth most populous county in Colorado with an estimated population of 545,358 (2012 US Census Results) covering 773 square miles (see Figure 1). It is located just west of the City and County of Denver and directly south of Boulder County. The northeastern portion of Jefferson County incorporates several Denver Metro suburbs including Arvada, Wheat Ridge, Lakewood, Golden, and Morrison. The western and southern portions of the county contain the less-populated, unincorporated lands and communities in the foothills west and southwest of Denver.



**Figure 13: Jefferson County.**

The Jefferson County Type II Incident Management Team (IMT), part of the Jefferson County Sheriff's Department, manages all major incidents in Jefferson County. This team is made up of full-time staff from the Sheriff's office and county personnel that join the team during an activation.

### 7.3.3.2 Use of Social Media in Recent Disasters.

The Jefferson County IMT first experimented with the use of social media during the 2011 Indian Gulch Fire, but they were not able to launch a full social media plan because of friction with the federal-level incident management team. The first full trial of what they now call their “Integrated Social Media Strategy” came later during the 2012 Lower North Fork Fire. The fire was originally started as a prescribed burn that spread when a cold front with 50 mph winds passed through the area spreading it across containment lines to receptive fuels where it ignited the wildfire. It burned 4,140 acres and resulted in three citizen fatalities, loss or damage to 25 homes and numerous outbuildings and the evacuation of thousands of residents. The IMT used a blog and Twitter account as the primary communication platforms during this incident. They also created a Google map to share information about the fire perimeter, property damage, and the resource center for evacuees. They used Facebook to share information, but the content was not managed directly by them. The same tools and strategies were used again in the 2012 Bluebell Fire and the 2013 Lime Gulch Fire.

By the time the JeffCo IMT was activated for the 2013 Floods, the subject of this paper, they added Facebook to their “Integrated Social Media Strategy,” and were in the process of formalizing a standing VOST team (St. Denis, Hughes, & Palen, 2012). The accumulated experience and their interest in adopting the VOST protocol demonstrates a progressive orientation toward social media use going into the 2013 Colorado Floods.

### ***7.3.2 The 2013 Colorado Floods & their Impact on Jefferson County***

The storm began on Monday, September 9<sup>th</sup> with steady rainfall forecasted throughout the week. On Wednesday, September 11<sup>th</sup> the storm intensified producing widespread flash flooding in the Denver-Boulder metro area. Mandatory evacuation orders were issued for parts of Boulder County—JeffCo’s neighbor to the north—including Four Mile Canyon, Jamestown, and portions of the University of Colorado Boulder campus. Residents in affected areas were encouraged to shelter in place. Residents of some towns and cities in Boulder and St. Vrain County were isolated because of severe road damage. The

National Guard evacuated residents and pets from mountainous areas by air. FEMA approved a Major Disaster Declaration on Saturday, September 14<sup>th</sup>.

In Jefferson County, directly south of Boulder, storm conditions also caused damage, though to a lesser extent than their neighbors to the north. On September 12<sup>th</sup> at 6:24 am the Jefferson County Sheriff's Office activated their "Emergency Blog." Flash flood conditions in Coal Creek Canyon washed out portions of the road and damaged the natural gas supply. As the heavy rains continued, Bear Creek overflowed its banks flooding downtown Evergreen. Leyden Creek in Arvada overflowed its banks causing widespread flooding for the City of Arvada. Affected residents were notified via CodeRed, a notification system, and advised to "shelter in place," a safe option, but one that can limit access to information if power is out, or cellular reception is limited.

### **7.3.3 Method**

We conducted interviews with the JeffCo IMT less than 3 weeks after the height of the event. We conducted an initial interview with a member to gather information about their history of social media use and an overview of their use during 2013 Colorado Floods. We transcribed this interview and reviewed it to identify key topic areas for a group interview with members of the IMT, which happened one week later. During the group interview, all but three of the 8 members of the IMT were present. We conducted a group interview at the Sheriff's office, focusing on five topical areas: 1) how they used social media during the 2013 Colorado Floods, 2) motivations for their use, 3) how social media is affecting communications with mass media and public, 4) integration of social media into formal response procedures, and 5) details about their employment of a Virtual Operational Support Team (VOST) into their future response. The group interview was video- and audio- recorded and transcribed.

#### **7.3.3.1 Data Collection and Coding**

We collected and analyzed the data from each of their online and social media accounts during the 2013 Colorado Floods. This included the Jefferson County Sheriff's Office Facebook page, the official Twitter account: @jeffcosheriffco, the VOST Twitter account: @JeffCoVOST, the Jefferson

County Sheriff's Office Emergency Blog: <http://jeffcosherriff.blogspot.com>, the 2013 Colorado Floods Map, and the form used to gather photos and videos from the public. We also had access to the archive of the JeffCo VOST Skype chat to identify key communications from the VOST monitoring efforts.

Collection began on Thursday, September 12<sup>th</sup> when the first flood-related posts appeared, and ended on September 19<sup>th</sup> timed with the last blog update. The *2013 Jefferson County Flood Data Set* includes 115 blog posts, 361 tweets, 157 Facebook posts, and 11 Facebook albums containing 731 photos. We also analyzed the public's engagement on the JeffCo Facebook page and with their Twitter accounts. The *2013 Jefferson County Public Engagement Data Set* included 5125 Facebook likes, 1027 public Facebook comments, 169 Jefferson County Sheriff's Office Facebook comments, 54 public tweets and 49 reply tweets from the Jefferson County Sheriff's Office Twitter account.

Each post and tweet was coded for relevancy to the flood and the content was coded using a set of 8 topic categories and a set of sub-categories. The coding scheme was developed inductively with multiple passes over the data before settling on the final scheme. The first author coded all the data for consistency. The sub-categories allowed deeper analysis within each category. Five of the categories relate directly to emergency communication and emergency work. The remaining categories look at how the accounts are interconnected with one another and the relationship to other sources of information and the public (see Table 11).

Category	Description
Hyperlinks & Explicit References	Hyperlink connections to sources of information during the storm or explicit references to other sources of information Sub-categories: Contact Information, CodeRed, Emergency Blog, External Sources, Facebook, Flood Map, Photo/Video, Submission Form, Internal Web
Online Engagement	Captures all types of online interactions such as mentioning other online accounts, reposting or retweeting official sources of information, sharing information in an online format (e.g. photos, videos, interactive maps), or engaging in direct conversation with the public through online tools Sub-categories: CodeRed, Emergency Blog, Facebook, Flood Map, Photo/Video, Reply, Request, Retweet, Thanks, Twitter (including follows and mentions),
Protocol	Descriptions of official emergency protocols (e.g. 911)
Public	Publicly generated comments or replies Sub-Categories: Comment (general), Feedback, Information Sharing, Reply, Thanks
Rumor	Messages addressing misinformation or rumor
Safety	All messages related to public safety Sub-categories: Flood, Fraud, Gas, Road, Water
Services	All message related to disruptions of utilities of government services Sub-categories: Natural Gas, Water Supply, US Mail
Status	Updates on changing conditions as a result of the storm Sub-categories: Closures (road, parks, schools), Emergency Response, Evacuation, Flood Conditions, Natural Gas, Resources, Water Supply, Weather

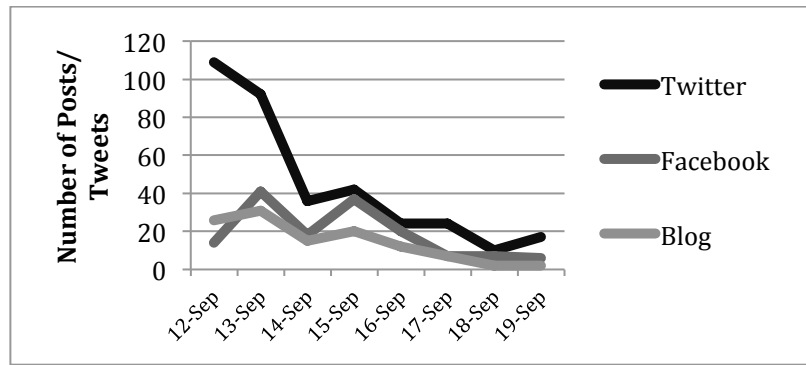
**Table 11: Content Categories.**

#### 7.4 Findings: Quantitative Descriptions of Use

Each of the online tools serves a unique function in their communication plan. The team summarized it this way in their interview:

*Twitter is for delivering the news, Facebook is where we talk about the news, and the blog is where we provide the details.*

The JeffCo IMT produced a total of 619 messages over eight days: Twitter messages outnumbered Facebook and the emergency blog each day (Figure 14). This is consistent with prior research findings that when Twitter is used for sharing emergency information, the number of messages tends to outnumber the volume of communication on other online tools (Hughes, St. Denis, Palen, & Anderson, 2014). This difference was the most pronounced during the first two days of the storm when conditions were the most volatile. Half of the messages (313) were sent on September 12-13; 64% of these were tweets.



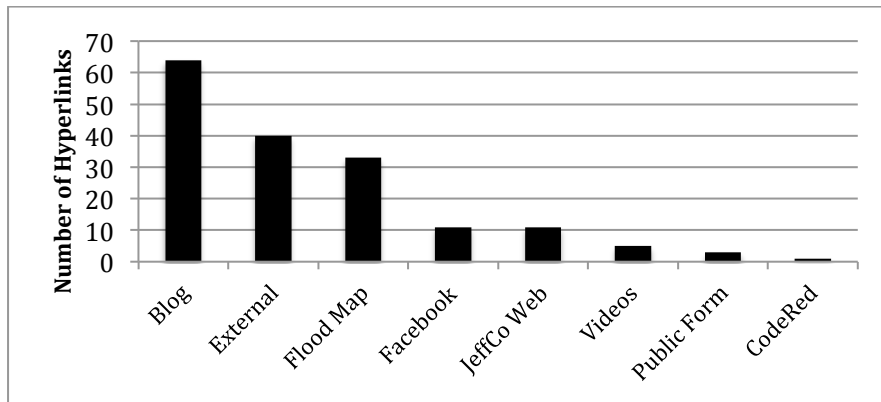
**Figure 14: Summary of Daily Communications during the 2013 Floods.**

#### ***7.4.1 Twitter as Real-Time Notification Tool***

The IMT reported that Twitter is unmatched in terms of getting the information out quickly to a broad audience. The Jefferson County IMT used multiple strategies for reaching their constituents: the use of relevant hashtags, frequent messages in the early days of the storm helped to establish a presence on Twitter, and hyperlinks within these tweets helped to establish the blog, Facebook page and map as valuable sources of information.

Hashtags are a convention developed in emergencies to allow people to monitor communications from multiple sources surrounding an event (Sutton, Palen, & Shklovski, 2008). Nearly all tweets generated by the JeffCo Twitter account (with the exception of retweets and direct replies) contained at least one hashtag. There were 27 different hashtags used in all, but a small set of these were used for the duration of the floods. The primary hashtags were #cccf an abbreviation for Coal Creek Canyon Flood (185 times), #jeffcoflood (175 times), #jeffco (49 times), and #coflood (109 times).

A limitation of Twitter is the 140 character tweet limit. Often URLs are embedded within tweets to link to detailed information. The JeffCo Twitter dataset contained 169 links (47%). As we see in Figure 15, the largest number of links is to the blog.



**Figure 15: Hyperlinks Embedded in JeffCo Tweets.**

#### ***7.4.2 The Emergency Blog as the “Information Backbone”***

The JeffCo IMT refers to the Emergency Blog as the “information backbone” of their communication plan. They describe it as a “living, breathing press release” that is continually updated as new information comes out. The content focuses exclusively on emergency updates and coverage generated by the PIO team. There is no facility for public comment, making the blog more formal than their other online tools. The format of the blog allows for an expanded narrative and deeper content than the other tools. Many of the posts have the format and style of a formal press release while other posts have more of a journalistic quality—reporting on a story from the incident management team’s perspective.

The blog acts as an information hub providing direct links to all sources of information: the Facebook page, Twitter, CodeRed, the Jefferson County Government website, a community resource list, and contact information for the Jefferson County Sheriff’s office.

#### ***7.4.3 Community Engagement on Facebook***

The JeffCo IMT managed the content of the event’s Facebook page for the first time during the 2013 Colorado Floods (other groups were responsible for Facebook communications during events in 2011 and 2012). The team reports that they were impressed by the value that it added:

*“We can have conversations with the citizens, and they with one another, in a public forum for all to see. Through this type of dialog you start to understand your community and what is important to them. That is invaluable”.*

There were 1027 public comments and 5125 public likes distributed across the 150 flood related posts, 11 photo albums and 731 photos. These likes and comments were produced by 1761 unique user names.

Our coding scheme focused primarily on the questions and comments that were directed to the sheriff’s office, but that is only a small part of the communication on the Facebook page. We counted a total of 163 publicly generated questions on the page, but only about 87 of these were emergency response specific. The IMT was diligent about monitoring and answering these questions, but the public also actively participated. This was particularly true when the discussion was about information in photographs. Two of the albums contained a series of aerial photos, and the Sheriff’s department had limited information about where they were taken. Members of the public provided numerous replies pointing out landmarks and providing location-specific information. We counted a total of 98 public replies to questions, 77 informational posts, and 18 providing community feedback directly to the Sheriff’s department. This accounts for 35% of the public comments.

The remaining 65% of public comments demonstrate the value of the page as a forum for public conversation surrounding the floods. They used the page to check in with one another and report on personal welfare, offer sympathy, prayers or help to one another, and to talk about the effects of the floods on their community. In the album “Coal Creek Canyon Flood, September 12” we observe residents of the Canyon checking in with one another. As an illustrative example, in one photo there is an open mailbox full of mail in the middle of the flooding. The owner of the mailbox posted a message to a neighbor sheltering in place, asking them to retrieve the mail or shut the box. The neighbor replies that it was not safe to go to the box, and the next morning replies again saying that the box is not longer even there and offers additional help.

Intermingled within these comments are other neighbors’ comments and even a little humor. These sorts of conversations illustrate the value of the page *as a place* to come together as a community. From



the response perspective, these conversations provide direct insight into what is going on within the community.

#### ***7.4.4 The Importance of an Interactive Public Information Map***

The JeffCo IMT Team created a Google map to provide public safety information; they explain that this kind of map is different than a hazards map that emergency professionals use and is tailored to usability. The team reports that geospatial representation is critical for communicating to the public. If they provide a good map, they find that phone volume calls decrease. The map is interactive in that it allows the viewer to navigate and zoom. When other blog sites embed it, it updates automatically with their changes, which makes it additionally authoritative.

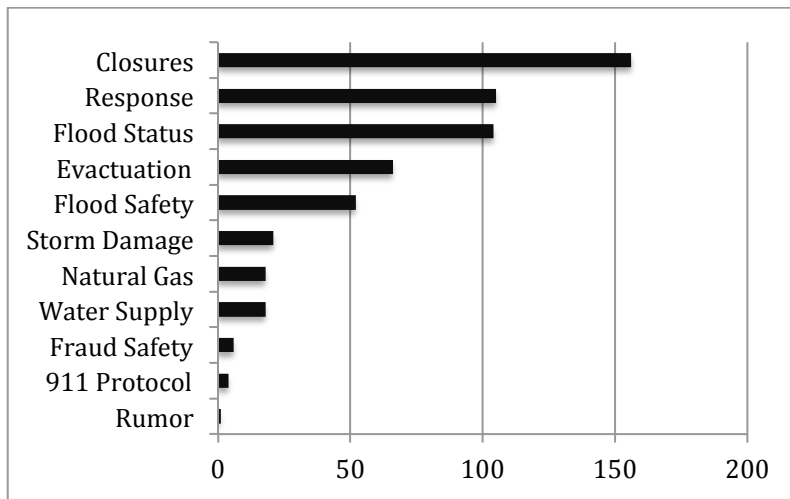
#### ***7.4.5 Gathering Photos and Videos from the Public***

On September 14, the Jefferson County IMT published a Google Form requesting photos and videos of flood damage via a series of tweets. The form was integrated into the blog and posted four times to the Facebook page. The form standardized the submission process and captured source of photo/video, ownership, where taken, when taken, and optional contact information. They received about 57 responses to their request through either email or the form, which they used to document the severity of the flood conditions in Jefferson County. Part of the aim was to secure state and federal disaster declarations. Public response was a critical part of this process. The photos were posted in a separate album on Facebook to make them public.

#### ***7.4.6 Emergency Work***

Figure 3 shows a summary of the content distribution across the emergency blog, Facebook page, and Twitter by the primary responsibilities of emergency work as described in our coding scheme. Posts if necessary are assigned multiple content categories. The largest number of them related to closures where 89% of these messages referred to road closures. The smallest categories are fraud safety, 911 protocol, and rumor. We interpret this volume as an indication that rumor mitigation, fraud, and

bypassing of protocol were not difficult to manage on social media during the floods. The Jefferson County IMT report that they were aware of rumors, particularly relating to resilience of local dams and water supplies, which they addressed through updates.



**Figure 16: Number of Posts by Category Across the Emergency Blog, Facebook, and Twitter Accounts.**

#### **7.4.7 VOST**

Just before the 2013 Floods, the IMT was in the process of forming an official VOST (St. Denis, Hughes, & Palen, 2012). With the team members defined, but not trained, they decided to deploy the team for monitoring and message amplification purposes only. The VOST was active during the eight days of the activation, and provided extended social media monitoring coverage to the IMT. They looked for emergency requests by the public, as well as the spread of misinformation. The VOST made number of communication “catches.” The most notable of these were fraudulent tweets asking for donations for the Colorado National Guard troops. The IMT then counteracted this misinformation across their online platforms.

