Social Media as Local Crisis Infrastructure: The Interconnected Work of Citizens, Responders, and Journalists in the Social Media Crowd

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Abstract

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and Journalists in the Social Media Crowd

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This research considers the role of social media after the deadly 2014 Oso Landslide: how impacted community members, responders, volunteers, and journalists made use (and sometimes did not make use) of social media. Drawing on CSCW, HCI, and Crisis Informatics scholarship that treat social media systems as sites of information work, this study employs several methods to understand social media use after the Oso Landslide including extensive analysis of the public digital record, interviews, sites visits, and post hoc participant observation. Common sampling, computational, and quantitative techniques used by social media researchers are integrated into an interpretivist ethnographic approach thereby enabling an examination of social media use in the broader context of the affected community's information work following the disaster.

This study finds that social media were widely used by citizens, responders, and journalists working within the crisis-affected region. Though social media were not used by everyone in these groups, social media platforms played a substantive role in the information work for each of these groups. In some cases, social media were the primary means for doing certain kinds of information work pertaining to the crises and were integrated into many aspects of the response. The breadth of work

and nature of the work taking place through these systems makes these systems candidates for consideration of *social media as local crisis infrastructure*. Yet, what is visible on social media is only a partial lens into community information work. Institutional arrangements, coordination practices, local cultural practices and sensibilities shape what is visible on social media. A desire for privacy and other practical considerations shape what community members, volunteers, and responders choose to share publicly. Many chose private or semi-private use of social media for community conversation, suggesting an ongoing need for trusted community information intermediaries.

In this new kind of infrastructure, traditional regional media continued to play an important role, serving as common resources across responder and citizen interviewees who continued to reply upon news produced by regional journalists that circulated through social media and other mediums. Looking at several key instances of publicly visible online information work over different points of time, this work reveals that the social media work of citizens, responders, and journalists were often inter-dependent. From the earliest tweets raising public awareness of the landslide minutes after it occurred to post-emergency considerations of accountability, future preparedness and mitigation years afterwards, citizens, responders, and journalists played complementary and distinct roles in the production and dissemination of information. Aligned with pre-social media arrangements, journalists in regional news organizations with ties to print and broadcast followed by regional responding organizations were important as information sources. Different from pre-social media arrangements, citizens were active curators and disseminators of information from journalists and responders. This suggests that though social media have reshaped the contributions of citizens, responders, and journalists to public crisis information, their respective contributions remain tied to their social roles, their respective resources, practices, and their specific relationship to the impacted community.

Together, these findings suggest that effective community information work is more likely to be the product of synergistic and complementary information work by citizens, responders, and journalists than it is to result from the work of one of these groups alone. Thus though social media has created new platforms for participation, enabling dynamic citizen and responder communication during emergencies, evidence here suggests journalists have not been replaced. Regional journalists were instrumental to *civic sensemaking* about the landslide from the earliest moments of the crisis through long term recovery. Considering the crisis-related information work of journalists, citizens, and responders as related and interdependent leads to a different way of conceptualizing local crisis infrastructure. Because local journalism is in decline, these findings have consequence for considering the crisis information infrastructures that can support communities in future emergencies.

Contents

Dedication

This work is dedicated to all who responded to the Oso Landslide. To the friends, family members, community members and survivors. With particular remembrance to the 43 people lost.. May this work honor their memory. May it serve in some way to prevent similar tragedies.

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Introduction

Overview

Ever since social media systems became widely adopted the relationship between traditional media and social media has been contested. The accelerating decline of the traditional news industry and the simultaneous cultural ascendency of social media systems elevate concerns about the rapid shift taking place in how we become informed about important matters such as crises. "Traditional media" and "social media" are two concepts intractably loaded with meaning. By focusing on the role each played in supporting a crisis-affected community in the aftermath of a deadly U.S. landslide, this research sharpens the focus on these systems as they pertain to one critical use case, disasters and their aftermath. Concurring with numerous case studies of social media use in the aftermath of crises, this research finds social media were integral to the information work of citizens and responders from just minutes after the landslide through years into long term recovery. Yet, complicating narratives about social media systems as platforms for unmediated citizen and responder activity, a closer look in this case reveals traditional media were a strong presence on social media. The contributions of regional journalists in particular are hard to separate from the social media-supported work of citizens and responders.

This study builds on 15 years of Crisis Informatics case study research looking at social media use in the aftermath of crises. Drawing on methods and techniques widely used in Computer Supported Cooperative Work, this research gives an ethnographic account of the information work of citizens, responders, and journalists post-crisis, closely examining coordination and collaboration that took place through social media systems. Informed by theories of social behavior formulated in Disaster Studies, this research privileges the experience of the affected community, uncovering and contextualizing how community information work took place (and sometimes did not) through social media systems.