## **7.5 Discussion**

### ***7.5.1 An “Integrated Social Media Plan”***

The Jefferson County IMT refers to the coordinated content of their online tools as an “integrated social media plan.” Although the content is similar, each platform is used for slightly different purposes. The emergency blog is activated only in an emergency and serves as the “information backbone” such that all communications going out on other channels refer back to it. Twitter provides real-time notification to the public as details change. Facebook is used as a persistent forum so that members of the community can comment on information, ask questions, and provide new information to the IMT team and the general community. The emergency map provides concise visual geospatial information. A Google form helped solicit information in a streamlined fashion from their constituents. They expanded their immediate team to include the newly formed VOST, which focused on extending their monitoring coverage.

### ***7.5.2 A Community Sheltering in Place***

Due to the severe flooding and dangerous conditions, residents in communities impacted by flooding were instructed to shelter in place. Widespread road closures made travel difficult or impossible. During the height of the storm, mass media coverage was focused primarily on the events in Boulder County and so Jefferson County residents could not get information that way. These conditions created a public communication challenge that is different than in the wildfires that more typically affect this region, where people must evacuate, and therefore congregate in public areas that public information officers can reach. The IMT reports that their social media plan helped them bridge this new information gap.

### ***7.5.3 “We are Our Own Media”***

In addition, their plan helped them be “their own [mass] media.” The Jefferson County IMT found themselves supplementing the limited media coverage and soliciting information from the public to

provide “homegrown” coverage of the storm. Because the media were focused on areas that had even greater impact, and because there were many locations they couldn’t reach, the IMT employed their public information officers to act as journalists who reported their stories on Facebook page and the blog. This type of embedded reporting is becoming increasingly common during emergency response (Hughes & Palen, 2011)

An emergency blog post on September 15<sup>th</sup> titled: “Neighbors Helping Neighbors: Colorado National Guard on the Job” illustrates this nicely. Through the use of photos and narrative, the post tells the story of the Colorado National Guard helping residents of Coal Creek Canyon to protect their homes from flood waters. Photos show soldiers and neighbors working side-by-side building sandbag barriers. The format of the story is a clear departure from purely fact-based emergency communication:

*Across the counties of the Front Range and Eastern Plains, the story is the same: neighbors helping neighbors, whether uniformed or in hip waders or flip flops. Amid destruction and tragedy, communities pull together to overcome whatever nature hurls at their doorsteps.*

This sort of coverage provides an inside perspective that wouldn’t have been possible otherwise.

#### **7.5.4 Social Media Communication and Mainstream Media**

The IMT team reports that maintaining personal relationships with mainstream media contacts remains critical, but most of their emergency communication is now done through social media. During the floods, they were not contacted by the media and they did not hold press conferences, yet the information they were posting online was being picked up and shared across mainstream media. Instead, all the local media agencies follow them on Twitter. The IMT reports that they observe their messages being shared verbatim across the local news crawlers within minutes of sending a tweet. They also uploaded video footage to YouTube and in some instances it aired on the local news. This type of behavior illustrates a shift in communication that minimizes the time it takes to get information to the public on both social media and mainstream media channels.

### **7.5.5 Balancing Command and Control with the Need for Immediacy**

The communication plan has evolved to adapt to meet the information demands of the public. In the words of one of the IMT team leaders:

*“The old days of ... having a press conference in the morning and sending out a press release and having a press release in the evening, those days are long gone. The public will not stand for it. When information is so readily available in the rest of their lives and [they] have a catastrophic event going on in their lives – it better be even more readily available!”*

Making information available this quickly requires a more flexible organization within the command and control structure with more autonomy for the public information team. They establish this shift in communication style with the incident commander at the start of the activation.

*“I think one of the keys to the success of this team is the ability of the team to communicate very proactively without seeking authorization from a higher authority. Under classical incident command everything that goes out has to be reviewed by the incident commander and that system does not work because you would have to be in there literally every 5-10 minutes and our team since it’s inception has had the authority to proactively push information out and, only in the most serious of consequences, fatalities and things like that, do we go through that process where it’s not time-sensitive, where it’s not life-safety, evacuation notices and so that is very different.”*

This shift requires a high level of trust between the incident commander and the incident management team, but it also requires a high level of trust between the team members and an efficient, open communication style. The team’s working style has evolved so that they all work in close proximity to one another around a table. This allows them to share ideas easily and develop a shared awareness, much as we see in safety-critical mission control systems (Heath & Luff, 1992; Watts, Woods, Corban, Patterson, Kerr, & Hicks, 1996).

### **7.5.6 Monitoring Public Communication**

The Jefferson County IMT believes that if a group is going to use social media,. they must participate and interact in the larger conversation. The public expects a group with a twitter presence to monitor their questions and concerns, and to respond. However, this kind of work is far more taxing than to simply push out messages.

A team could choose to ignore public communications and instead publish statements making it clear that the channel is not being monitored. However, the reality is that, despite clearly defined emergency protocols, requests for emergency assistance are being sent on social media channels (Hughes, St. Denis, Palen & Anderson, 2014). For the Jefferson County IMT, they chose to do their best to monitor public communications and are part of a growing emergency response community that has chosen to do so. During the 2013 Colorado Floods, there were two incidents needing immediate response that were found during the monitoring effort.

## **7.6 Conclusion**

The Jefferson County Type II Incident Management Team is in the minority of groups in the emergency response community that are developing and implementing a wide-berth strategy for integrating social media into their practices. They refer to it as their “Social Media Strategy” but clearly define it as an extension of their traditional communications. They plan to continue to hold press and citizen briefings and to maintain information within the community on the “trap lines” during their more typical wildfire hazards—the physical perimeter around a wildfire region that the public cannot cross. The explicit use of the phrase in the strategy “social media” is an indication of the novelty of what they are doing. From a broader perspective, we see that this team is developing an “Integrated Communications Plan” that extends traditional practice to meet changing information expectations through a wider range of options.

The 2013 Jefferson County Flood communications highlight new possibilities for emergency response communication through ICTs. Their use of social media as an extension of their traditional practices suggest that there are opportunities to communicate quickly and efficiently with a broad audience. There are opportunities to craft the story and provide richer coverage—an opportunity that proved to be really important in circumstances where there is an information dearth. The public engagement on their Facebook page and on Twitter is an indication of public receptiveness to this style of

communication and growing expectations that responders provide some means of direct, public communication.

We should be looking to innovators such as these to see what lessons can be learned and understand the circumstances where they can be applied. Through these experiences we can begin to understand the role that social media could potential play in the communications and conversation between emergency responders and the public.

## **7.7 Reflections on the Action Research**

The Jefferson County Type III Incident Management Team (JeffCo IMT) displayed a level of mastery that proved really critical during the storm. The relationships they had with both the media and with local residents laid the foundation for effective communication during the storm. I was intrigued by how they were able to, as one member put it “provide the most local of local news”. Within this team, public engagement is intentional, not incidental. I have not seen this type of coverage being generated by any other organization. The closest parallel is recent work of Kris Eriksen, Public Information Officer for Portland, during the 2014 Two Bulls Fire in Oregon. She worked with a local PIO to produce “Updates from Nate” during the fire to provide personalized coverage at the local level. It is too early to predict, but I would anticipate that as emergency response organizations get comfortable with communicating on the public stage created by social media, we will see a more personalized level of coverage and more community relationship building like these examples.

I have worked with the COVOST across multiple non-emergency incidents, providing aggregated summaries as part of the after action reports for these incidents. They are interested in both the aggregated summaries and also the filtering work detailed in Chapter 8. I reviewed findings from these studies with them, but there have not been any emergency responses in Colorado over the course of my analysis. Based on my experience during the 2013 Colorado Floods, getting at the individual and local content is a high priority. The team leader for the JeffCo VOST identifies this as a primary concern with social media

monitoring. If I had had the opportunity, I would have like to have worked through a round of analysis with this team.



## **CHAPTER 8. Use of Aggregated Twitter Data to Support the Monitoring of Public Social Media Communications During an Incident**

### **8.1 Study Summary**

This study looks at the use of aggregated Twitter data across four wildfires in eastern Washington State to support the ongoing social media monitoring efforts of the public information teams and VOST teams responding to these incidents. The initial phase of analysis occurred during the 2014 Carlton Complex Fire in Okanogan County, Washington. Post-hoc review and subsequent data analysis led to the development of a strategy for identifying a segment of tweets likely to contain information from individual and local sources. This strategy is based on characteristics of the source of the tweet and embedded content rather than textual content of the tweet. The filtering strategy was developed and refined on the 2015 Carlton Complex data set and repeated the following summer during the 2015 Wolverine Fire, the 2015 Chelan Complex, and the 2015 Kettle Complex Fires in Northeastern Washington.

**This study addresses research questions RQ3 through RQ5.**

### **8.2 Introduction**

#### ***8.2.1 Microblogging in Disaster***

Twitter, a microblogging platform, has been one of the most widely used and rapidly adopted tools for sharing information in disasters. It is a form of lightweight computer mediated chat that allows users to send short messages called *tweets* to anyone subscribed to their stream. By default, Twitter accounts are publicly visible. Users can view tweets from any publicly visible account or they can subscribe to another user's stream by *following* them. Twitter does not require reciprocity and so a user has both *followers* who read them and those they are *following* themselves. Tweets are publicly visible by default and content is searchable, allowing twitterers to look for tweets related to a particular topic or event across the network. This ability to search content and to follow new streams allows users to quickly adjust the content displayed in their timeline in response to changing events or interests. Conventions

such as use of the hashtag character ‘#’ developed within the context of disaster (Messina, 2007) as a way to associate tweet content with an event or topic. Tweak the Tweet (TtT) (Starbird & Stamberger, 2010) extended this idea into a disaster-specific syntax that supports automated detection of key pieces of information. Other conventions within Twitter have evolved to support conversational exchange and collaboration (Honeycutt & Herring, 2009). A sizable body of crisis informatics research looks at how Twitter has been used across a range of events around the world and how it has been adapted to support a variety of emergent response efforts (Acar & Muraki, 2011; Qu, Huang, Zhang, & Zhang, 2011; Sarcevic, Palen, White, Starbird, Bagdouri, & Anderson, 2011; Starbird, Palen, Hughes, & Vieweg, 2010; Starbird & Palen, 2010; Starbird & Palen, 2011; Sutton, 2010; Vieweg, Starbird & Palen, 2010).

There are no formal curation mechanisms in Twitter. Organization occurs from the bottom-up through direct manipulation of the data itself. This occurs through the distribution of new information, the redistribution of information, or direct manipulation of previous content. These interactions work to continually shape the information space while simultaneously driving the need for ongoing interaction and re-organization as people engage with this new information (Starbird, Palen, Hughes, & Vieweg, 2010). In this complex, heterogeneous, and unwieldy information environment, ongoing interactions draws the most relevant and timely information into the foreground. Without retransmission, Twitter communications die off as other topics of conversation and information emerge.

Two studies look closely at bottom-up organizational processes within Twitter (Starbird & Palen, 2010; Starbird, Palen, Hughes, & Vieweg, 2010). The authors observe that organizational activities take three primary forms: *generative* information production interjects new and original material into the Twitter informational eco-system, *synthetic* information production integrates outside knowledge into tweets, and *derivative* activities direct others to valuable information (Starbird, Palen, Hughes, & Vieweg, 2010). *Generative* information derives from two different orientations to the data: 1) autobiographical narrative such as first-person observations and status updates or 2) adaptation of information from other sources into the discussion typically in the form of commentary. They found that generative content occurred in only 10% of the overall sample, but 80% of these were produced by individuals local to the

hazard. Synthetic information production occurred in approximately 25% of the overall sample, with local and national media using this method at the highest rates to bring information from outside sources into the discussion space. Derivative informational behaviors (retweets, @-mentions, re-sourcing, and embedding of URLs) occurred in 75% of the overall sample and although significant, at lower rates in local-individual user streams. The process of retweeting acts as a recommendation system passing existing information along to followers (Starbird & Palen, 2010). Non-local users tend to retweet information related to high-level or journalistic accounts of the events whereas local users are more likely to retweet information directly related to the emergency.

Research shows that information production and tweet practices vary based on role, relationship and proximity to the hazard, and the circumstances of the hazard itself. In general, tweets related to disaster or mass convergence events are focused on information broadcast and information brokerage in comparison to a general sample of tweets (Hughes & Palen, 2009; Qu, Huang, Zhang, & Zhang, 2011). The content of tweets is influenced by a number of factors including type of incident, the specific circumstances, composition of the impacted population, and phase (Vieweg, Starbird, & Palen, 2010).

### ***8.2.2 Social Media for Emergency Response – VOST Practices***

The core function of a VOST team is to provide situational awareness and monitoring resources to the activating agency. Included in this is the *gathering of key questions and concerns, sharing of answers and resources (as approved) and the archiving of activity across social media if requested* (from VLC Meeting Summary 5/25/2012). VOST teams monitor specifically for information about what is happening within the impacted community, for issues and concerns, identification of information gaps, unsafe conditions, people in need of resources or assistance, blame, criticism, misinformation and rumor. My observations of the practical aspects and challenges of social media monitoring are drawn from time spent as a participant observer on multiple VOST teams (see methods chapter), my interactions with members of the VOST Leadership Coalition (VLC) and the documents produced within the Social Media in Emergency Management (SMEM) community.

Social media monitoring is typically focused on monitoring comments posted to public-facing social media accounts for the incident (typically Facebook and a blog), Twitter, popular photo and video sharing sites (e.g. Instagram and YouTube), and any specific sources identified by the activating agency. If resources permit, team members also look at comments posted to mainstream media sites. Monitoring the public-facing social media accounts is the most straightforward because there is often a built-in notification mechanism. The search for relevant information on other platforms is often more difficult and error prone. The teams keep track of relevant search terms, hashtags, and geo-location codes in the workbook and monitor based on these, but some portion of content goes undetected, especially if the volume of social media communications is high.

Twitter, in particular is both an optimal place to look for breaking information and a uniquely challenging space to monitor. As discussed in the introduction, the sheer volume of information that is created through the generative, synthetic and derivative activities both continually shapes what is relevant in the moment, but also creates an extremely noisy and unwieldy information space in need of continual reorganization and interpretation (Starbird and Palen, 2010; Starbird et al, 2010). In addition, embedded (synthesized content) often appears in the form of a shortened hyperlink, making it difficult to see what a tweet contains without click through the link, an activity that can be prohibitively time consuming.

My research goal was to explore how aggregated Twitter data could be used during an event to organize and make sense of this unwieldy information space.

### **8.3 Study 8A: The 2014 Carlton Complex Wildfire, Washington State**

**This study addresses research question RQ3.**

The first phase of this study began during the 2014 Carlton Complex Wildfire in Washington State (see Appendix - Incident 11.4). The Portland National Incident Management Organization (NIMO) Team, a federal all hazards team, took command of the fire on the evening of July 19<sup>th</sup>. My focus during this initial phase was to categorize frequently occurring sources – the Twitter accounts and sources of embedded information that showed up the most frequently within the data set, so that I could aggregate and analyze the information across these segments of information (Table 12).

#### **8.3.1 Data Collection**

Data collection began on July 17<sup>th</sup>, 2014 as soon as I received word that Portland NIMO was responding to the fire and the VOST team had been activated. The initial collection terms included variations on the complex name and the names of the four fires contained in the complex. As events unfolded I added place names related to evacuation orders and the term #firestorm2014 being promoted by the media. The data collection from July 17<sup>th</sup>, 2014 to July 30<sup>th</sup>, 2014 contains 24,319 tweets.

#### **8.3.2 Methods**

##### **8.3.2.1 Data Processing**

Tweets were extracted from the data collection at daily intervals during the fire. The extract process was run at the end of the day so that a summary from the previous day could be provided to the PIO team and the VOST at the start of the next day. A Python script was used to expand any shortened uniform resource locators (URLs) embedded in the tweets. Refine, a data-cleaning tool, was used to identify and categorize the most frequently occurring *unknown* Twitter accounts and URL domains (Table 12). These values were then added to a reference table. Once the categorization process was complete, a second Python script formatted the tweets for analysis in Tableau, a data analysis and visualization tool. In total, I categorized 209 URL domains and 354 Twitter accounts using the categories in Table 12.

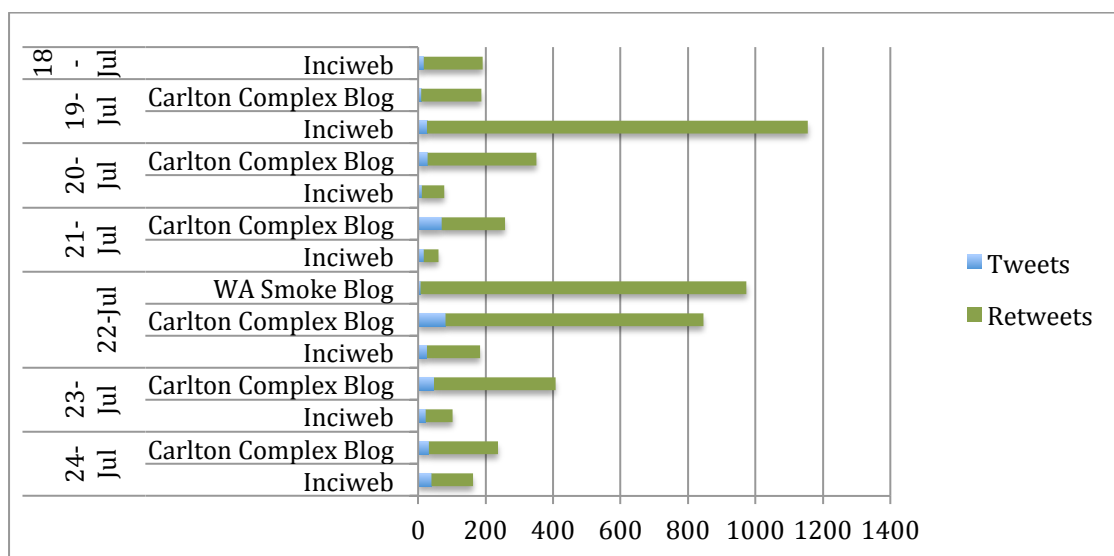
Source Category	Description
Official Information Source	Account or site providing official information and updates about the fire. This includes emergency services, fire, civic and weather service sources.
EM/Fire Related	Account or site of an individual with a background in emergency response or officially part of the Carlton Complex response. This includes accounts for members of the VOST
Mainstream Media	Account or site associated with mainstream media, individual journalist or media personnel
News Aggregator	Not associated with mainstream media but used primarily for aggregation or rebroadcast of mainstream media coverage across a range of news topics
Spam/Other	Any account or site generating content unrelated to the incident (noise)
Social Media	Social media sites (e.g. Facebook, Instagram)
Fundraising	Fundraising sites or accounts (e.g. GoFundMe)
Individual	Account or site of an individual – further classified by geography and relationships to the fire (Directly Impacted, Local to Fires, Washington Resident, Pacific Northwest, & Unknown)
Business/Organization	Account or site of a business or private organization – All local businesses and organizations were flagged
Unknown (default value)	Not yet categorized

**Table 12: Twitter Account and URL Domain Categories.**

#### 8.3.2.2 Data Analysis & Reporting

Tableau was used to produce daily summaries that looked at Twitter activity both in general and by category. Where appropriate, analysis was done at the individual tweet, link, or URL domain level.

After the fire, the daily summaries from July 17<sup>th</sup> to July 30<sup>th</sup> were compiled into a final report along with an overall summary.



**Figure 17: Comparison of Official Accounts by Day**

### 8.3.3 Results

#### 8.3.3.1 After Action Review (AAR)

I met with the PIO team via Google Hangouts during the first week of October to review the final summary. All three members of the PIO team participated in this session. Audio from the meeting was recorded and transcribed. Due to the intensity of the fire, this was our first meeting to review the content of the reports.

The aggregated data and categorization facilitated side-by-side comparison within specific segments of the data such as official information channels, social media, and mainstream media coverage. The reports were particularly useful for looking at the effectiveness of official information channels and communications. For example, the Carlton Complex Blog was created in the afternoon of July 19<sup>th</sup> and the account level graph showed how quickly the blog surpassed Inciweb in terms of retweets (Figure 17). Information at the tweet level helped identify which information was gaining the most traction with the public. For example the spike for the *WA Smoke* blog was related to an air quality report. Social media summaries were also an important resource for the VOST, however retweets often reflected content with broad appeal rather than local relevance (e.g. drone footage or satellite views of the fire).

One result from the analysis that surprised us was the more than half of most active Twitter accounts were individuals at the local level sharing incident-specific information.

The overarching conclusion from the PIO team, however, was that with a few exceptions, the daily summaries mostly added detail to what they already had a sense of or had a limited ability to influence such as media coverage. They report that they still valued the reports but more from an ongoing documentation standpoint rather than as a tool for supporting social media monitoring efforts. The lead PIO summed it up this way:

*“In the thick of it, [...] what I really want to know is what I don’t know”*

As we continued the discussion, she elaborated on what she meant. It is the small pieces of information coming from the local community that she is the most interested in finding and that often slips through the cracks. This information can help them gauge local community sentiment, identify information gaps, detect unsafe conditions, or pick up on instances of misinformation, rumor or fraud.

This comment prompted a second round of post-hoc analysis of the 2014 Carlton Complex Dataset. I wanted to see if I could use the previously categorized information as a way to identify tweets that were more likely to come from local and individual sources. If finding this information was like looking for a needle in a haystack, I wanted to see if I could reduce the size of the haystack.



## 8.4 Study 8B: Post-Hoc Analysis of the 2014 Carlton Complex Data Set

This study addresses research questions RQ3 and RQ4.

### 8.4.1 Defining a New Strategy

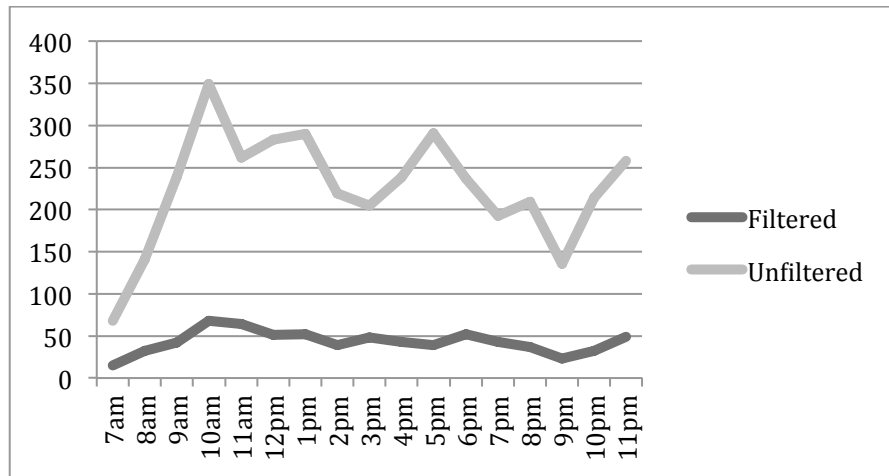
My theory was that information coming from official sources, emergency or fire related accounts, and mainstream media or that contained links to these sources were unlikely to contain new information coming from local and individual sources. Using the previously coded information from the fire, I created a new view of the data set using the following criteria:

Source Category	Status
Retweets	Filter Out (redundant with other content)
Official Information Source	Filter Out
EM/Fire Related	Filter Out
Mainstream Media	Filter Out
News Aggregator	Filter Out
Spam/Other	Filter Out
Social Media	Keep for Review
Fundraising	Keep for Review
Individual	Keep for Review
Business/Organization	Review tweets from local businesses and organizations only.
Unknown	Keep for Review

**Table 13: Filtering Criteria.**

### 8.4.2 Initial Results

Surprisingly, over 80% of the tweets were filtered out using this simple strategy. To put this in perspective, this reduced the tweet volume from July 18<sup>th</sup>, the highest volume day during the fire, from 4033 tweets to 755 tweets (Figure 18). The daily peak occurs from 9 until 10am coinciding with morning updates and breaking news that the fire grew dramatically overnight and that the towns of Pateros and Twisp suffered devastating losses. Before filtering there were 349 tweets and after filtering there were only 68 tweets. This reduction in volume puts the monitoring load within reach of a single person.



**Figure 18: Filtered and Unfiltered Tweets from July 18<sup>th</sup>, 2014**

More importantly, a qualitative assessment of the data revealed a large number of the remaining tweets contained personal narrative and information coming from individual and local community sources. This content matched what the PIO team identified as the sort of information potentially relevant to response. To validate these results, I repeated my analysis using a more systematic approach.

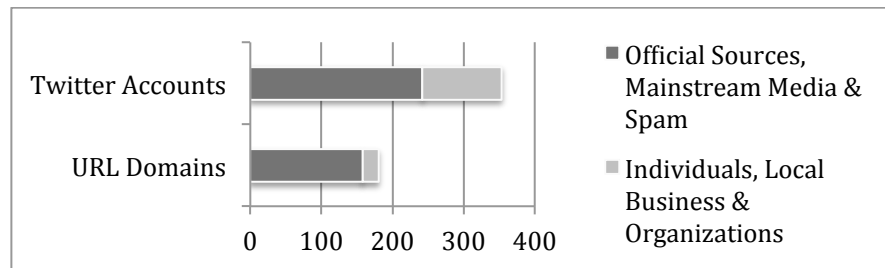
#### **8.4.3 Methods**

Starting with a fresh copy of the data with embedded links fully expanded, I re-assigned categories to the most frequently occurring accounts and URL domains in the data. I bounded the analysis to a ten-day period from 3pm July 17<sup>th</sup>, 2014 through 3pm July 27<sup>th</sup>, 2014. The partial day of July 17<sup>th</sup> was included because it contained tweets from the most explosive phase of the fire. Beginning with tweets from July 17<sup>th</sup>, I categorized all *Unknown* Twitter accounts and URL domains occurring at least ten times up to that point. Working through the data set a day at a time, I applied the filtering strategy and calculated the percentage of tweets that were filtered out. In the end all Twitter accounts and URL domains that appeared on average at least once a day had been categorized.

#### **8.4.4 Filtering Results**

The data set contained a total of 21,416 tweets with 6,606 unique tweet authors. I categorized a total of 353 Twitter accounts and 182 URL domains but only 242 Twitter accounts (3.6% overall) and 158 URL domains (27% overall) were associated with the sources used to filter out tweets. The remaining

values were associated with individuals, local businesses, and organizations (see figure 19). The filtering results were very similar to the first analysis with 82% of the tweets being filtered out overall (86% during the heaviest volume days of the fire). The final *Filtered Data Set* contained 3,873 tweets.



**Figure 19: Filtered and Unfiltered Tweets from July 18<sup>th</sup>, 2014**

### 8.4.5 Qualitative Evaluation

#### 8.4.5.1 Methods

Two samples were created by randomly selecting 1000 tweets from the *Filtered Dataset* and 1000 tweets from the *Known Source Dataset* (*Official* + *Media* + *Spam*). I excluded retweets from the *Known Source Data Set* to eliminate redundant information and allow a broader sampling across this dataset. Nearly 80% of the tweets in the *Filtered Data Set* were categorized as *Unknown* and so these were re-categorized prior to analysis to evaluate the content of these tweets.

Each tweet was assigned a content category reflecting the primary purpose of the tweet. Table 14 contains a summary of the content categories including a general description and the circumstance when this type of communication requires emergency response. The tweets were also coded across two additional dimensions: the first dimension specifies whether the information is *locally relevant* or if it applies to a *general audience* and the second dimension specifies whether the content contains *first-person informal style* versus a *formal/informational style* (Table 15 provides example tweets across both dimensions). If the tweet contained any form of personal narrative, it was coded as *informal/personal narrative*. The coding scheme was developed through multiple passes on the data and revised during analysis to make presentation of the results simpler.

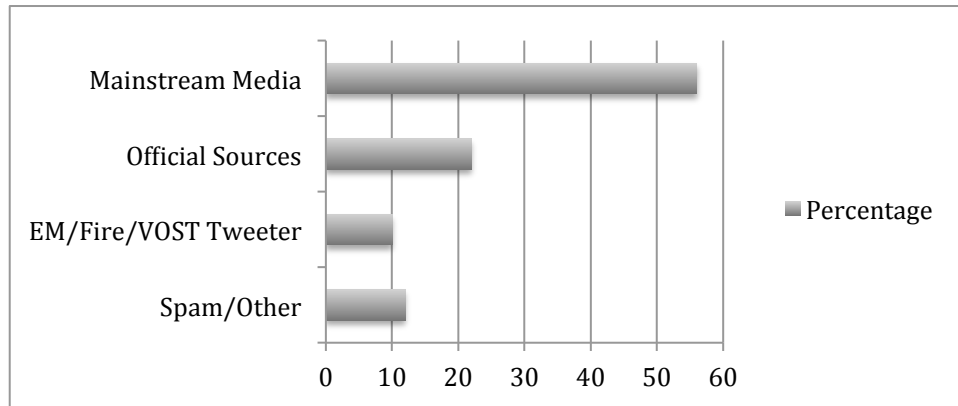
<b>Content Category</b>	<b>Description</b>	<b>Response Relevant</b>
Seeking Information or Assistance	Tweets looking for information or help related to the fire	Any tweets that help identify gaps in public information or individuals in need of assistance
Information Sharing	Information coming from individual or local business/organizations including photos, videos, status, or other locally relevant information	Misinformation or Rumor Any information that adds to current response effort
Known Sources	Embedded links to media, official sources or spam that did not get caught by filtering categories	n/a
Off-Topic	Tweets that contain key words but are off-topic (e.g. vacation photo from Lake Chelan)	n/a
Opinion/Reaction	Tweets that express opinions or emotional reactions to the fire	Any tweets that contain criticism or blame regarding handling of the response
Thanks/Wellwishes	Tweets that primarily provide support such as expressing gratitude for emergency response or emotional support for the impacted community	Feedback about response
Volunteering/Fundraising	Content related to any form of volunteering, fundraising, or community response/request	Anything that sounds potentially fraudulent, unsafe or falls under formal response

**Table 14: Content Categories.**

<b>Classification</b>	<b>First-Person informal Style</b>	<b>Formal Informational Style</b>
<b>Locally Relevant</b>	Relying on social media for updates - no power or cell svc in the Methow. #CarltonComplex	Hwy 20 between Twisp and Okanogan is now re-opened. #WaWILDFIRE #CarltonComplex
<b>General Audience</b>	Hurricane Katrina, Super Storm Sandy, Carlton Complex Fire, Haiti, just to name a few. You never know when... <link to survivalist literature>	For perspective, the Carlton Complex Fire would stretch from Lynnwood to Tacoma and Bremerton to Issaquah. It's... <link to image>

**Table 15: Examples of Content Classifications.**

#### 8.4.6 Results Known Source Sample



**Figure 20: Distribution for Out-of-Filter Tweets by Account/Domain Category.**

Over half (56%) of the tweets in the *Known Source Sample* either came from mainstream media sources or contained embedded links to media coverage. Over a third of tweets (34%) came from emergency response and official organizations, contained official information or came from *Em/Fire Related* accounts. The remaining 12% fell into the *Spam/Other* category (see Figure 20). Over half (54%) of the tweets were in a formal informational style and contained general information. Only 4.8% were in a first-person informal style and contained localized content (Table 16).

Classification	First-Person informal Style	Formal Informational Style	Local vs. General
Localized Content	4.8% (48 tweets)	19% (190 tweets)	23.8%
General Audience	22.2% (222 tweets)	54% (540 tweets)	76.2%
Informal vs. Formal	27%	73%	

**Table 16: Distribution Local versus General Information, Formal versus Informal Style.**

The first-person, localized content came primarily from the *EM/Fire Tweeter Category* and the personal accounts of mainstream media personnel. Within the *EM/Fire Tweeter* category, emergency responders used their personal accounts to share photos and information with their friends and family (see examples figure 21) or to answer questions and share information with the public. Although no emergency relevant tweets were identified, it was difficult to assess the official status or credibility of a

number of these accounts. Further research is needed to know whether additional classification would be useful to separate out vetted and non-vetted sources. Media personnel reported on local conditions from where their current vantage point or conversations with local citizens. There may be local information here but most of this information was contained in general media coverage.



Photo 1: @LocalFF1 [25 July 2014] Snohomish Co. Strike team has been released after 10days at the #CarltonComplex. #methowstrong



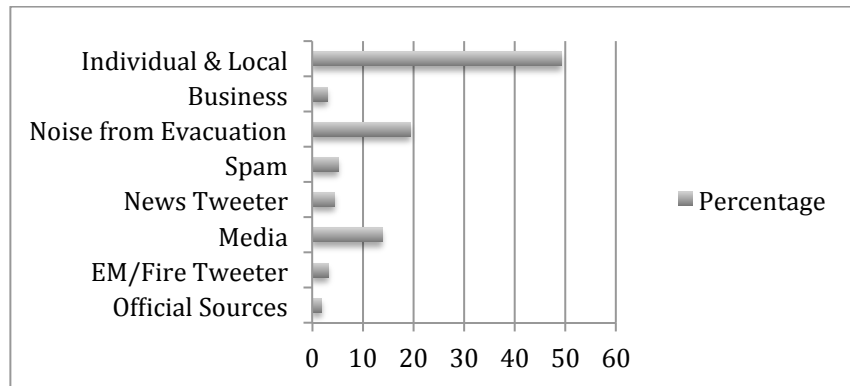
Photo 2: @LocalFF1 [18Jul 2014] Snohomish county crews continue to battle the fires in the #Methow. They've made some incredible save #keepuptgefight

**Figure 21: Examples of Content from Personal Accounts EM/Fire Personnel.**

#### **8.4.7 Results Filtered Sample**

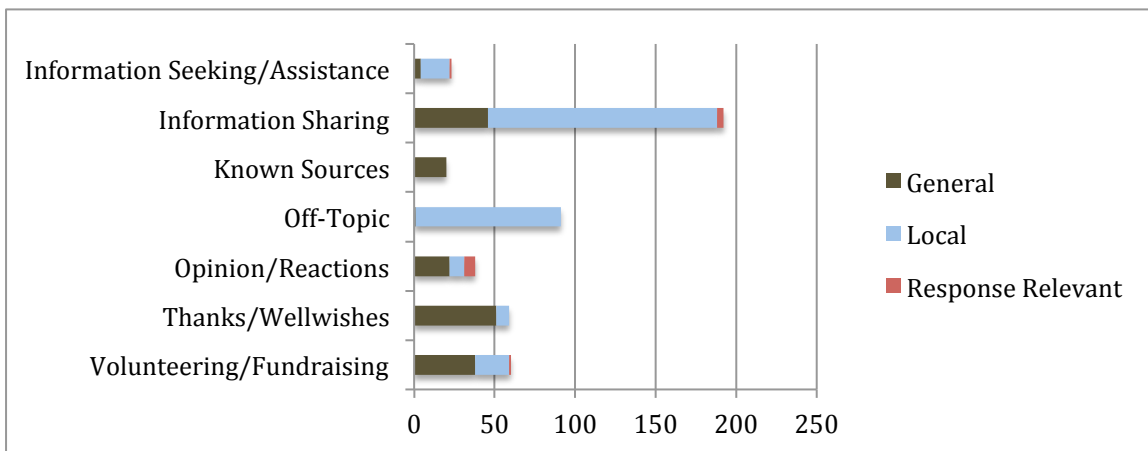
##### **8.4.7.1 Source Categorization**

After *Unknown* sources were categorized, almost half almost half (49.2%) of the tweets were from individual and local business accounts. The remaining sources fell into categories that would have otherwise been filtered out. The most significant sources of noise were undetected media sources and noise introduced by the evacuation terms (see Figure 22).