For citizens, responders, and journalists within the region, social media were integral to many kinds of important information work. Social media platforms were in several cases the primary or foremost means of producing and sharing information about the landslide. In other cases, social media platforms were important complements to other forms of communication. Though certainly not everyone involved in the response used social media, the breadth and importance of information work taking place through social media platforms make them candidates for consideration as local crisis infrastructure. The flexible, heterogenous arrangements that social media systems afford fit well with the demands of the emergency period. Though flexible, these arrangements are not without form. Citizens, responders, and journalists can be seen in several instances making distinct contributions respective to role-specific practices.

Notably, civic information in the long term was closely associated with regional news organizations.

The Deadly 2014 Oso Landslide

This dissertation follows the aftermath of a tragic event: the destruction of a rural neighborhood, the rescue of a handful of survivors, the recovery of the human remains of 43 lost lives, and long term efforts to rebuild, remember, restore, and heal.

Figure 1. Aerial photo showing the full extent of the 2014 landslide area taken from the east. The damned river and flooded houses are visible in the foreground. The debris in the center covers the former Steelhead Haven neighborhood. Credit: Mark Reid, USGS (Public domain.)

The Steelhead Haven development was, in many ways, not very different from thousands of neighborhood enclaves across the United States. Just off a state highway, the forty-some late-20th century houses and cabins were typical middle class housing stock. The most distinctive trait of the enclave was location. In 1960, when realtor and developer Genevieve Taylor petitioned Snohomish County to parcel 48 acres along the North Fork of the Stillaguamish River in the North Cascade Mountains of Washington State for cabins, houses, and mobile homes (Baker and Armstrong, 2014), the name she gave the proposed development perfectly evoked the spot's appeal. Both sport and commercial fishers alike already frequented "The Stilly" to fish steelhead trout and salmon. With only one road traversing the valley (State Highway 530) and only one industry (logging), the valley retained much of the natural beauty it had when Europeans first encountered the Stillaguamish Tribe living along the river in the 1850s.

Yet how it was that anyone was allowed to build in that particular location is an open question. The hill north of the development was unstable. The deposits of glacial debris that comprised "slide hill" had been coming down for a long time. Evidence of slide activity stretches back before human occupation of the valley. At the foot of the "slide hill" is a flood-prone river. In the soft glacial deposits that comprised the valley, the river tended to move, sometimes by hundreds of meters. Tucking the development into the bend of the river made it vulnerable to two serious natural

hazards.[1] By the early 1950s, several state agencies had also identified the location as problematic. A number of engineering solutions were considered, some taken. The state also considered buying out the private property owners, but was unable to raise the funds to do so. All of this occurred before the first cabin in Steelhead Haven was built.

Yet, once the land was parceled, people quickly arrived. Some built simple riverfront cabins for recreational use, others permanent homes. In retrospect, it may seem surprising that even when a landslide destroyed most of the structures in Steelhead Haven in 1967 (through, thankfully, took no human lives), building resumed again in 1970. But the area was beautiful. The land was cheap.

What those who lived in Steelhead Haven understood of their risk is an open question. According to the U.S. Geological Service, landslides are a threat in all 50 states and kill on average 25 people a year in the U.S.[2] (USGS, 2017). There are likely thousands upon thousands of people living in slide prone areas who either do not understand the risk or are willing to play the odds. County and state agencies had been saying the area around Steelhead Haven was unsafe since at least the 1950s, yet, with pressure from landowners, over that same time, pursued several engineering solutions such as reinforcing the north side of the river bank to reduce risk at the site. Such efforts may have signaled to homeowners that the risk was manageable. Reporting after the 2014 slide, The Seattle Times wrote that the county had again considered buying out homeowners as recently as 2006, but, reportedly, homeowners weren't interested (Baker and Armstrong, 2014).

Saturday morning March 22, 2014 started like any other. Some in the neighborhood were running errands, others were at home. It was sunny (Keaton et al, 2014). For residents of the Pacific Northwest, where winters are rain-soaked and overcast, a sunny day in early spring would have been appreciated by Steelhead Haven's nature-loving residents. The previous three weeks in particular had endured relentless rain. Though rain is a fixture of spring in the Pacific Northwest, the previous two months had seen rainfall accumulations 150% above average (USGS, 2017). The sunshine that day belied the fact that the hill above Steelhead Haven was saturated with water. Seismic readings in the region had noted a 1.1 earthquake nearby around 8 am— not usually significant in the seismically active region. Other seismic readings examined later picked up what appeared to be human activity near the slide area. These readings would raise questions about what contributed to destabilizing the hill. The immediate causal factors would be explored later through research by various experts and, as is common in the U.S, through lawsuits brought on behalf of survivors.

Whatever the cause, at 10:37 AM local time the hill began to avalanche (Allstadt, 2014). Depending on the source[3], it took between one and four minutes for 18 million tons of sand, till, and clay (USGS, 2017) to flow over Steelhead Haven. According to USGS, "That amount of material would cover approximately 600 football fields 10 feet deep."