**Figure 22: Distribution of Account Categories after Re-Categorization of Unknowns**

#### 8.4.7.2 Content Categorization



**Figure 23: Content Distribution In-Filter Data Set**

Information brokerage (*Information Seeking* and *Information Sharing* categories) accounted for 43% of the *Individual & Local Business* tweets with 76% containing locally relevant information (see Figure 23). Only 26.5% of these tweets contained photos or embedded images, but nearly 90% of the photos were from local, individual sources. The other content categories: *Opinion/Reactions*, *Thanks/Wellwishes*, and *Volunteering/Fundraising* contained more general audience than localized content. These are categories where proximity to the incident doesn't limit involvement and reflect the variety of ways that individuals use social media to offer support and participate from a distance. In comparison to the *Known Source Sample* the information coming from individual and local sources was strongly biased towards first-person narrative (67.2%) and localized information (64.8%) (see Table 17).

Classification	First-Person informal Style	Formal Informational Style	Local vs. General
Localized Content	48.4% (224 Tweets)	16.4% (76 Tweets)	64.8%
General Audience or Outside Source	18.8% (87 Tweets)	16.4% (76 Tweets)	35.2%
Informal vs. Formal	67.2%	32.8%	

**Table 17: In-Filter Local versus General Content, Formal versus Informal Style.**

#### 8.4.7.3 Curating Individual and Local Content

Overall, the quantitative results indicate that nearly half of the filtered tweets were from individual and local sources with a strong bias towards personal narrative and localized content, but the larger question is how does this filtered view support social media monitoring during an incident? A qualitative look at the data suggests that the filtering strategy could support a shift in social media monitoring practices away from detecting information at the individual tweet level to a more holistic approach that allows connections to be made over time and across sources. I will use a couple examples from the *Filtered Sample* to illustrate this. These examples demonstrate how information within is shaped over time and across tweets and that basing judgment on the content of one tweet is potentially and probably frequently incomplete.

The *Filtered Sample* contained only a subset of the filtered data, but as I worked through the sample, I quickly started to make connections.



#### 8.4.7.4 Example One

The following tweet (Figure 24) was in the *Filtered Sample* from July 18<sup>th</sup>. The tweet itself doesn't contain much detail, but another tweet within the conversational stream places it at 6:30pm on July 17<sup>th</sup>. We also learn that this was taken as the fire crossed the ridge between Pateros and Brewster north of Highway 97. This information is being shared with a reporter from national media source and I was able to find a news story containing a longer narrative,



**Figure 24: Photo Taken During Evacuations.**

*She has no idea if her family's cabin near Brewster, [...], is still standing after they packed up their boat and watched the flames head straight for Pateros. "It's one thing to have your vacation ruined, but it's another to have your house go up in smoke," Booth added.*

All of this information identified her as a local resident impacted by the fires. During the evacuation she tweets out looking for information on the area surrounding her cabin and later after she returns to the area tweeting photos of her cabin and the surrounding area. Within these tweets is an exchange with another local resident looking for information about the area. She responds with a couple photos and information she gathered about the damage as she drove through (Figure 25). Although this example may not add situational awareness, it illustrates how information takes shape across tweets and how a local picture and narrative is constructed within the larger stream of tweets over time.



**Figure 25: Reply to Another Local Resident with Assessment of Damage.**

#### 8.4.7.5 Example Two

A second example, illustrates how information in the locally filtered data provided backstory for a tweet flagged as *Blame/Criticism*. The following tweet was retweeted numerous times including the version below:

@btjones [9:19PM - 20 Jul 2014] Yup. @mike1234: "Hands down, we failed you on the info side," Michael Liu of USFS tells 120 people at Brewster HS  
#CarltonComplex

The original tweet and account were deleted, but this modified tweet came from an individual in the *Filtered Sample*. Prior to this, he tweeted a series of Instagram photos that documented efforts to protect his home from the fire, his eventual evacuation and later, photos of the damage to his neighborhood. Comments associated with these posts provided detail about the location of the photos, areas that were on fire, and the impact of the fires on his community (see photos in Figure 25).



**Photo 3: Bally Hill Road #Cougarflats  
#Carltoncomplex**



**Photo 4: Upper Beaver Creek at 9pm Our "house" is  
in smoke above the torching cottonwoods.**



**Photo 5: #couldbeworse #carltoncomplex #cougarflats**



**Photo 6: Four of six homes made it on our road. Our  
sympathies to those who were less fortunate.  
#carltoncomplex**

**Figure 26: Sample of Photos Taken During Evacuation and After the Fires.**

A later tweet on July 30<sup>th</sup> contained a link to a story titled “Firestorm” on his blog chronicling the fire in pictures. Embedded within this is a photo from a community meeting with the following caption: “7:00 PM – Officials refused to answer questions at the first community meeting in Twisp”.

This example illustrates how contextual information was useful for linking to additional information about the informational failure.

## **8.5 Study 8C: Using the Filtering Strategy during the 2015 Wolverine Fire and Chelan Complex Fires**

**This study addresses research questions RQ3, RQ4, and RQ5.**

### ***8.5.1 Trialing the Filtering Strategy on an Incident***

Although the Post-Hoc analysis looked promising, I wanted to observe how this information took shape during an incident. I had two primary questions:

- How does the curation of individual and local content support social media monitoring over the course of an incident?
- Can the definition of known sources be built over time and leveraged across incidents?

The filtering strategy was used as part of the social media monitoring efforts during the 2015 Wolverine Fire and the 2015 Chelan Complex Fire in Northeastern Washington State (Incident 11.5). The Pacific Northwest National Incident Management Team 2 (PNW Team 2), a national Type 1 Incident Management Team, assumed command of the Wolverine Fire on August 4<sup>th</sup>, 2015. The Wolverine Fire included three fires: the Wolverine Fire, Blankenship Fire, and Goode Fire. Early in the morning on August 14<sup>th</sup>, a dry lightning storm ignited new starts south of the town of Chelan where the Incident Command Post was based. The fires grew rapidly by mid-day and burned into the town of Chelan destroying structures and forcing evacuations of hundreds of residents. The PNW Team 2 assisted local agencies with these fires and on August 15<sup>th</sup> at 0600 they assumed command the Reach Fire, First Creek Fire, Antoine Fire, and Cagle Fire. These fires were later renamed the Chelan Complex.

### ***8.5.2 Methods***

This study involved participatory research working as a member of the Pacific Northwest Virtual Operational Support Team (PNW VOST) assisting PNW Team 2, during the fires.

Prior to the activation, I met with the team lead of the PNW VOST. We reviewed results from study 8B and discussed using the filtered results in parallel with regular social media monitoring. Because the data is not available in real-time, we decided to use the extracts as a way to catch any information missed during social media monitoring and to validate the filtered results against what logged in the

workbook (see 6.6.6). The incident room was created on August 1<sup>st</sup> and the team began pre-incident monitoring activities and setting up the workbook. During the activation, I provided ongoing social media monitoring support while working in parallel with the extracted data. I also worked as co-lead when the team lead needed to step away. This meant that I filled in as the VOST leader as needed, posting updates to the public-facing social media platforms, keeping an eye on monitoring efforts, managing escalations directly with the PIO team as needed, and amplifying information from official accounts.

#### 8.5.1.1 Data Collection

Data collection began on August 1<sup>st</sup>, 2015 as soon as we received word that PNW Team 2 was assigned to the Wolverine Fire. Data collection terms included variations on the complex name and the names of the three fires contained in the complex. It also contained terms for Holden Village, a community under threat from the fires. After the dry lightning storm on August 14<sup>th</sup>, I added terms for the new fires and the areas under evacuation. We also added multiple terms for the complex due to multiple names circulating on social media before officially being named the Chelan Complex. When we heard about the worsening conditions near Twisp, Washington at approximately 3pm on August 19<sup>th</sup>, I added the term *Twisp* to the data collection anticipating that the PNW Team 2 could potentially be called to assist with this fire similarly to what happened on August 14<sup>th</sup> with the Chelan fires. Shortly after this, news about three firefighting fatalities in Twisp, Washington was released to the media. There was a large spike in the data collection after 3:30pm. The term was later deactivated and added to a separate collection for the Okanogan Complex on August 20<sup>th</sup>. The data collection spans from August 1<sup>st</sup>, 2015 until the PNW VOST stood down on August 21<sup>st</sup>, 2015 and contains 24,662 tweets.

#### 8.5.1.2 Data Extraction, Pre-Processing, and Filtering

Data was extracted at regular intervals throughout the fire. Prior to August 14<sup>th</sup>, the volume was low and data was extracted approximately twice a day. When the volume increased during the fires in Chelan, the data extraction process ran every 2-3 hours during the day. The account and URL domain classifications from Study 8B were used as a starting point for the data classification. Each extract was

processed and filtered using the same methods described in Study 8B. The filtered tweets were then loaded into a shared spreadsheet for review. The spreadsheet was shared with the VOST Lead other team members working from this information.

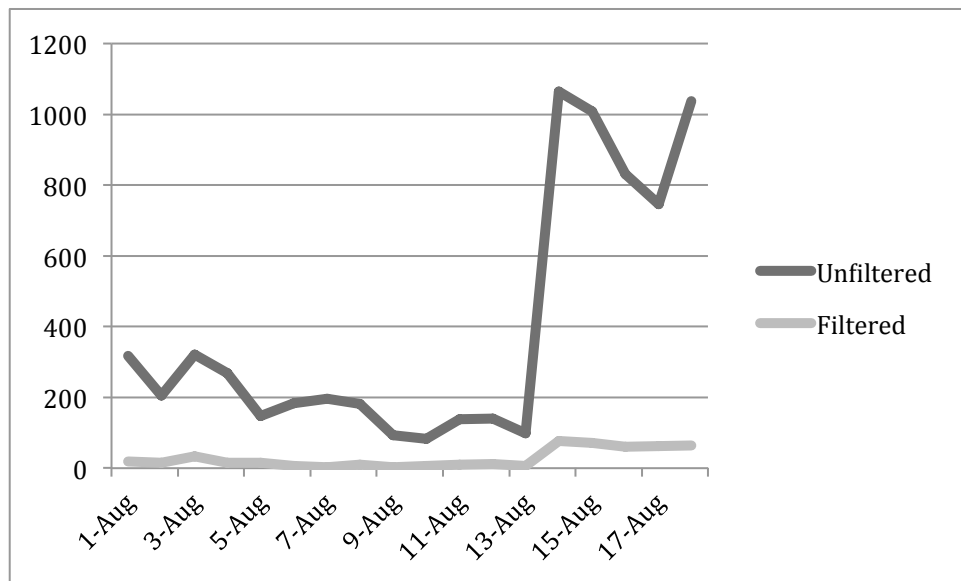
#### 8.5.1.3 Data Coding, Logging, & Cross-Comparison

Over the course of the fire, we developed a coding and analysis strategy for working with the filtered data. After filtering the for known sources and known embedded content using the filtering criteria (table 13), the remaining Twitter accounts classified as *Unknown* were re-classified and added to the Classifications Table as we worked through the current filtered dataset. If the resulting classification would have been filtered out, the tweet was deleted from the results to reduce the amount of ongoing noise. If it came from an *Individual* or *Local Business* source, the content was coded using the same content categories defined during the Carlton analysis (table 14). If we determined that the tweet needed to be logged, we captured the logging code in the filtering results and then marked the entries in the workbook with the keyword *EPIC* to indicate that it was in the EPIC data set. To make the results easier to scan, we also developed a color scheme with yellow background for records considered for logging, red for escalation, and blue for discussion.

During the first part of the fire, Twitter traffic was slow enough that we were able to keep up by scanning Twitter periodically for new information. The data extracts served as a safety net to make sure that we didn't miss anything during active monitoring and to confirm that all the expected results were in the filtered dataset. On August 14<sup>th</sup>, several factors led to a shift in practice. The volume of Twitter traffic increased by approximately five times the prior volume. At the same time, the volatile circumstances surrounding the fires meant our workload managing out-going updates and amplification also rose dramatically. In response to the increase in volume, the EPIC data extraction was done every 2-3 hours. This meant that we could review tweets in more timely fashion. The data was organized into three main slices within the shared spreadsheet: the full set of tweets, the filtered tweets, and a tab containing fully expanded URLs for all embedded content.

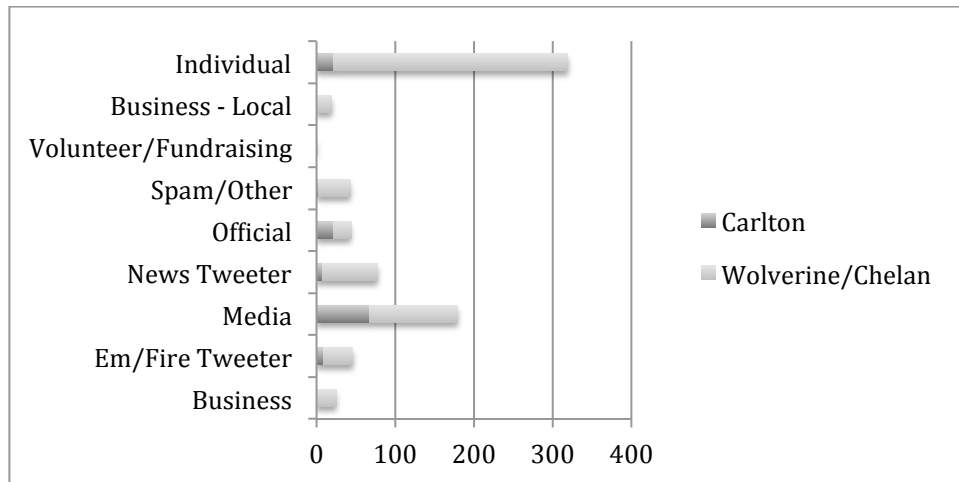
### 8.5.2 Results

Filtering results prior to August 19<sup>th</sup> were similar those for the Carlton Complex data set. Approximately 8.1% of the tweets were identified as coming from individual and local sources once the *Unknowns* in the filtered data set were re-categorized. Filtering proved less effective after August 19<sup>th</sup> when the stream was flooded with new sources surrounding news of the fatalities in Twisp, Washington (28.9% of tweets remaining after filtering).



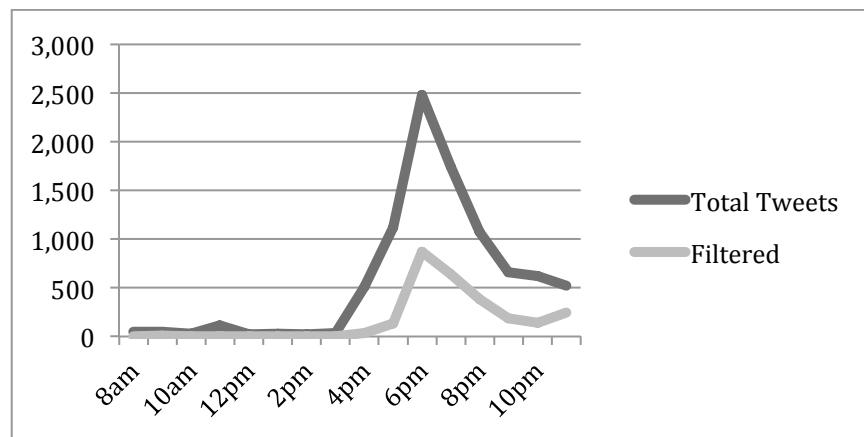
**Figure 27: Filtering Results.**

Most of the account and URL domain categorizations were new to the Wolverine Fire (83%). Not surprisingly, the categories where there was significant reuse from Carlton were official information sources (50%), media sources (37%) and EM/Fire Tweeter accounts (20%).



**Figure 28: Source Categorization by Incident.**

The following hourly graph shows how dramatically the tweets rose on August 19<sup>th</sup> (see Figure 14) after 3:30 pm. There were 8,736 tweets after 4pm making scanning all tweets or even the filtered data set unfeasible. The sudden influx of new sources meant that the manually coding process could not keep up with the volume and the filter results rose to over 30% of the overall tweet volume. This demonstrated that in the long run, more effective automated processes are needed for dealing with circumstances such as a sudden increase in emotional-support related tweets.



**Figure 29: Hourly Profile for August 19<sup>th</sup>, 2015**



## **8.6 Study 8D: Providing Data during the 2015 Kettle Complex**

**This study addresses research questions RQ3 and RQ6.**

There was only a short break between fires for PNW Team 2 and the PNW VOST teams. We stood down the Wolverine Fire/Chelan Complex activation on August 21<sup>st</sup> and then began work on the Kettle Complex near the Canadian border on August 26<sup>th</sup>. For this activation, I performed light social media monitoring and I agreed to continue to provide data to the team throughout the fire, but I was not actively involved in the social media monitoring. My goal was to provide the data in a couple different formats and gather feedback about which they used.

The Kettle Complex is composed of three fires: the Stickpin Fire, Renner Fire, and Graves Mountain Fire. The fires were ignited by a lightning storm on August 11<sup>th</sup>, 2015, burning just south of the Canadian border in Washington State. The combined acreage for the fires is approximately 76k acres.

### **8.6.1 Methods**

#### **8.6.1.1 Data Collection**

Data collection began on August 25<sup>th</sup>, 2015 when we received word that PNW Team 2 was assigned to the Kettle Complex and continued until the team stood down on September 8<sup>th</sup>, 2015. Data collection terms included variations on the complex name and the names of the three fires contained in the complex. We also add a few terms to capture the area of British Columbia threatened by the fires and evacuation areas. The daily tweet volume for this fire was similar to the first phase of the Wolverine Fire where tweets ranged from a high of 346 tweets to a low of 69 tweets. The data collection spans from the afternoon of August 25<sup>th</sup>, 2015 until the PNW2 VOST stood down on September 8<sup>th</sup>, 2015 and contains 2,032 tweets.