Deposits up to 25 feet deep damned the North Branch of the Stillaguamish River, forming a temporary lake 2.5 miles in length. This flooded houses to the east of Steelhead Haven (USGS,

[1] The Stillaguamish Tribe freely shared their advice to avoid living in the spot with anyone who cared to listen.
[2] The USGS article does not mention the threat of slides on tribal lands or U.S. territories such as Puerto Rico. In light of recent disasters in U.S territories, consideration should be given to how dividing up reporting in this manner impacts preparedness for these regions.
[3] There are slight differences in details between different technical and public reports that explain how the slide occurred, range of impact, and so forth. Ironing them out these minor differences is outside of the scope of this research.

2017), necessitating swift water evacuations. The river would not resume its normal course until mid-May.

As the hill debris met water from the river it became a slurry of rock, water, and mud, thereby increasing the slide's speed and force (USGS, 2017). Sweeping across the valley at an average speed of 40 miles an hour, the slide bulldozed structures in its path, burying them in mud up to 70 feet deep in some places (Patel, 2014). In just a few minutes, exceeding the worst-case scenarios that county planners had relied on in their hazard assessments of the area, 47 structures were destroyed and 43 lives were taken. The youngest was only 4 months old, the oldest, 91.

Debris slurry moved over Steelhead Haven from the north, crossing over a one mile stretch of Highway 530, destroying the road and damaging structures on the side of the valley opposite Steelhead Haven. The mile-long road blockage effectively sealed off those living at the east end of the Stillaguamish Valley including the 1347 residents of the logging town of Darrington. As residents of a rural small town, the people of Darrington were used to long commutes to the more populous areas to the west where they worked, went to school, got health care, and so forth. Until a temporary road was put in place weeks later, an additional 80 miles/90 minutes of driving each way was tacked on to these essential trips. Extra time and cost of travel taxed Darrington residents, many of whom were of modest means. For three weeks after, the town's food pantry regularly averaged 1300 patrons a week. The disruption to this essential road explains one of the two names given to this slide, "SR 530Slide". "530slide" was predominantly used by county and state responders during the emergency and persisted in official reports and related thereafter.

Divided by the landslide, and with communication limitations on-site, rescue operations started up somewhat independently on either side of the slide. First on scene were the local firefighters from Oso (4.5 miles to the west of the slide) and Darrington (11.5 miles to the east of the slide). As in many rural areas in the United States, the fire companies near the slide are comprised of community volunteers who are trained and empowered to respond in such emergencies. The magnitude of the slide quickly became apparent. Calls for "mutual aid[4]" went out within minutes. Nearby volunteer fire departments in Snohomish and Skagit counties quickly mobilized, along with regional Search and Rescue teams (also volunteers), Washington State Patrol and other agencies.

As volunteer and professional responders from the region mobilized, one of the first responders on scene hiked to the top of a nearby slope to understand the scope of the slide. As he made his way to the summit, he made his progress known to fellow responders via emergency radio. (His messages were recorded and later shared over YouTube). Calling what he saw a "Type 1 Incident", the responder conveyed the magnitude of what he saw to everyone listening. A "Type 1 Incident" is, in the emergency management parlance of the United States, the classification for the most complex kind of incident according to the system of emergency plans used to coordinate emergency responses (FEMA, 2017). Type 1 Incidents are those that exceed the response capabilities of local, county, and state resources. In such cases, the Federal Emergency Management Agency coordinates response efforts and supplies additional resources.

Indeed, over 30 government agencies— federal, state, local, and tribal— along with dozens of private contractors were involved on-site as part of the official recovery and repair operations within the first

[4] "Mutual-aid agreements" are pre-arranged agreements between response organizations to provide support when called upon. It is common for adjacent local jurisdictions in the U.S. to have mutual aid agreements in place.

few weeks. The one square mile of damage was a busy worksite for at least 1000 people. The last human remains were not recovered until July. Highway 530 repairs stretched into September. Redress for victims and survivors stretched out years. Lessons learned for other landslide-prone communities are still being researched and articulated through government sponsored research and planning initiatives at the local, regional, state, and national levels of government.

Though it was unclear what danger these volunteer and professional rescuers were subjecting themselves to by entering an active slide area, 8 people were rescued that Saturday. Given the potential danger of working in an active slide zone, somewhat controversially, nearby community members also rapidly responded the day of the slide. Claiming both needed general knowledge of the area along with equally necessary specialized knowledge and equipment to access the mud field, local loggers supplied their equipment and expertise to reach and navigate the vast mud field. Unfortunately, after that Saturday there would be no more rescues. Because most of the response personnel and resources accessed the landslide from the west and because the Oso Fire Station was the closest response organization on the west side, the slide also quickly became known as "The Oso Landslide" or "The Oso Mudslide".

In parallel to the FEMA-coordinated official response[5], a large volunteer-driven community response mobilized. To collect the massive amount of spontaneous donations of household goods and clothing, an all-volunteer effort took over a large warehouse in the closest city to the west (Arlington). The warehouse overflowed with goods offered to the few survivors. A horse farm near the slide became the collection point for donations of pet supplies that also arrived in massive quantities for the few surviving pets.