#### **8.6.1.2 Data Extraction, Pre-Processing, and Filtering**

The extract process ran once or twice daily and new data was appended to an existing shared spreadsheet. I did not process filtered tweets for this round. We added a small number of accounts as we noticed them during monitoring and I did two rounds of data cleaning to identify and filter out spam,

media, and official sources of information that could be easily identified. Four views of the Twitter data were supported and two views of the embedded content (see Table 18).

Source Category	Description
All Tweets	All data, nothing filtered or deleted
Tweets - Excluding Spam	All tweets with accounts and URL domains identified as 'Spam/Other' filtered out
Source Tweets Only	All retweets (RT) and modified tweets (MT) were removed
Filtered Tweets	Content Filtered According to Criteria in Table 3
All Links	Fully Expanded URLs for embedded content
Links – Excluding Spam	All links with accounts and URL domains identified as 'Spam/Other' filtered out
Links – Filtered	Links Filtered According to Criteria in Table 3

**Table 18: Data Views.**

#### 8.6.1.3 Post Incident Feedback

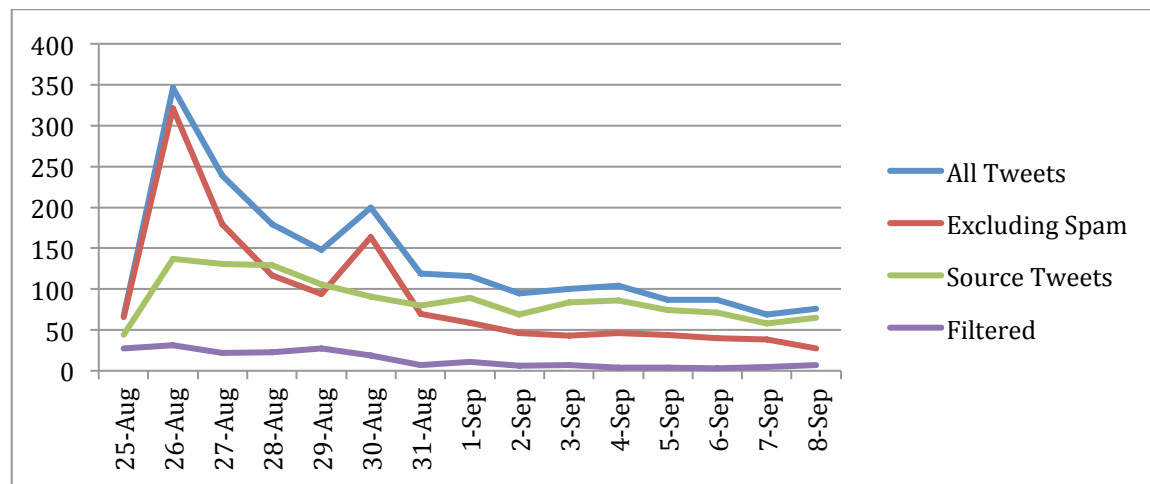
After the VOST activations for the 2015 Wolverine Fire, the 2015 Chelan Complex and the 2015 Kettle Complex were complete. I compiled archive versions of the data and gathered feedback from the VOST team lead. This was done through direct conversation and written feedback posted to the chat.

#### 8.6.2 Results

Throughout the Kettle Complex, the volume of tweets was low enough that the VOST was able to keep up with the traffic on Twitter and the team lead used *TweetDeck*, a real-time tool for tracking and organizing tweets. Although she thought the filtered view was potentially useful, there were a couple key factors that inhibited its use. The first is that she felt more time was needed time to prove to herself that filtered data was capturing what she was interested in and to evaluate the source categorization. Secondly, the data was not provided in real-time and so the information was always slightly dated rather than reflecting in-the-moment information. Finally, the spreadsheet format made it easy to curate the information, but it was also cumbersome to use and the visual aspects of the tweet such as embedded

content was reduced to textual information. The format of the data made it difficult to envision using it in real time.

The data extracts served more as a backup reference and archive. Because of the low volume of tweets, the *All Tweets* tab was the preferred view. The most useful part of the extract during social media monitoring was the *All Links* tab. Access to fully lengthened URLs consolidated into a concise list made scanning new embedded content easier. The full URL was visible and the number of links to scan was cut roughly in half (48%). If spam was filtered out, this dropped to 30.6%. The addition of the domain and domain classification make it easy to sort and organize the information.



**Figure 30: Comparison of Volumes Based on Different Views.**

The graph (Figure 29) shows the volumes associated with each of the views. The volume across the fifteen days steadily declined and the problem of spam steadily increased. After August 31<sup>st</sup> spam accounted for roughly half the tweets. Most of this content was related to job spam and was easily filtered by searching for the keyword ‘job’ in accounts and URLs. Even though we didn’t clean and code the filtered content, the filtered dataset made up only 8% of the overall volume after obvious spam, easily identified media accounts and official sources were classified. There was significant reuse of categorized sources: *EM/Fire Related* (86%), *Official Sources* (32%), *Media* (20%), and *News Aggregator* (18%).

## 8.7 Discussion

Developing the filtering strategy based on feedback from one team and trialing it with another team across multiple incidents highlighted some of the factors that influence the value and effectiveness of applying filtering strategies and providing aggregated information. There was a clear difference in monitoring style and orientation to information between the two teams. In the first scenario, the Carlton Complex, I was working directly with the PIO Team and VOST resources were limited. The lead PIO is specifically concerned with what is being said at the individual and local level. She doesn't pay much attention to media content unless there is a specific reason. I actively monitored Twitter during Study 8A and then after the fact in Study 8B when I applied the filtering strategy, I realized how much individual and local information slipped through the cracks and how interconnected the communications were. In contrast, the PNW VOST has a dedicated team leader and a full team of experienced volunteers. They have developed a robust social media monitoring strategy over time that helps them to catch and log information in real-time. PNW VOST casts a wide net across a variety of sources including both mainstream media and social media. This strategy worked well during the 2015 Wolverine Fire and the 2015 Kettle Complex activations. When the volume of tweets went up on August 14<sup>th</sup>, catching everything in real-time was not possible. The data extracts served as an important safety net for the team and then on August 19<sup>th</sup> when the Twitter traffic rose dramatically, it wasn't possible to keep up with the volume even by restricting monitoring to the filtered data set. Additionally noteworthy, these studies were done for teams with dedicated social media monitoring resources. This is likely to not be the case for most incidents and so the ability to filter results could potentially bridge the gap for teams with limited resources.

Other important considerations are incident type, magnitude, level of social disruption, and the size of the impacted population. These studies were done on wildfires where there is a clearly defined perimeter and formal, tactical methods are effective at dealing with the hazard. In high-impact, more diffuse events such as widespread flooding or earthquakes, the ability to identify and isolate local and individual content could play a larger role in supporting situational awareness. It could also play an

important role in identifying time and safety-critical issues within the community requiring response and the opportunity to identify and engage with activities occurring at the community level. Across the fires, we observe that as the level of social disruption rises, social media traffic rises correspondingly. This rise in volume often outpaces even a fully staffed team. This effect is even more pronounced in densely populated areas (e.g. Hurricane Sandy) and the ability to focus monitoring efforts on the content most likely to be from individual and local sources could prove valuable to formal emergency response and to citizen-led emergent response efforts as well.

#### ***8.7.1 Automating the Categorization Process and Building a Source Repository***

The filtering strategy developed and trialed across these fires is in an early prototype phase, based on manual coding and the analysis of aggregated Twitter data. More research is needed to explore its potential use in real-time, but a number of observations can be drawn from the research completed so far with this rough prototype. Using information about the sources of tweets and embedded content so that certain known sources could be filtered out proved to be a highly effective strategy for identifying a much smaller set of tweets likely to contain information coming from the individual and local sources. The categorization was based on manual examination of the frequently occurring Twitter accounts and URL domains, but much of this process is potentially automatable.

The data that I have coded so far could be used as training data to determine the common characteristics and keywords associated with individual categories. For example, *News Aggregator* accounts often have extremely high tweet volumes (over 100k) and keywords in the profile that indicate news is being pulled from multiple sources. Examination of the stream content shows links across multiple media sources. In comparison, *Mainstream Media* account profiles have common keywords such as the station call letters, terms related to media such as ‘reporter’ or ‘journalist’. The embedded content comes from a limited set of sources such as the media website and associated social media accounts. This automated analysis could be used to identify sources for filtering out and also preliminary identification and categorization of *Individual* and *Business/Organization* sources and their proximity to a disaster.

Preliminary results indicate there is potential benefit in maintaining an ongoing repository of categorized accounts and URL domains. This is particularly true for *Official Information Sources*, *EM/Fire Related Sources*, and *Mainstream Media Sources*. These are the information sources and sites most likely to appear across events. We have an extensive set of data collections for Project EPIC that could potentially be used to both validate and refine source categorization and also to build a substantial repository across a wide variety of information sources within Twitter and across the Internet. This repository could then server as a starting point for any new incident.

#### ***8.7.2 Building a Flexible Interface that Leverages Emergency Response Expertise***

I would argue that the most important contribution of these studies is not that I've been able to identify individual and local sources of information, but that being able to organize and provide different views of the information based on the specific circumstances of the incident and needs of the incident response team is important. Better tools are needed to support these social media monitoring and the curation of relevant information across social media tools. When social media traffic is low or when there are adequate resources, an effective filtering strategy is probably unnecessary, but when volumes are high or when locally relevant information is important, the ability to filter for specific types of information and curate it effectively could be critical.

Any tools developed to filter and categorization data would have to operate in real-time. Circumstances during a disaster are often volatile and the relevance of information can deteriorate quickly. That said, the ongoing curation of information related to an incident is an important aspect of any design. The lack of curation tools is a gap in what is needed to support social media monitoring practices. How to orient and manage this information in an ongoing basis can only be answered as part of an ongoing exploration.

### **8.8 Conclusion**

This research is a first step in terms of exploring a new approach that potentially combines both automated methods with the judgment of emergency responders organizing and monitoring social media

streams in real time. Through a manual and labor intensive process, I've shown how classification of a relatively small segment of information sources can help identify difficult to catch information coming from individual and local sources. This is an important segment that needs to be evaluated in terms of the larger whole and addressed as part of a larger solution for curating emergency social monitoring result.

## **8.9 Reflections on the Action Research**

The study in Chapter 8 was motivated by a general challenge faced by emergency responders when dealing with social media data. The information space itself is unwieldy and when circumstances intensify during disaster or emergency response, navigating this information space is difficult, and there is a general feeling that you have to be missing something important. I have spent hundreds of hours monitoring social media during incidents and there is also a feeling that so much of the information is redundant or that relates to general news and information sharing rather than the detailed information we are hoping to pick up on. As a researcher and member of Project EPIC, I have access to social media data and in particular the Twitter data collections surrounding events. It is part of my job on Project EPIC to monitor social media conversation and make sure that the Twitter collections capture as much of the relevant conversation surrounding a disaster or emergency event as possible. I wanted to see if there was some way that the virtual operational support teams could benefit from these data collections either during or after an event.

During an initial phase of the analysis, I worked with the COVOST during two non-emergency events: the 2014 USA Pro Challenge Cycling Race and the Vail 2015 Alpine World Ski Championships. During both of these events, I gathered data during the event and used this to generate a comprehensive report that was included into the after-action-reports (AAR) for the activating counties after the event. I followed the same source categorization scheme described in Study 8A of Chapter 8. I did not make any value judgment about the information and my goal was to provide comprehensive analysis and let them tell me which information was the most valuable. With both events, the official organizations valued being able to see which accounts and which message gained the most traction during the event and also to

monitor where and how official accounts were mentioned across Twitter. The general conclusion, echoing the results from the Carlton Complex as well, is that the aggregated summaries were a valuable part of chronicling what happened after the fact and considered useful for planning for future events.

The 2014 Carlton Complex Wildfire was the first time that aggregated summaries were provided during an event. There were a few key portions of the analysis that were deemed valuable: the analysis of information related to the official accounts and the aggregation of information related to the fully expanded URLs. During the incident, daily summaries of social media traffic related to the blog versus the official information site InciWeb allowed the PIO to demonstrate how quick the blog became the preferred source of information. The aggregated information related to the embedded content allowed us to efficiently identify social media posts and scan them for relevant information. This was really important when VOST resources were limited on an intense fire. In general, however, these were not the results I was hoping for. When Kris Eriksen made the comment in the after action review that what she really wanted to know was “what she didn’t know”, it precipitated a major shift in thinking. Although I think the statement is an oversimplification, what she is getting at are the small pieces of information embedded within the noise that have the potential to make a big difference. It could be a tweet from someone who can’t reach a family member within an evacuated area, echoes of criticism at the local level, or a photograph or video that has response relevance or that could go viral on social media.

The results of the post-hoc analysis were surprising for two reasons. I was surprised that such a small amount of known source information could be used to filter out such a large part of the data. Data that overall did not contain emergency relevant information. The second surprise was how rich the remaining tweets were in terms of both individual and local content and the personal narrative tone of these tweets. Much of this content I either did not see during the incident, or because we weren’t curating this information over time, that I did not make connections between this information and saw each tweet in isolation. These were interesting results, but they were drawn after the fact. I wanted to see how this information would be used during an ongoing response.



The analysis during the 2015 Wolverine Fire, the 2015 Chelan Complex and the 2015 Kettle Complex helped to shed some light on this, but it also illustrated how important context of the incident and characteristics of the VOST team shape what views of the information are valued over time. During the slow portions of the Wolverine Fire and during the Kettle Complex, volume was low enough that the VOST leader only worked from the complete set of data. There was no benefit to filtering when volume was low. When the volume rose sharply during the evacuations in Chelan, we were trying to monitor social media while simultaneously posting social media updates and amplifying messages from the Chelan Office of Emergency Management. The filtered data was a huge help. It was all we managed to get through during the height of activity. Once the intensity passed, the full tweets were a valuable reference for what we might have missed across other sources. Finally, after the sharp spike following the fatalities in Twisp, Washington, I realized that the filtering strategy in the current form is no match for tragic situations. It illustrated to me that some form of automated filtering of this sort of content could help eliminate content related to the outpouring of emotional support and well wishes for those impacted by the tragic events in Twisp.

I would like to talk about the after action feedback related to these studies. The team lead for the PNW VOST reported that although she was interested in the results, she was not ready to trust them without further analysis so that she determine what was missed from her standpoint. She also was uncertain about how I had classified my sources. I'd like to acknowledge her concerns and highlight the importance for involving members of the team in the definition of the filtering criteria. There was not time before the fire, but it would be important to give her a chance to compare results, and to make a pass at defining the data that was used for filtering on a future event. I am glad that I trialed this filtering strategy on her team because it illustrated how different teams value different views of data. Her team does a more comprehensive job of monitoring across sources. They are not just focused on picking up emergency relevant information from individual and local sources. They also monitor mainstream media communications. Her typically works on fires in Oregon and Washington and so she has a wealth of knowledge about sources within this region. I think it would be a valuable exercise to involve her in

categorization of sources and to create some sort of linkage between these definitions and the information that is maintained over time within the team workbooks.

Overall, I feel that this study was a valuable exercise and we made significant progress in terms of understanding what social media content looks like and how it could potentially be segmented to serve different social media monitoring situations. We weren't able to look at how connections across individual and local sources changes the monitoring process, but that was not really possible as part of a wildfire response. Wildfires are events with clearly defined perimeters and are often less socially disruptive than other events. I think analysis of this sort of content would be more beneficial on an event where impact of the hazard is diffuse and the social disruption is higher. I also believe that I've made significant progress with this manual simulation of the filtering and analysis process, but this study would be better served if we had real-time access to the data and better tools for organizing and analyzing the results.

## **SECTION FIVE. Synthesis and Conclusions**

### **CHAPTER 9. Synthesis and Conclusions**

#### **9.1 Summation of Research Approach**

My research spans four years of working alongside an innovative group of emergency responders committed to finding ways to effectively integrate social media and related ICTs into their public information practices. These solutions continually take shape through a combination of their collective knowledge of formal emergency response, strong technical and communication skills, and an innovative mindset. As a researcher in crisis informatics, my goal has been to work within this community to gain knowledge of these practices and how they take shape – a “knowing how” in this environment of ongoing invention and adaptation combined with my “knowing what” from the field of crisis informatics. Across these studies, I’ve captured both general principles and practices and how they have adapted these to meet a range of circumstances.

Action research is framed as a cyclical enactment as researcher and co-research participants manipulate the environment surrounding practical and contextually based goals and evaluate the knowledge generated by these changes (Greenwood & Levin, 2006; Hayes, 2011 & 2014). In general, this assumes that the research environment is stable and the co-researchers can collaboratively define a systematic plan of action and evaluate the results. Within the context of emergency response, the hazard itself often poses the changes of circumstances that drive adaptation of practice both in terms of public adaptations and, in parallel, those of emergency response practitioners. As a researcher, I would argue that the only way to truly understand what is needed in this volatile and ever-changing environment is by working alongside the innovators and inventors of these new practices as they work to design solutions to address real-world information needs and to solve problems in context. It is only from within this context that practical evaluation can occur regarding what works and where important gaps still exist. The interventions introduced later in my research grew from an understanding of the complexity of the information space and the challenges this posed when searching for emergency relevant information

within the broader social media conversation. These interventions evolved and were trialed across a series of incidents and evaluated to generate new knowledge of how these circumstances and the views generated in context could support better social media monitoring within emergency response.