Much volunteer work focused on meals and food donations. The Darrington Community Center offered free dinners to any who came for several weeks. Volunteers from the regional response community used their off time to cook hot meals for those on duty on the site—sharing that responsibility with local restaurants, coffee shops, and even an insurance company. Supplies such as boots and shovels were collected for those working on-site. And so on.

Numerous Fundraisers and memorial events were mounted. Music concerts and marathons and balls have marked the anniversaries. They continue to the present. At the 5th anniversary, a beautiful permanent memorial was placed on-site, designed by a regional artist to commemorate "the deadliest landslide in U.S. history." Where the entrance to Steelhead Drive once was, a metal sculpture of mailboxes now represents the victims and the homes they loved enough to risk their lives for. The stretch of Highway 530 is now officially called "The Oso Slide Memorial Highway."

The Importance of Social Media in the Slide Response

As with so many crises of the early 21st Century, social media were important in the aftermath of the landslide. Social media were integrated into the work of the 30 plus response agencies involved in the immediate aftermath of the disaster. Minutes after the landslide, Washington State Patrol began tweeting about the landslide. With phone and internet communications down due to the slide, county

5 A common misconception is that FEMA has a standing army who respond to disasters. Rather, FEMA is more of a coordinating mechanism for moving resources between municipal, state, and private entities. For example, one of the community liaisons FEMA deployed to Oso was a fire captain from Boston. Recovery teams drew from police and fire departments out of Texas, Indiana, and elsewhere. These additional resources coordinated through FEMA supported the mission of the lead local response agency in this case, Snohomish County.

officials asked members of the public to relay messages to officials in the town of Darrington via Facebook. In the following days and weeks, other agencies including FEMA, Washington National Guard, the Washington Department of Transportation, the US Geological Service, NASA, and dozens of other government agencies would connect with the public via social media, as would Washington's Governor, U.S. Congress Members, and many other elected officials.

The #530slide Twitter hashtag introduced by the lead response agency, Snohomish County, was appended to official updates on response progress for several weeks after the slide. Following the hashtag was a good way to stay up to date on the response. Response organizations used public Twitter posts and direct messages to communicate with news organizations. FEMA community liaisons joined community controlled Facebook pages and groups to raise awareness of recovery and memorial planning meetings. Liaisons privately messaged with surviving family members via Facebook, when that was the family's preferred mode of communication. The Washington Department of Transportation (2014) used a Flickr account to share photos of the damage.

Official response made much use of social media because they have become a standard way to engage the public. *Citizens*– used here to denote individuals who had no official, professional role in the emergency response– brought awareness of the slide into the public sphere through public and private posts on Twitter and Facebook just minutes after the landslide occurred. They mused about the causes of the slide on Reddit. They curated Pinterest boards of the slide's damage. On Facebook they made event-specific pages to coordinate community response activities, discussed rebuilding plans with government liaisons in hyperlocal news pages, and debriefed privately with each other about the status of recovery efforts. They created GoFundMe pages to raise money for survivors. They posted numerous YouTube videos and blog posts. They stitched together a narrative account of the landslide and its aftermath on Wikipedia that continues to evolve with time. They marked event anniversaries on dedicated Facebook memorial pages and hyperlocal news groups. In these ways, and many others, social media were woven into the fabric of the official and community response to the disaster.

What of Traditional Media?

Given the longstanding role that traditional media have played in informing the public after disasters, it is interesting how much of the information work of a contemporary crisis response can be told without mention of traditional media.

The narrative told above aligns with early social media evangelism that viewed social media platforms as ways for "the people formerly known as the audience" (Gillmor, 2006) to engage in "random acts of journalism" (Bruns, 2016). This has been borne out in numerous studies over the last 15 years that show citizens leveraging social media systems to do vital information work during crises. Likewise, crisis responders including official government organizations now regularly use social media to engage with the public during crises. Occasionally, in the field work of this study, I heard emergency responders and people working for social media companies promote the adoption and use of social media by response organizations as a way to circumvent traditional media, positioning social media platforms as an "unmediated" way to reach citizens. Conversely, citizens sometimes explained their crisis-related information work via social media as filling a gap not addressed by journalists. Such statements are indicative of the many different perspectives in play on what effective crisis information is and how it is achieved. There is certainly some truth to the argument that journalism is being displaced and some logical rationale behind claims that others— whether responders or citizens— should fill the gap.

Yet a closer look at social media activity pertaining to the Oso Landslide reveals the partial nature of these truths: traditional media were a strong presence on the social media platforms leveraged by citizens and responders during the emergency. Looking closer still, regional news organizations with

ties to the legacy infrastructures of print and broadcast news were particularly prominent in many of the online spaces with which responders and citizens engaged. Such findings suggest that in the complex information environments of today's crises, the question of who-is-mediating-what to-what-effect turns out to be more provisional, more nuanced, and more complicated than we are often able to fully consider. This study addresses one aspect of that complexity: *the relationship between the information work of citizens, responders, and traditional journalists that takes place through social media systems when crises occur.*

Contributions of This Work

This research tightly focuses consideration of "traditional media" and "social media"— two concepts intractably loaded with meaning— by streamlining their consideration to one important dimension of media systems: information work. Drawing on the sub-genre of Human Computer Interaction research known as Computer-Supported Cooperative Work (CSCW), this research starts with the question: *What social and technical arrangements supported the information work of the crisis-affected community?* CSCW looks at social media systems as sites of information work. This research draws upon the rich array of techniques CSCW has developed to understand information work on social media platforms.

This research is informed by received wisdom in Emergency Management practice and Sociology of Disaster findings that position crisis-affected communities as "the first responders" and view disaster response as largely organized around supporting the affected community. Therefore this research focuses on the social and technical arrangements that supported *pro-social* information work of benefit to the affected community.

This research is anchored within and builds upon a particular genre of CSCW research, *Crisis Informatics*. Crisis Informatics has built up a strong corpus of case studies on the use of social media during crises by citizens and responders. Crisis Informatics researchers have considered traditional media's role in relation to citizen and responder information work on social media from many different angles. To that corpus, this research gives symmetric consideration to the social media information work of journalists alongside citizens and responders.

Most studies examining information work that takes place through social media systems during a crisis have focused only on the emergency phase. However, the information work that follows after disasters, mass-casualty events, and other complex or large-scale crises continues for years, sometimes decades, afterwards. This research considers a wider time-frame from the initial emergency through the first five years of long term recovery.

From this vantage point, several important attributes of the social and technical systems that supported the crisis-affected community come into view:

Contribution 1: Social Media as Local Crisis Infrastructure

This work will show that social media systems performed as local crisis infrastructure during the emergency phase of the disaster. Social media systems were important sites of work for those in the affected community and those who supported them during the emergency. Therefore, *social media systems may be considered a form of local crisis infrastructure.* However, when information work done through social media is placed in the context of community response, it becomes apparent that what is publicly visible on these platforms is shaped by the intentions, goals, and needs of community actors. Absent of contextual knowledge of local arrangements and practices, social media can be an imperfect lens into affected communities.

Contribution 2: Distinctive, Interdependent Social Roles within Digital Mass Convergence
An early and persistent finding in the Sociology of Disasters is that individuals spontaneously converge on sites of disaster and social roles blur as everyone works to meet the demands of the crisis. Crisis Informatics studies have demonstrated that this pattern of spontaneous mass convergence extends into the digital sphere. This work shows that citizens, responders, and journalists were all important in the digital convergence that took place on social media platforms. In some cases, the information work of these groups appears independent; in other cases inter-dependent and complementary. This complicates the idea that the social media crowd is interchangeable. Rather, the findings of this case study suggest that *effective community information work is more likely to be the product of synergistic and complementary information work by citizens, responders, and journalists than it is to result from the work of one of these groups alone.*

Contribution 3: Displacement without Replacement: Local Journalism and Civic information
Though a full spectrum of different kinds of media were active around the landslide, this research will show that a particular kind of media maintained an important and distinct role in producing information vital to the affected community: Journalists working in traditional news organizations situated within the disaster region with ties to print and broadcast were important information mediators during the emergency within the information work that took place via social media. Regional journalists were important to online information sharing from the first minutes of the crisis through long term recovery. I argue the *ongoing production of information about the landslide by regional journalists contributed to civic sensemaking as the meaning of the landslide was interpreted and reinterpreted in light of current community concerns.*

Why This Matters

Social media have become important tools shaping how individuals, organizations, and governments respond to disasters. Social media increasingly shape our understanding of disasters. Since this study began in 2015, awareness and concern has grown around the fact that social media can be vehicles for mis- and disinformation that distort or even deny a crisis-affected community's experience. At the same time, we seem ever-more dependent on these systems when crises strike. Understanding the social arrangements that support the information work of crisis-affected communities is an important consideration in larger debates and proposed interventions in "fixing" social media. Developing such an understanding takes on greater importance now as I write in 2020, a year in which a global pandemic has brought the experience of crisis to each of our doorsteps. A better understanding of the social arrangements that enable pro-social information work to occur via social media systems in the wake of a crisis can inform a range of potential design and policy questions.

Understanding who contributes to such pro-social information work is also a matter of equity. Just as social media have ascended in prominence and power, the trajectory of traditional journalism in the 21st century has been one of devolution. Starting with policy changes in the 1990s that led to widespread changes in the economics of the news industry, newsrooms have been closing, trimming back staff and cutting back on what they cover. Audience migration to the internet exacerbated that trend. Though audiences still want news, the business case for providing it has become ever harder. News organizations compete (largely unsuccessfully) for ad dollars against search engines and social media companies, and the Ad Tech industry, a complex web of companies that place programmatic advertising on websites through automated auctions. Following a decades-long trend, U.S. news organizations decreased newsroom staff by 23% between 2008 and 2019, with newspapers losing half their newsroom employees (Grieco, 2020). Local newsrooms have been disproportionately impacted (Hagey et al., 2019). Only some of that loss has been made up by digital-native news jobs (Grieco, 2020). The Covid-19 Pandemic has accelerated revenue loss in remaining news organizations. Perversely, due to the current mechanics of the Ad Tech industry, news revenues have declined due to the pandemic, even as demand for news about the pandemic remains high (Jurkowitz, 2020).