## **9.2 Post-Disaster Emergent Organization**

As introduced in the background, Kreps and Bosworth (1993) conceive of organization and social response to disaster as an ongoing process of enactment between organizational structure and individual role enactment with each continually shaping the other. The structural code defined in this theoretical frame makes room for a much broader range of organizational forms than the four-fold typology defined by Dynes (1970). They propose that even in what we think of as formal response, organization is a continually emergent process through the information at hand and the actions of responders as they formulate an appropriate response. Consequently, all forms of organization from social order (formal response) at one end to collective action at the other are continually enacted. This structural code also allows for the existence of partial forms. These partial forms can be as simple as individuals identifying necessary precautions, families making the decision to evacuate, or neighbors coming together to accomplish a set of localized goals. Structural forms exist so long as they are serving a purpose in the post-disaster social system. This broader perspective that encompasses a more diverse range of organizational forms, and includes both partial and temporary forms is a valuable way to think about post-disaster organization and the role that public information can provide as people organize across this social system with public information providing an important piece of the organizational glue.

If we view organization as continually enacted through conversation and text (Weick, 2012; Taylor and Van Every, 2003) and broaden our perspective to include the range of organizational forms defined by Kreps and Bosworth (1993), the circumstances of post disaster life are what drive this conversational process as participants work to assemble an accurate picture of current circumstances and formulate their response. Social media and ICTs have expanded both the range of participants involved in the conversation and visibility to a much wider range of content and sources. People assemble

information and converse across these sources as they make decisions and respond. Sources include official, mainstream media, friends, family and others, both online and off, as response is talked collectively into existence. At the center of this, official emergency updates serve a critical role as vetted and authoritative information and if handled effectively can serve what Fritz and Mathewson (1957) describe as the most immediate and crucial need for *speedy, accurate, authoritative information, coordinated and adapted to the specific needs of various groups concerned with disaster*. Importantly, within this new conversational space, we start to see how deeply situated these communications are and how increased visibility of public conversation shapes public information work which in turn drives individual communications and response.

### **9.3 Mixing and Synthesis of Information Across Sources**

Viewed as part of a larger network of communication, we see how communications across multiple sources within the post-disaster social system overlap with one-another and influence the ongoing conversation both within social media channels and on the ground. In some cases this influence is obvious as in the case of the rebroadcasting of information or the synthesis of outside information into personal content. Communications from emergency response organizations, official sources, and media are frequently incorporated into personal content and shared within both local and distributed networks. Mainstream media makes use of both official information updates and first-hand accounts from people on the scene as part of their coverage.

What isn't clear within this network is how or if emergency responders are making use of information being produced and shared by members of the public in their decision-making and organized response. Analysis of the data alone from the Hurricane Sandy Data Set showed limited evidence of direct engagement with the public through social media. We highlighted two examples where we observed public communications shaping the response and messaging within emergency response. But these examples were a minority within the larger sample. As a researcher working within the virtual operational support community, I have been able to observe a clear shift over time in the climate for social media use

and how this shift has led to more experimentation with social media, more direct engagement with the public and evidence of how publicly produced information is helpful in shaping the public information work of emergency responders.

#### **9.4 Observable Shifts in Social Media Use**

When my research began following the 2011 Shadow Lake Fire, members of the Shadow Lake VOST reported on the negative climate associated with the use of social media as communication medium and a general mistrust of information gathered from social media sources. The Shadow Lake VOST itself was a means to get around a strict mandate against the use of social media within the US Department of the Interior. One year later, the analysis of online communications from Hurricane Sandy showed that over half of the departments were using at least one form of social media to communicate regularly with their constituents. Usage dropped off dramatically during the storm and we have no information as to why, but these departments appeared to lack the capacity to maintain online communications during the storm. Even so, the nearly one third (29%) of the departments that used social media to share storm specific information represents a significant shift in just one years time. Most of these departments used social media to provide updates, but there is limited evidence of direct engagement with the public.

For those departments that used social media only to broadcast updates, this represents a translation of old techniques into new channels rather than true evolution of practices. The development of virtual operational support is highly significant as it represents an effort to transform communication practice to support a new, bi-directional flow of information between public and emergency response.

#### **9.5 Transforming Emergency Response**

Although a broadcast strategy remains important, a broadcast only model of communication misses much of the potential for the gathering of relevant information and a richer model of communication and information sharing across within new channels. I have chosen the term ‘emergency

responders as inventors' carefully because I see in these early models defined within the virtual operational support community as the re-invention of emergency public information practice and a redefinition of emergency resources within this virtual space. They built a framework where nothing existed before and there was little support for their ideas. This small community of innovators has oriented themselves towards a continual evolution of ideas in an environment where communication technology is continually evolving and the volatile circumstances of disaster require the skills to gather information effectively and to adapt communication quickly to shifting circumstances.

### ***9.5.1 Virtual Operational Support***

#### **9.5.1.1 Virtual Operational Support Teams (VOSTs)**

Looking across this growing community of teams, there are many similarities and shared practices, but as the number of teams grow and the concept is adapted across a wider range of social and organizational contexts, it is clear that VOST is an underlying concept, not a fixed set of rules or practices. As a voluntary extension of an official emergency response team, the organizational structure and practices are designed to mesh effectively with those of the official response organization. The processes and protocols described in Study Three, section 6.6 show how formal response protocols have been translated into the virtual practices used to coordinate with and support the federal type 1 team. Operational cues such as the creation of the incident room signal a shift to active duty among the team members and the corresponding orders to "stand down" and the archiving of the room signal the end of the virtual response. The workbook formalizes the recording of their activities, and the daily update of the *ICS 204* sheet makes the teams current objectives explicitly understood. The results and activity tabs serve as an official record of the team's work, while the backchannel communications within the incident room supports the ongoing sharing of information and discussion surrounding response activities. The operating procedures for each team are unique and tailored to the working relationship established with the activating agency, but across all teams work practices are formalized to allow the extension of resources to a team composed of trusted digital volunteers.

#### 9.5.1.2 Virtual Operational Support as Community – “A Coalition of the Willing”

Members of the VOST Leadership Coalition (VLC) describe themselves as *A Coalition of the Willing*. Initially this term did not make sense to me, but I’ve come to realize that it relates to a *willingness* to explore new ideas and share lessons learned across activations in the ongoing evolution of a core idea. The orientation of the VLC and broader community is towards the ongoing evaluation of recent knowledge gained through experience with an eye on the future both in terms of public behavior and emerging technologies. The crowd-sourced agenda makes the formation of new ideas collaborative and democratic rather than driven by organizational dictates or a steering committee. Anyone can take the stage and share a new idea or table something for discussion within the group. This open structure is important for fostering new ideas and the innovations that make VOST work across such a diverse community.

As a community, relationships both within and across teams are generally tight-knit. Ongoing communications within the various rooms including the cross-community *All Things VOS* room and the internationally focused *VOSG* room foster the building of relationships and the sharing of information and expertise across the broader community. These tight-knit relationships are evidenced by the frequency that VOST members “drop in” as needed, especially among the more experienced and founding members within this community. On numerous occasions, I’ve observed or heard of requests for additional assistance from an individual team to the broader community, particularly in sudden onset events such as earthquakes or tornadoes. The 24/7 nature of the room in a globally distributed community means that there are generally people awake and listening when help is needed, and the chat format means that those who are not can catch up quickly if the need arises.

Viewed collectively, the cross team practices contribute to the overall resiliency of the individual teams. The focus on sharing lessons learned across activations allows the teams to collectively build knowledge and strategies for handling new situations. Ongoing training and collective exploration of new technologies builds a common base of knowledge and community discussions help to establish and maintain a consistent vision of virtual operational support. It is also clear that these virtual channels



support the organization of activities both online and off related to pushing the ideas related to virtual response beyond the bounds of the current community. The ongoing conversations within this community build trust and familiarity among its members and supports an open channel of communication when need for support arise. Within a community continually training and preparing for responding to disaster, this resiliency is an important strength that often allows them to mobilize faster than resources on the ground.

Looking across these attributes: strong alliance with formal response, orientation towards shared knowledge and evolving practices, the establishment of trust and open communication across both a global network and within individual teams, VOST represents a unique solution and serious effort towards transforming public information work within the virtual world. This grassroots movement within emergency response is built from and supported by the same technologies used to share public information and engage with the public. Ultimately, new ideas will come forward and replace virtual operational support in its current form, but the work of this community represents significant progress towards the incorporation of social media into public information practices.

#### ***9.5.2 High Engagement and the Emergence of New Communication Practices***

Social media supports new forms of communication and interaction with the public, allowing a more visible and direct channel of communication than ever before. We have observed how visibility across information sources within this space can reshape understanding and the interactions between participants within this space is highly situated and ongoing communications can reshape the setting of expectation and calibration of response on both sides. The two examples highlighted in Study One show how public communications can bring important information to light about emergent situations and important gaps requiring emergency response. As an action researcher, I've been able to observe this process first-hand within the context of the event as it unfolds and the backchannel conversation associated with the evaluation of this new information. I've also had the opportunity to discuss new approaches and shifts in practice with emergency responders as they evolve their practices through the course of their experiences. The Integrated Social Media Strategy developed by the JeffCo IMT

represents one of the most carefully thought out and sophisticated plans for leveraging current technologies in practice. In addition to this, I have also observed key shifts within a federal response team to supply information directly to local response and community organizers. I will summarize each of these strategies, both of which work to provide the right level of information directly to the people who need it.

#### 9.5.2.1 Reframing Disaster Communication Practices

The evolving communication practices the JeffCo IMT describe as the *Integrated Social Media Strategy* (Study Four) represents a successful approach to mixing traditional communication practices with new online channels. But more importantly, it represents a shift from the traditional broadcast model of emergency communication to positioning themselves at the center of the informational ecosystem for their community. Through a variety of social media platforms, they have developed a strong communication link with their constituents providing both general updates and highly localized coverage tailored to specific needs within their community. They have reframed both how they share information with mainstream media and the public simultaneously. They also developed the ability to produce their own coverage as needed. By embedding PIOs within the emergency response, they are able to produce content from the front lines and provide coverage that is not available anywhere else. This ability to produce their own content gives them more control over coverage and minimizes their dependence on mainstream media, a factor that proved critical during the 2013 Colorado Floods. Additionally, they have established direct channels of communication with and within their community through the creation of a forum for public conversation and the sharing of information across these sources. They displayed a willingness to improvise during the floods by gathering key information directly from local residents, which was then used to secure a disaster declaration. This information was then integrated this into the community forum.

Viewed collectively, this evolving strategy represents a significant reframing of emergency response communications with the emergency response organization positioned as hub within the larger informational ecosystem. The level of direct engagement with members of the community and public

involvement in information gathering during the floods also suggests a move towards a bi-directional flow of information and stronger support for public participation in the future.

#### 9.5.2.2 Sharing Updates Directly Within Local Response and Community Channels

In addition to my published research, I've been following a shift in practice by Kris Eriksen, PIO for Portland NIMO (introduced in Study Two). In 2014 she travelled to Australia where she met the creator of the *Tassie Fires: We Can Help* site, a citizen-created and community-led response effort that provided vital support to the communities impacted by the 2013 Tasmanian Bushfires. This site was highly effective at responding to the unmet community needs during this large-scale event (Hyde, 2013). Inspired by the effectiveness of this community-level response, Eriksen decided to shift her focus from establishing and promoting the official federal sites to forming a stronger connection with local response and community led efforts. Her goal was to communicate and provide the updates from the federal level directly through local and community channels. She reports that in the past, she has watched as the official accounts fall into dis-use after they leave and her goal is to foster the channels of communication shouldering the burden of recovery after they leave.

She tried this for the first time on the 2014 Funny River Fire in Alaska, a large fire occurring in the region where she lived when she returned home from Australia. Even though she was not assigned to the fire, she formed an alliance with members of the local emergency services team and several community level groups, providing them with the latest updates from the federal team. I followed communications across these sites throughout the fire and during recovery. My observation was that it was highly effective to have the community level conversation, local emergency updates and official federal information mingled in the same conversation. The transition from Type 1 team back to the local emergency services happened smoothly because members of the community were already getting information directly from the local PIO. She repeated the same strategy during the 2014 Two Bulls Fire in Oregon by providing daily coverage of information through the local PIO delivered as "Updates from Nate".

It is still too early to assess this new approach, but it may be an effective new strategy for supporting local communities as they move from response to recovery in the future. During the response, the availability of official information directly within community channels may support more effective community organization, and information flowing directly from the community to emergency response may support a clearer picture of community needs and the tailoring of public information, provided where it is needed. This tight-coordination of communications may also diffuse some of the conflict that often arises when federal teams take over the response on large-scale events by establishing a more personal relationship with the community and allowing their issues and concerns to be heard.

## **9.6 In Search of a Clearer Picture During Response**

One of the most challenging aspects of social media monitoring is sifting through an often noisy and complex information space for emergency relevant information. VOST teams use a variety of tools and strategies to monitor social media channels and search across a wide range of sources to detect the small but important segment of the conversation that has emergency relevance. As mentioned in previous studies, VOST work is coordinated through the use of everyday tools adapted to meet their needs. There are no specialized tools or defined strategies for getting at emergency relevant information. Study Five describes a series of collaborative experiments to determine if aggregated Twitter data could be used to simplify view of the information in meaningful ways. These strategies evolved over the course of multiple incidents and multiple teams and offers new knowledge about how the categorization of information sources could potentially be used to report on and filter information down to the individual and local level. It also shows that different circumstances necessitate different views of the data and that more work is needed to incorporate both automated techniques and the flexibility to incorporate emergency response expertise into the organization and categorization of sources.

One of the primary observations is that there is no one-size-fits all solution for either individual teams or that is appropriate across all incidents. The circumstances of the disaster continually reshape the composition of the information space on Twitter and the resources and objectives of the team doing the

social media monitoring also influence what view of the data is most appropriate in the given circumstances.

#### ***9.6.1 Team Resources and Objectives***

Each of the teams involved in this research operate under different resources constraints and social media monitoring objectives. For Eriksen's VOST, resources are limited and the ability to get at the individual and local information is a critical objective, especially during high volume and volatile events. For her team, the reduced data set and expanded URLs were ideal. In contrast, PNW VOST operates with more resources and they monitor for emergency relevant information across both social media and mainstream media sources. The team lead for PNW VOST was interested in the results, but was reluctant to use this information without further evaluation of how sources were categorized and the resulting data sets. As a third reference point, I provided the same type of detailed summary that was created during the Carlton Complex to the COVOST following two non-emergency events: the 2014 USA Pro Challenge Bike Race and the 2015 USA World Cup Ski Race. This team values the high level summaries as part of after action reporting and they were interested in the filtered results as well. They emphasized that timeliness of the data was crucial. If the data was any more than a few hours old, it loses its value.

#### ***9.6.2 Volume and Composition of the Data***

The circumstances related to a disaster or an event continually shapes the composition of the information space, which in turn affects the value of the filtering or segmenting of the data. Throughout the 2015 Kettle Complex and during the early phase of the 2015 Wolverine Fire, social media volume was low. It was easy to follow the conversation without the use of filtered results. At the start of the 2015 Chelan Complex, social media volume and the demands of managing social media communications both rose sharply. It was no longer possible to keep up with social media traffic in real-time. The filtered results operated as a safety net so that we could try to catch relevant information that could have otherwise slipped through the cracks. Finally, when the volume rose dramatically related to the circumstances in Twisp, it was clear that certain circumstances require more than simple filtering

mechanisms to manage effectively. Another important consideration for this research is that all of these trials occurred on wildland fires or non-emergency events. As discussed earlier, fires have a clearly defined perimeter and fit well with the tactical procedures defined by ICS. Publicly generated content is less likely to be response relevant than in more diffuse hazards or when there is severe social disruption such as earthquake, floods, hurricanes, or epidemics. The applicability of the filtered results and the curation of information over time for this content may be much more relevant in these sorts of events. The results of action research are always provisional. The results up until this point look promising, but more research is needed to evaluate how this information would be used across different types of events. In addition, the tools and processes I used were crude and did not make the data available in real-time. Future research would benefit from the real-time availability of data, the curation of the information over time, and the definition of automated processes for improving the results.

### **9.7 The Myth of Best Practices**

One final point that merits discussion is the emphasis on defining best practices within emergency response. There is an ongoing tension within the virtual operational support community. Some believe that VOST teams should be moving towards the definition of standard operating procedures that would allow them to be resource typed and ordered like other resources within NIMS. They believe that a lack of standardization and best practices is preventing VOST from gaining broader acceptance. In a recent special session of the VLC, the topic of governance and definition of best practices was tabled for discussion. Within the group there was strong opposition to explicitly defining best practices and to implementing governance structures across the larger community. A number of studies conclude that it is too early for the establishment of best practices (St. Denis, Hughes, & Palen, 2012; Hughes, St. Denis, Palen, & Anderson, 2014) and that support for improvisation is critical part of emergency response (Kendra & Wachtendorf, 2007; Mendonca, Beroggi, & Wallace, 2001). I would argue that what constitutes best practices in a fast changing and globally connected environment looks very different from the traditional conception of best practices.

In an environment where technology is continually changing, and within the context of disaster where circumstances are often volatile and require improvisation, I would argue that “best practices” is a misnomer. Best practices are actually those that support the ongoing evolution of ideas, sharing of collective experience as emergency responders, and an orientation towards facing new challenges and leveraging additional resources effectively through the use of evolving means. Best practices should be viewed as provisional – dependent on new information and context of use. It is misguided to think that there are one-size-fits-all solutions in an increasingly globally connected world and in disaster where improvisation and adaptation are a necessary skill.

## **9.8 Research Contributions**

This research adds to the body of literature within Crisis Informatics by focusing on the challenges and innovations within the emergency response community as they integrate social media into their communication practices and move towards a new vision of emergency response communication that includes and is tailored to needs of the diverse participants engaged in social media conversation surrounding a disaster.