Whether the devolution of the traditional news industry is a cause for concern, and one's views of what, if anything, should be done about it, depends largely on the theory one has of the value of journalism and traditional news organizations. Many competing theories are at play. Early on, social media evangelists viewed citizens empowered by social media as potentially replacing journalists (Gillmor, 2006) or at least extending their capacity (e.g. Aitamurto, 2015). A large body of research hence has shown that citizens can do valuable information work via social media. Though, in some cases, rather naïve and untheorized ideas of "crowd work" as supplanting journalism were presented, the many rich examples of citizen information work taking place through social media cannot be denied.

But can citizens do a comparable or better job at all of the kinds of information work that, in times past, would have been taken on by journalists working in traditional news organizations? Given the three decade decline in newsrooms, this question is arguably moot. In a study published in 2012, Public information officers (PIOs) told Hughes and Palen (2012) that the newsrooms in their jurisdictions had shrunk to the point where they were no longer reliable partners in getting crisis information to the public. The assumption of these PIOs is that newsrooms were on their way out and not coming back. They viewed it as their responsibility to make use of social media to assure that crisis information reached the public in the absence of traditional news organizations.

Information systems are made, not born. The devolution of the traditional news industry is no more a matter of fate than the Eiffel tower or a silicon chip. Rather, our current information infrastructure is the culmination of two centuries of technological innovation, public policy, and cultural evolution. Throughout that evolution, crises have remained an important use case in shaping information systems. Crises are a rationale for the development of information systems. Just as the telegraph industry grew rapidly around the information demands and climate of the Civil War (Davies, 2014), today, the ability to identify individuals in imminent danger during a disaster is arguably the most compelling use case for mass surveillance systems employing "big" social data. At the same time, the limits of so many of us relying on social media in emergencies are becoming apparent. Journalists and news organizations are getting fresh attention as part of the solution to curbing online misinformation and other ills of our contemporary information landscape. Whatever interventions are considered, they should be informed by an empirical understanding of the information work of crises-affected communities, who performs that work, and how they are situated and resourced.

Chapter Summaries

Chapter 2 situates this work in the field of Crisis Informatics. Drawing from Computer Science, particularly the sub-field of Computer Supported Cooperative Work, as well as Disaster Studies and Emergency Management studies, Crisis Informatics offers a fresh perspective on the relationship between social media and traditional media— a perspective grounded in the experience of a crisis-affected community. Crisis Informatics has developed a rich corpus of studies on social media use by citizens and responders. Crisis Informatics researchers have considered traditional media's role in relation to citizen and responder information work on social media from many different angles. This research extends inquiries on the role of local journalism within the Crisis Informatics framework. Additionally, this dissertation answers calls within Crisis Informatics to extend the scope of analysis beyond the emergency period.

Chapter 3 summarizes the main research activities informing the study: the evolution of an initially open-ended research question about the role of social media for the affected community to one more focused on traditional media; data collection (via intensive contextual interviews, participant-observation, and recurrent examination of the public digital record), and analytic techniques (with detail given about how journalists were identified).

Chapter 4 Using retrospective social media data as a resource in an ethnographic study brings particular methodological challenges. This chapter offers an extended example illustrating some key methodological challenges and how they are addressed in this work. The need for a tight integration between computationally-assisted techniques and techniques drawn from interpretivist social science is emphasized.

Chapter 5 canvases the use of social media by citizens, responders, and journalists working within the crisis-affected region. Though social media were not used by everyone in these groups, social media platforms played a substantive role in the information work for each of these groups. In some cases, social media were the primary means for doing certain kinds of information work pertaining to the crises and were integrated into many aspects of the response. The breadth of work and nature of the work taking place through these systems makes these systems candidates for consideration as local crisis infrastructure. In this new kind of infrastructure, traditional regional media continue to play an important role as common resources across responder and citizen interviewees. However, the reliance on social media shifts control of the technological systems employed outside of the impacted region.

Chapter 6 Whereas Chapter 5 maps community information work taking place *through* social media platforms, Chapter 6 zooms out to look at the context of social media use within the community response: That is, how did social media fit (or sometimes not fit) into the overall information work of community response? This chapter illustrates how what is visible in the public social media record gives an incomplete account of community response work. By comparing three different community-led response efforts that each focused on feeding and supplying food to community members and responders, patterns behind the relative visibility of different community efforts become apparent. One effort that intentionally served as a public face for the official response was far more visible than otherwise comparable community efforts. Institutional arrangements, coordination practices, local cultural practices and sensibilities shape what is visible on social media. These findings raise questions about the utility of relying on social media systems and/or social media data as a lens into crisis-affected communities in the absence of interlocutors such as local media organizations who have situated knowledge of community resources and customs.

Chapter 7 again looks closely at information work taking place through social media, this time paying close attention to the respective contributions of citizens, responders, and journalists after the crisis. Whereas Chapter 5 considered the information work *within* each of these groups, this chapter considers more closely the relationship *between* each group's respective information work. The picture that emerges complicates the narrative that vital information work done by citizens and responders via social media takes place absent of contributions from journalists. Rather, it appears in several cases the respective efforts of citizens, journalists, and responders complement each other in important ways. Legacy arrangements in news organizations can be seen even within online mass convergence after the landslide. Among the most influential social media users are regional news organizations, providing information from the earliest moments after the landslide well into long term recovery.

Chapter 8: Discussion and Conclusion Motivating a discussion of design implications that follow from this research, I pose consideration of social media systems and local journalism systems as two instrumental components of "local crisis infrastructure". The findings demonstrate that the value social media systems provide to the affected community is, to some degree, interdependent with the information produced and shared by journalists working within regional news organizations. Considering the particular arrangements that support a crisis-affected community can help ground interventions that aim to improve the information infrastructures we rely on, including those that aim to "save" journalism and those that aim to "fix" social media systems. Most importantly, considering

the work of journalists, citizens, and responders as related and interdependent shifts how we may conceive of local crisis infrastructure.

2

Literature Review

The widespread adoption of digitally-networked Information and Communication Technologies near the turn of the 21st century has led to profound changes in how we communicate. Scholars across a range of disciplines have closely followed these technological shifts and their social consequences. Indeed, given the far-reaching consequences of the shifts taking place, it is difficult to find a field or venue that has not given these changes some consideration. Several academic fields such as "Internet Studies" have emerged to track these changes (Silver, 2004), while more established disciplines have carved out venues that focus upon these shifts. For example, the peer-reviewed journal *New Media & Society* publishes empirical studies and theoretical considerations pertaining to these shifts from communication scholars, media studies scholars, and cultural studies scholars. Similarly, the peer-reviewed journal *Digital Journalism* is a forum to track the changes taking place through the lens of journalism studies.

The changes taking place in how we communicate have had far reaching consequences for how people come to understand crises. Historically, traditional media have played an important role in public understanding of crises— a role that has been increasingly devalued as internet technology has "disrupted" traditional media. The question of how the changes taking place impact how we understand contemporary crises is also a concern among many kinds of scholars. I explore these questions from the point of view of Crisis Informatics research, as explained below. But first, I would like to acknowledge that a broad range of researchers across many disciplines investigate different aspects of how the public comes to understand crises. Many studies in the computer science subfields of Human Computer Interaction and Computer Supported Cooperative Work address these concerns. A number of researchers with research programs that repeatedly consider the role of traditional media within social media have examined the relationship of old and new media pertaining to crisis events. For example, Bruns et al, published multiple papers and a report looking at social media use in the wake of the 2011 Queensland floods, paying careful attention to traditional media's role within social media (Bruns, Burgess, Crawford, and Shaw, 2012; Bruns and Burgess, 2014; Shaw, Burgess, Crawford, and Bruns, 2013). Lotan, Graeff, Ananny, Gaffney, Pearce, and boyd (2011) considered the role of journalists among other social media users during the Arab Spring uprising. These are but a few examples of studies that overlap in terms of topic and technique with this study and the Crisis Informatics scholarship I describe in more detail below. In these cases the scholars are not crisis researchers per se. They contribute to Computer Science venues specializing in the sub-fields of Human Computer Interaction and Computer Supported Cooperative Work, as do Crisis Informatics scholars. Though common in CSCW and HCI research the questions and techniques described in more detail below are not exclusive to HCI and CSCW research. For example, using techniques common in Crisis Informatics, geographers Shelton, Poorthuis, Graham, and Zook revealed geographic disparities in the use of Twitter after Hurricane Sandy (2014).

This study approaches these questions from the perspective of Crisis Informatics. The multi-disciplinary field of *Crisis Informatics* has forged one path to understanding some of those changes,

focusing specifically on how information flows in contemporary crises. Early studies focused on citizen response mediated through digitally networked technologies. These studies extended long-established discoveries made in Disaster Sociology into the (then) novel world of the digital sphere. Shortly thereafter, Crisis Informatics researchers turned their attention to formal response, closely attending to social media as a new interface between formal and informal response. Understanding how formal response was adapting to the widespread adoption of social media was an important focus of attention within the many novel changes social media systems enable in how humans respond to crisis. Part of that work entailed helping response organizations to understand how the public made use of social media in crises. Though, as explained below, traditional media has been considered in many Crisis Informatics studies, the field's emphasis on understanding the social media behaviors of citizens and responders has, commensurately, lead to less attention to the role of traditional journalism within social media.

Crisis Informatics has developed a strong methodology and case study corpus around the use of social media in contemporary crises with a particular focus on how citizens and emergency responders make use of social media. Features of the Crisis Informatics lens this dissertation employs include: treating social media systems as sites of work; closely examining patterns of interaction between social media users (especially citizens and responders); centering analysis around a crisis event; and employing theories of human behavior from disaster sociology and emergency management. This dissertation extends Crisis Informatics research that considers the how traditional media is situated in relation to the social media work of citizens and responders after a crisis. By extending the timeframe of analysis beyond that commonly used in Crisis Informatics research, this dissertation considers (and reveals) a longer evolution of interaction patterns between citizens, responders, and journalists than is common in Crisis Informatics studies.