Study One provides an overview of social media use across a population of emergency responders. It reflects general social media use during a widespread event and serves as a baseline for comparing both innovative practice and for comparison of how social media use evolves over time.

Study Two and Study Three look specifically at the implementation and continued evolution of virtual operational support across four years of study. It offers insight into how this group of skilled emergency responders came together for the first implementation and how the structures they have designed support the ongoing growth and evolution of virtual operational support and the resilience of this worldwide community of teams. It also compares two very different technologies-in-practice, one oriented towards continued innovation and one that supports the alignment of the formal and the informal. It also documents the growth of a grassroots movement from within emergency response that has been able to invent new structures and practices to successfully support the bridging of the gap between formal

response and new informal channels. These teams have also built a model of resiliency that should be considered in a world where technology can help to bridge the gap between on the ground response and the rest of the world.

Study Four and Study Five look specifically at emergency communication practices. Study Four analyzes the communication practices within a “best in field” example. Social media tools and technologies are continually evolving, but this case study shows how one organization carefully leveraged the tools at hand to provide a high level of coverage for their community that might otherwise have face information dearth. Study Five looks at new strategies for analyzing and identifying important segments of information within the conversation on Twitter surrounding an incident. In collaboration with two teams, I have identified a successful strategy for using ongoing knowledge of sources as a means for filtering down to individual and local content. Over time, this content reveals an ongoing narrative thread at the local level and the evolution of information across sources that were not visible at the tweet level. By trialing it across multiple teams and incidents, we were able to evaluate the contextual factors that influenced the value of different views of the information during an incident. Results look promising but more research is needed to assess the value of this information across different types of events and new strategies for analyzing this data in real time, with views and organization tailored to the response teams using this information.

## **9.9 Exiting the Research Site**

As my research draws to a close, I’ve had to think through my exit strategy from the research site(s). My role will change moving forward, but I still feel a strong commitment to this community and the work they are doing to support emergency response. I won’t be able to volunteer on the level that I have throughout the course of my research, but my plan is to continue my involvement as time permits, especially on larger incidents where more resources are needed or to help my local community. This level of volunteerism is common within the VOST community where many of its members have full-time jobs but help when they can.



## **9.10 Concluding Remarks**

The work being done within emergency response to adapt and evolve emergency public information practices within new communication channels is important. Providing accurate, timely and authoritative information is foundational for post-disaster response and organization of communities impacted by disaster. As public communication shifts to these new channels to share information and organize their efforts, it is imperative that emergency response organizations develop strategies to operate effectively within these channels as well. Learning to use social media tools to broadcast updates is only one piece of the puzzle. Making sense of this complex information space, and incorporating that knowledge back into emergency response and emergency communications is significantly more challenging. The growing body of crisis informatics literature demonstrates the complex and powerful work being done within this space by members of the public. This research offers an in depth look at the ongoing efforts of a small, but skilled community of emergency responders exploring new organizational structures and strategies for both making sense of this information space and bridging the gap between emergency public information and the communities they serve. I would argue that we are still in the early stages of the development of these practices and room for innovation and new ideas is critical. I would also argue that better tools are needed to help emergency responders capture and curate information as part of their ongoing efforts to capture relevant information and turn it into actionable knowledge.

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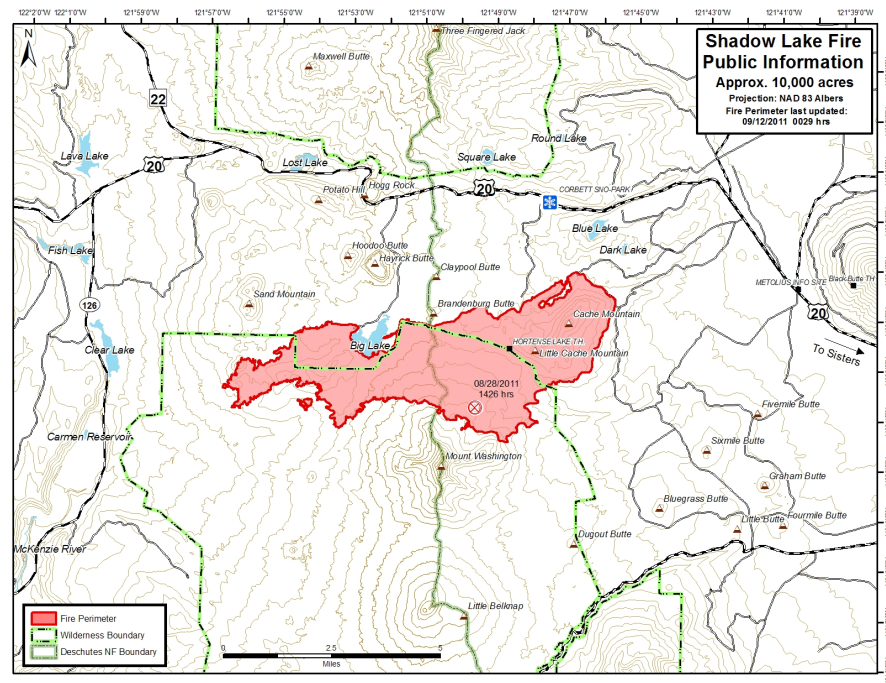
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## APPENDIX A. Incident Summaries

### A.1 The 2011 Shadow Lake Fire

*Incident Start Date: August 28<sup>th</sup>, 2011*



**Figure 31: 2011 Shadow Lake Fire Public Information Map 9/15/2011.**

Ignited by lightning, the Shadow Lake Fire began on August 28, 2011 in the Mt. Washington Wilderness—15 miles northwest of Sisters, Oregon (USA) and seven miles west of Black Butte Ranch. The Portland NIMO Team, a Type I team, took over management of the fire on August 31. Type I incident management teams are the most highly trained federally certified teams. Comprised of members through interagency agreements, these teams are called to manage the most complex and threatening wildland fires. On August 31, the fire, though serious, was still relatively small at an approximate 364 acres. The team used an indirect suppression strategy common in remote wildfires; they monitored the fire closely and confined it to the Mt. Washington Wilderness. This reduced the area's burn risk in future wildfires and offered the safest option for firefighters rather than placing them in a remote area with no roads, heavy downed wood, and no readily available safety zones. Despite precautions however, the conditions were such that the fire grew to over 10,000 acres in size, and resulted in the evacuation of the

Big Lake Recreation Area on September 3. Firefighters gained the upper hand on September 14, and the fire was reduced to smolder and smoke by September 18.

## **A.2 The 2012 Barry Point Fire, Oregon**

***Incident Start Date: August 6<sup>th</sup>, 2012***

The Barry Point Fire was started by lightning twenty two miles south of Lakeview in South-Central Oregon on August 6, 2012. The fire received heavy initial attack locally, but due to extremely dry fuels, drought conditions, and wind they were unable to catch it. A local Type 3 team took the fire until the Blue Mountain Type 2 team took over on August 9<sup>th</sup>. Complexity increased and a NIMO team was called to integrate with the Type 2 team, assuming command on the 13<sup>th</sup>. No social media had been put in place by earlier teams although there was a forest Flickr and Twitter account created on August 13<sup>th</sup> and the decision was made to fully engage with social media. A blog and Facebook account were added on the evening of August 13<sup>th</sup>. The fire continued to grow and was turned over to a Type 1 team on August 15<sup>th</sup>. The fire ultimately grew to over 93,000 acres.

## **A.3 The 2012 Hurricane Sandy, Eastern United States**

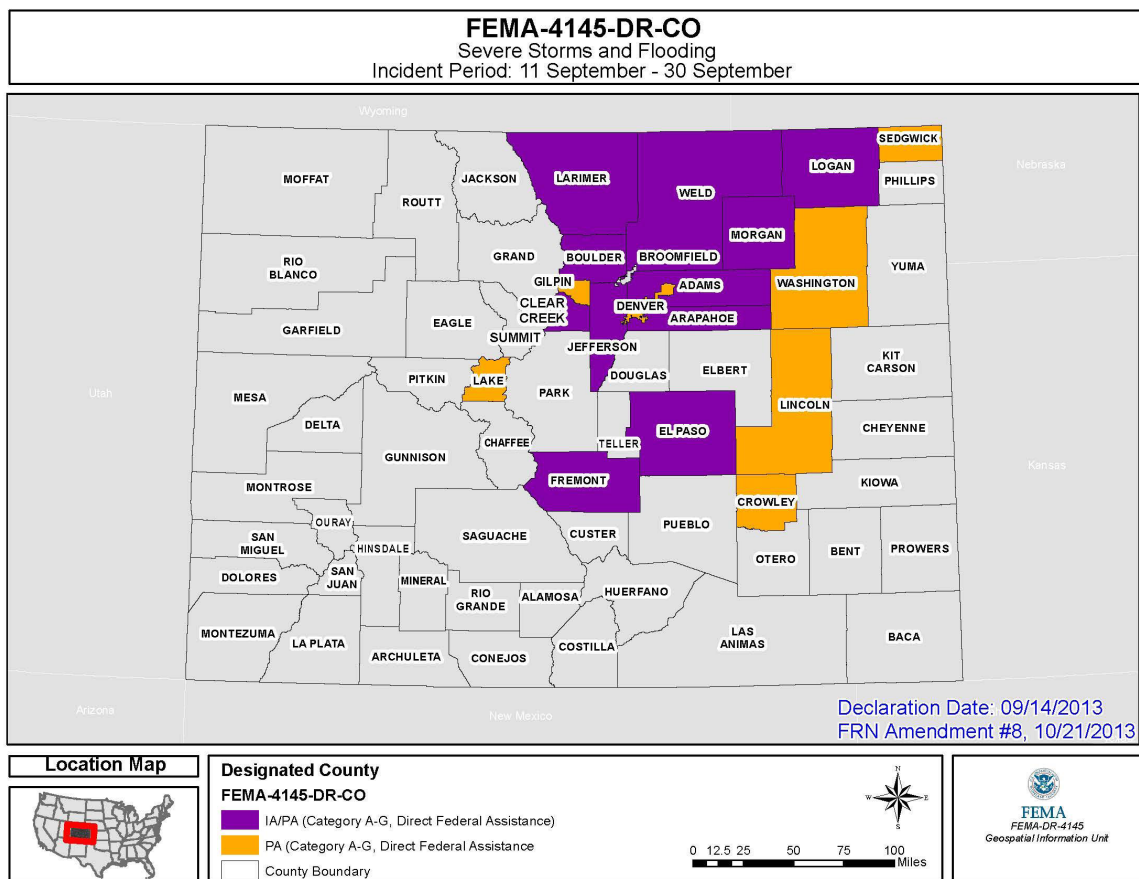
***Incident Start Date: October 29<sup>th</sup>, 2012***

On October 29, 2012 Hurricane Sandy made landfall at Brigantine, New Jersey, in one of the most densely populated regions of the United States (US). Hurricane Sandy was the deadliest hurricane (with 72 direct deaths) to strike the east coast in over forty years, and the second-costliest hurricane (estimated at \$65 Billion US dollars (National Climatic Data Center, 2013)) in US history (Blake, Kimberlain, Berg, Cangialossi, and Beven II, 2013). The storm displaced approximately 776,000 people (Yonetani & Morris, 2013) and damaged or destroyed over 650,000 homes (Blake, Kimberlain, Berg, Cangialossi, and Beven II, 2013). During the storm, nearly 8.5 million people lost power with outages lasting weeks in the more heavily impacted areas (Blake, Kimberlain, Berg, Cangialossi, and Beven II, 2013).

Several factors complicated the response to Hurricane Sandy. First, the impact of the hurricane was intensified by an existing winter storm system: a phenomenon known as the Fujiwhara effect (Fujiwhara, 1923) that caused the two storms to merge into one “superstorm.” Second, despite dire predictions from forecasters of extreme weather and a potentially lethal storm surge, a survey conducted after the event indicates that approximately 63% of residents in coastal areas chose not to evacuate (Gibbs & Holloway, 2013). Finally, a large winter storm—termed a Nor’easter—moved into the affected area a week later, causing additional difficulty for Sandy recovery efforts, especially for those still without shelter and/or power.

#### A.4 The 2013 Colorado Floods, Colorado

*Incident Start Date: September 9<sup>th</sup>, 2013*



**Figure 32: Counties Affected by Flooding in the 2013 Colorado Floods.**

The storm began on Monday, September 9<sup>th</sup> with steady rainfall forecasted throughout the week. On Wednesday, September 11<sup>th</sup> the storm intensified producing widespread flash flooding in the Denver-Boulder metro area. Mandatory evacuation orders were issued for parts of Boulder County—including Four Mile Canyon, Jamestown, and portions of the University of Colorado Boulder campus. Residents in affected areas were encouraged to shelter in place. Residents of some towns and cities in Boulder and St. Vrain County were isolated because of severe road damage. The National Guard evacuated residents and pets from mountainous areas by air. FEMA approved a Major Disaster Declaration on Saturday, September 14<sup>th</sup>.

### **A.5 The 2014 Carlton Complex Wildfire**

#### ***Incident Start Date: July 14<sup>th</sup>, 2014***

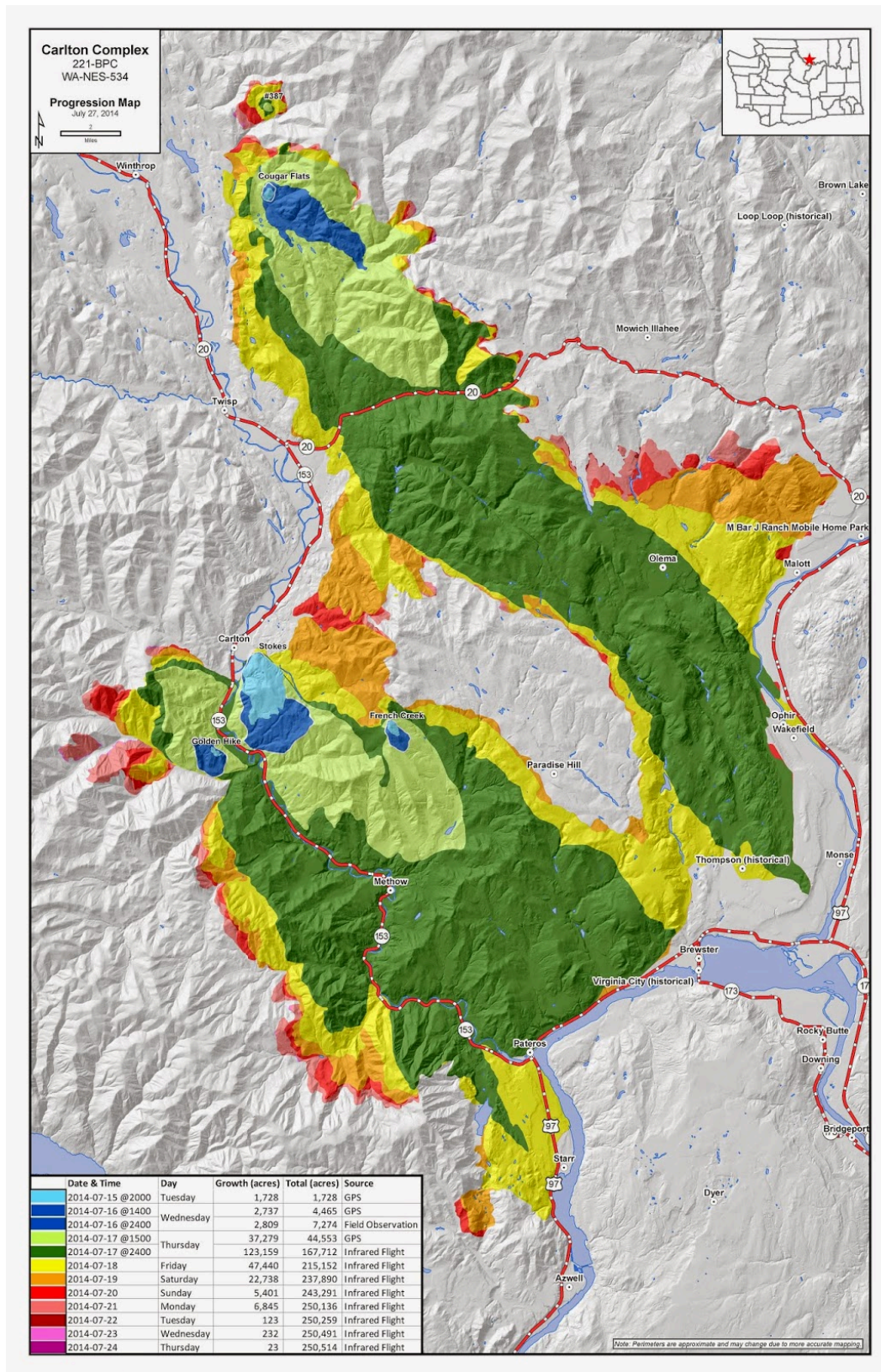
The Carlton Complex Fire ignited by lightning on July 14<sup>th</sup>, 2014 when a weather system moved through the Methow Valley, in northern Washington. The complex includes the Stokes Fire, the Gold Hikes Fire, the French Creek Fire and the Cougar Flats Fire. Hot weather and adverse wind conditions caused the fire to grow dramatically overnight from July 17<sup>th</sup> to July 18<sup>th</sup> to over 200,000 acres (see Figure n and Table n). The fire burned over a ridge into the towns of Pateros and Twisp burning approximately 300 residential structures. It damaged critical infrastructure resulting in widespread power and cellular outages. The PIO team reports that during the most active phase of the fire, a combination of rapid growth and critical infrastructure damage made sharing timely and accurate information challenging within the impacted community. Information sharing occurred through a variety of means including online sources and mainstream media where available, word-of-mouth, information posted within local community, printed handouts distributed by officials, and through personal contacts outside of the impacted area with access to updated information. The circumstances were so volatile that the PIO team focused primarily on managing information within the physical community and Facebook based on reports from the community that that was the easiest source to access from a mobile device. The VOST team provided social media monitoring support through the incident. By July 26<sup>th</sup> power was restored to most of the

Methow Valley. The Carlton Complex became the largest fire to date in Washington state history at 256,108 acres and occurred during the worst wildfire season on record.

Color Key	Date & Time	Day	Growth (acres)	Total (acres)
	2014-07-15 @2000	Tuesday	1,728	1,728
	2014-07-16 @1400	Wednesday	2,737	4,465
	2014-07-16 @2400		2,809	7,274
	2014-07-17 @1500	Thursday	37,279	44,553
	2014-07-17 @2400		123,159	167,712
	2014-07-18	Friday	47,440	215,152
	2014-07-19	Saturday	22,738	237,890
	2014-07-20	Sunday	5,401	243,291
	2014-07-21	Monday	6,845	250,136
	2014-07-22	Tuesday	123	250,259
	2014-07-23	Wednesday	232	250,491
	2014-07-24	Thursday	23	250,514

**Table 19: Growth Progression Key.**



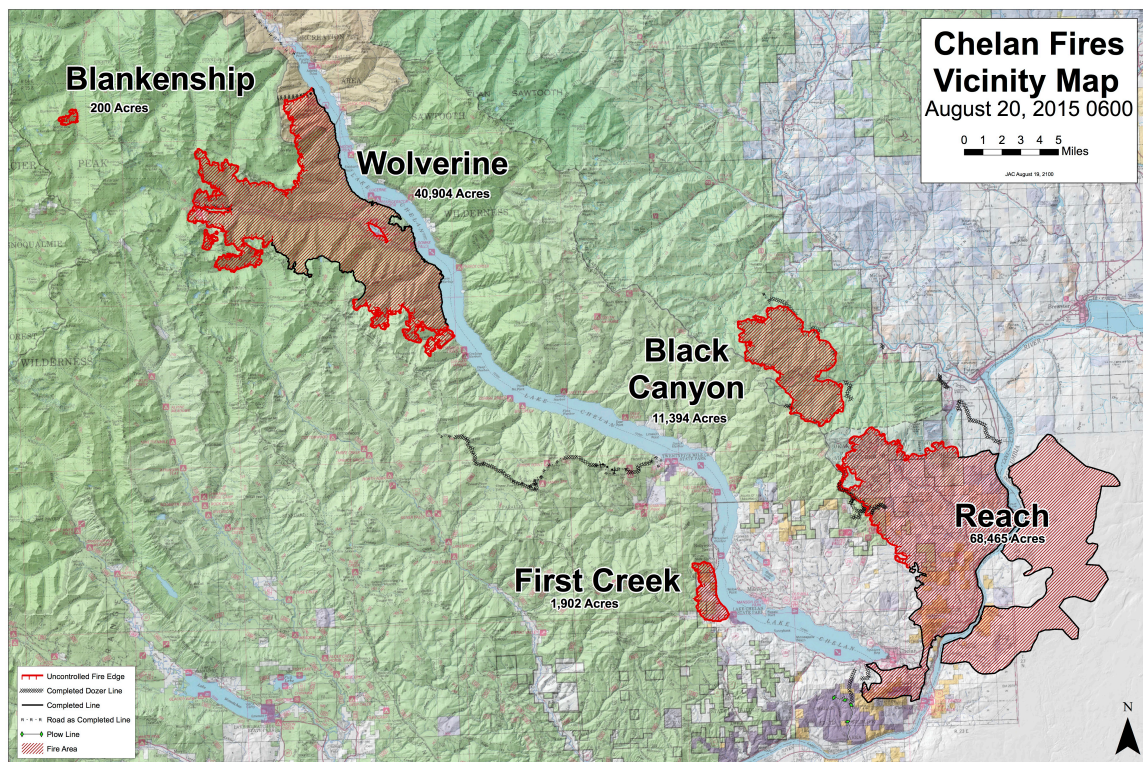


**Figure 33: Carlton Complex Fire Progression Map, July 27<sup>th</sup>, 2014.**



## A.6 The 2015 Wolverine Fire & Chelan Complex, Washington State

*Incident Start Date: June 29th, 2015*

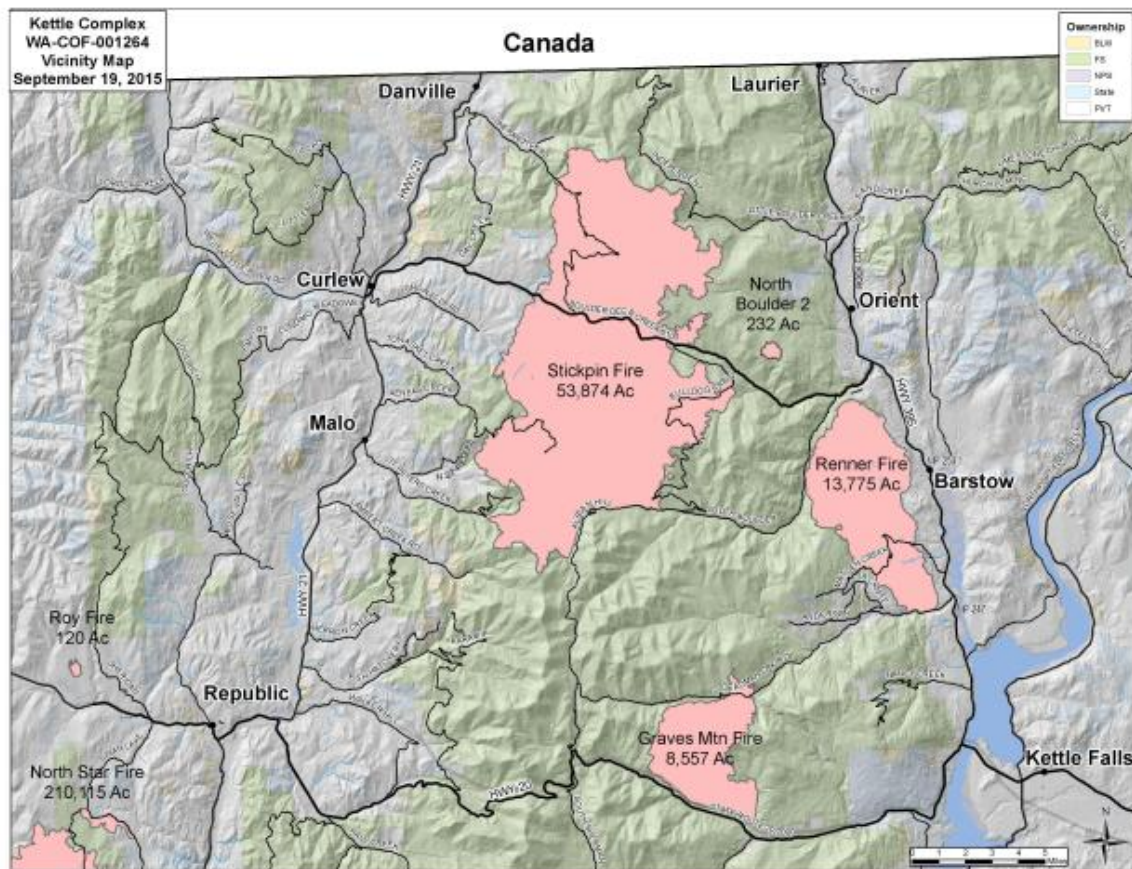


**Figure 34: Wolverine and Chelan Complex Perimeter Map.**

The Wolverine Fire ignited by lightning on June 29, 2015 three miles Northwest of Lucerne, Washington. When the Pacific Northwest National Incident Team 2 (PNW Team 2) took command of the fire on August 4<sup>th</sup>, the fire complex included the Wolverine Fire, Blankenship Fire and Goode Fire. Early in the morning on Friday, August 14<sup>th</sup>, a dry lightning storm ignited numerous fires in the vicinity of the town of Chelan. Crews and helicopters from the Wolverine Fire began assisting the local agencies battling five of these fires: Reach Fire, First Creek Fire, Antoine Fire, Cagle Fire, and the Black Canyon Fire. By 3pm in the afternoon, heavy winds began pushing the Reach, First Creek, Antoine, and Black Canyon fires to the Northwest burning into the town of Chelan. PNW Team 2 assumed command of the Reach, First Creek, Antoine, and Cagle Fires on August 15<sup>th</sup> at 0600. The fires combined into the Reach Complex and later renamed the Chelan Complex. In total, the Wolverine Fire grew to approximately 65,275 acres and the Chelan Complex grew to approximately 88,684 acres and consumed 51 structures.

## A.7 The 2015 Kettle Complex, Washington State

*Incident Start Date: June 29th, 2015*

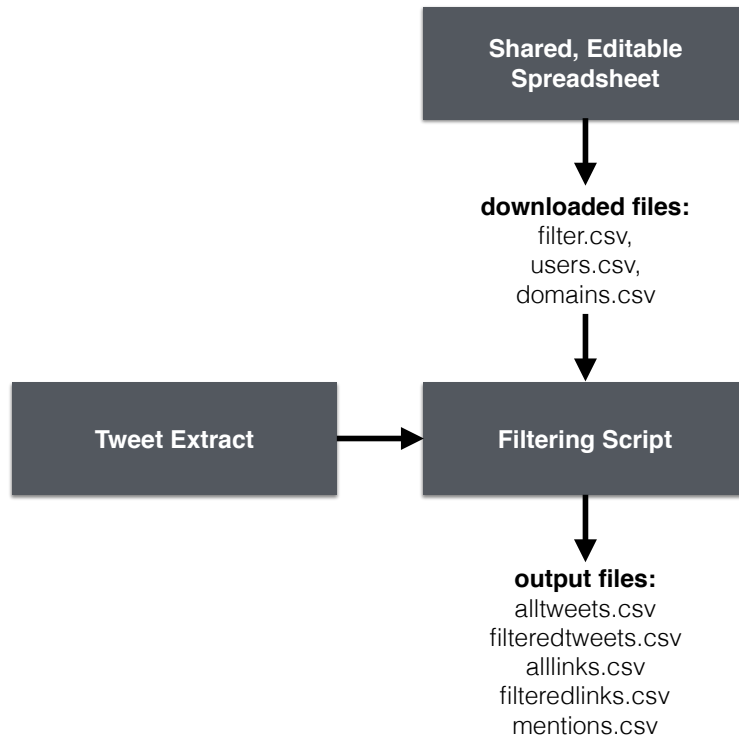


**Figure 35: Kettle Complex Perimeter Map.**

The Kettle Complex is composed of three fires: the Stickpin Fire, Renner Fire, and Graves Mountain Fire. The fires were ignited by a lightning storm on August 11<sup>th</sup>, 2015, burning just south of the Canadian border in Washington State. The combined acreage for the fires is approximately 76k acres.

## APPENDIX B: Overview of Tweet Filtering Process

### B.1 Overview



The filtering process takes a comma delineated tweet extract file, processes the data and determines the filter status for each individual tweets and the embedded content. By default, the criteria filters out content that is unlikely to contain information coming from individual and local sources (see section 8.4.1), but filtering criteria can be reconfigured based on team preferences or to adjust to changing circumstances during an incident (e.g. low volume). The filtering criteria are is defined in an editable, shared spreadsheet that also stores the source classifications used in the filtering process. There are three tabs in this spreadsheet: the *filter* tab specifies which source types are left *in* or filtered *out* by the filtering script, user classifications, and URL domain classifications (see specification in section B.). If changes are made to this spreadsheet, download the updated information before running the filtering script.

The filtering script generates five output files: one containing all tweets processed, one with filtered tweets, one with all embedded content, one with only those that are in the current filter, and one with all mentions (see file specifications section n).

I have simplified the file names in the diagram above, but I typically build the file names as *incident + date + extract# + output filename*.

## B.2 Filtering Script Algorithm

**Pre-processing step:** download the most recent data for filtering criteria, user source types, and URL domain source type classifications

### Processing steps:

**Step 1:** Open and read in the filtering criteria, user classifications, and URL domain classifications

- Read in the filter classifications and create filtering classifications table
  - Read in the URL domain classifications and create domain classification table
  - Read in the user classifications and create the user classification table
- If the user has a URL domain and it doesn't exist in the domain classification table then add it (defaulting to the user classification e.g. media)

**Step 2:** Create output files and write headings (see output spec n.n)

- Create tweet output file (all tweets) & write headings
- Create filtered tweets output file & write headings
- Create URL output file & write headings
- Create filtered URL output file & write headings
- Create mentions output file & write headings

**Step 3:** Calculate retweets

- Read previous retweets counts into retweet table
- Scan each input file and adjust retweet counts if higher value found

**Step 4:** Process tweets in input file list (Process tweets contained in each extract file)

### For Each Tweet:

- Set retweet flag (True if retweet flag set or text indicates it is RT or MT)
- Process the URL list for the tweet - **for each URL:**
  - Strip the url domain & strip the leading characters and trailing meta-characters from the URL so that links can be classified and compared across tweets
  - Determine the URL domain classification by looking up in domain classification table.
  - Format fields and save URL to link file(s)
- **If there is embedded media** – get media screen\_name, strip out domain, classify and write to the link output file(s)
- Process the mentions for the tweet - **for each mention:**
  - Format data and write to mention file
- If filter status = 'in' format and write to filtered tweets file
- Format data and write to tweet file(s)

**Step 5:** Save retweets

**Step 6:** Save new list of *newdomains*



### B.3 Source Definition Spreadsheet

There are currently three tabs in the source classification spreadsheet: classification, users, and URL domains. Column definitions are defined below. The *classification* tab defines the set of categories currently being used in the filtering process and whether it is currently ‘in’ or ‘out’ of filtering criteria. Unknown sources are included in the filtered set by default. The *users* tab contains all currently classified Twitter accounts. The *URL domains* tab contains all currently classified Twitter accounts.

Column Name	Description
Classification	Source Type e.g. media, official – em/fire, individual
Filter Status	‘In’ means keep for review ‘out’ means filter out

**Table 20: Classification Tab Columns.**

Column Name	Description
Screen Name	The Twitter Account ‘screen_name’ column from the extract
Classification	Source Type for this User e.g. media, em/fire tweeter, individual
Add Date	Date the user was added to source table
Incident	Incident name when the user was first added to the source table
User URL Domain	URL domain defined in the user profile

**Table 21: User Tab Columns.**

Column Name	Description
URL Domain	The URL domain for an embedded link
Classification	Source Type for this User e.g. media, official, individual
Add Date	Date the user was added to table
Incident	Incident name when added

**Table 22: URL Domain Tab Columns.**

### B.4 Data Cleaning and Classification Process

I used *OpenRefine*, an open source data-cleaning tool, to clean the data and to identify and categorize commonly occurring Twitter account and URL domain sources. Within *OpenRefine*, I first clean up any typos or errors across the source category classifications, and then look at the commonly occurring *unknown* sources. For each of these, I click on the relevant user or URL domain link for more

information. Each of these is categorized based on the information contained within the user profile or web site (see Table 8.2).

## B.5 Data Analysis Process

I used *Tableau*, a data visualization and analysis tool, for aggregated data analysis and visualization.

## B.6 Output File Specification

Column Name	Description
Row	File row number – used for debugging purposes
Tweet ID	Twitter Tweet ID
Timestamp	Tweet timestamp
Local Time	Timestamp adjusted to local time
Local Date	Local date mm/dd
Is Retweet	True if the tweet is a retweet – script parses for variations of ‘RT’ and ‘MT’
Retweet ID	ID for original tweet (if known)
User ID	Twitter User ID
User Class	User classification – based on content of users.csv Default = ‘unknown’
User Link	Link to user account on Twitter
Retweet Count	Retweet count for tweet
URL	First URL in ‘URLs’ field
URL Domain	First URL domain
URL Domain Class	URL Domain classification for first URL in URLs Default = ‘unknown’
URLs	List of embedded URLs for the tweet
URL Domains	List of URL domains for <i>URLs</i>
URL Classes	List of URL domain classifications for <i>URLs</i>
Mentions	List of mentions for tweet
Coordinates	Lat/Long Coordinates for tweet
Media URL	URL for embedded media
Media Screen Name	Screen name for embedded media
Media URL User Class	Classification based on <i>Media Screen Name</i>
Original Tweet	Link to original Tweet
Incident	Current incident name
Text	Text content for the tweet

**Table 23: Tweet Output File Specification.**

Column Name	Description
Row	Row number for tweet – used for debugging purposes
URL	Fully expanded URL with meta-characters stripped from front and back
URL Domain	URL domain for current link
URL Domain Class	URL Domain classification for current URL Default = ‘unknown’
Is Retweet	True if the related tweet is a retweet
Retweet Count	Retweet count for tweet
Retweet Num	Number of retweets for this tweet up to this point
Retweet ID	ID for original tweet
Local Time	Local timestamp for the related tweet
Screen Name	Screen for related tweet
User Class	User classification – based on content of users.csv Default = ‘unknown’
Incident	Current incident name
Original Tweet	Link to original tweet
Tweet ID	ID of original tweet

**Table 24: Link Output File Specification.**

Column Name	Description
Row	Row number for tweet – used for debugging purposes
Screen Name	User screen name field for author of tweet
User Class	User classification – based on content of users.csv Default = ‘unknown’
Mention	Mention (screen name)
Mention User Class	User classification for the mention – based on content of users.csv, Default = ‘unknown’
Local Time	Local time of tweet
Local Date	Local date mm/dd of tweet
Original Tweet	Link to original tweet
Tweet ID	Twitter ID for original tweet
Is Retweet	True if the related tweet is a retweet
Text	Text content for the tweet

**Table 25: Mention Output File Specification.**