Looking at Crises through an Informatics Lens

Because the need to communicate cuts across all aspects of a disaster, the question of how people produce and share information during crises has been of interest to generations of scholars across multiple disciplines. Disaster sociologists have often addressed this question directly (e.g. Tierney, Bevc, and Kuligowski, 2006). Further, the question is integrated into case study research. For example, disaster sociologist Kai Erickson's 1978 book *Everything in Its Path: Destruction of Community in the Buffalo Creek Flood* documents the tragic consequences that unfold after a decision is made to not inform a community in imminent risk of flooding about the potential danger. Anthropologists also consider communication to be one of the key elements of studying a disaster (Oliver-Smith, 2016). Journalism scholars too have also long been interested in the topic (e.g. Scanlon, 1988.) Historians have considered the relationship between communication and crises (e.g. Davies, 2014). Scholars of Risk Communication have frequently turned their attention to disasters (e.g. Eisenman, Cordasco, Asch, Golden, and Glik, 2007). Among the many lenses applied to the relationship between traditional media and social media in serving the public during crises, I examine this question from within the discipline of Crisis Informatics, a field whose primary aim is to improve emergency response by better understanding how citizens and responders use social media and other ICTs during emergencies.

Crisis Informatics adds to the perspectives taken by these other research communities by focusing on *information behavior*s particular to crisis contexts. Though Crisis Informatics is conceived as focusing on the information behaviors of people rather than specific technologies (Hagar, 2015; Palen and Anderson, 2016), it most prominently interfaces with other disciplines around social media use (e.g. Hagar, 2014; Palen and Anderson, 2016; Palen and Hughes, 2018; Reuter and Kaufhold, 2018; Soden and Palen, 2018). For more than a decade, the field has tracked the evolution of social media use by the public and emergency responders**.** In doing so, it has filled an important niche, steadily producing

research that can improve emergency management by "addressing challenges in disaster warning, response, and recovery" (Palen and Anderson, 2016).

Crisis Informatics is rooted in the Informatics and Computer Science research traditions. For example, the two researchers credited with naming the field of "Crisis Informatics", Christine Hagar and Leysia Palen " (Reuter and Kaufhold, 2018), respectively hold positions in informatics and computer science programs. Palen's collaborators, students, and former students (including my Phd advisor Kate Starbird) largely fill positions within informatics, computer science and engineering departments. This is true beyond the United States as well. For example, in Germany, the most prolific and long-standing cluster of Crisis Informatics research is associated with the informatics department at the University of Siegen. In both countries, funding has been closely tied to applied improvements to crisis response through engineering-focused funding directorates.

The Crisis Informatics niche is particularly suited to informing the design and use of information systems. Though positioned as a new field, it draws heavily on HCI and CSCW's long history of empirical research on how humans interact with critical information systems. Crisis Informatics research reflects a societal trend that Soden and Palen (2018) call the "informating of crisis". The field contributes to this trend in three ways: 1) Empirical studies examine the use of contemporary information systems during crises. 2) Crisis Informatics research makes use of information systems (including medium and large scale social data sets) as a means of study (Soden and Palen, 2018 ; Palen and Anderson, 2016) and 3) Empirical research is used to make recommendations about how responders and others should make use of information systems during crises.

Given the importance of information systems in emergency response, there is merit in such a focused research mandate. The field serves one of several research niches that support improved emergency response. However, it may be helpful to bear in mind that the research gap described in this chapter probably does not directly map to the understanding of emergency response practitioners responsible for communicating with the public. The findings of Crisis Informatics, risk communication, journalism studies and other areas of research may independently consider research questions relevant to emergency response, but the answers to those questions are often more holistically integrated into the work of the specialists responsible for communicating with the public during emergencies. For example, while communicating with the public and communicating with traditional media may be treated as separate research topics, a Public Information Officers often does both. The messages they craft are often informed, directly or indirectly by what is understood of risk communication best practices and so forth. Thus, there may be some differences here in how I describe the research gap and how those responsible for communication during emergencies do that work or conceive of that work.

Treating Social Media Platforms as Sites of Information Work

Crisis Informatics both contributes to and draws heavily upon two subfields of computer science: Human-Computer Interaction (HCI) and Computer Supported Cooperative Work (CSCW). According to Harrison et al (2007), Human-Computer Interaction considers how humans interact with technology through three different paradigms: "Human-Factors, Classical Cognitivism/Information Processing and Phenomenologically-Situated." Though all three of these paradigms can be traced to the early days of computer science, the phenomenological-situated paradigm became increasingly important as computer systems were widely introduced into office work in the 1980s (Schmidt and Bannon, 2013). The imposition of computer systems into office work, and particularly, work that entailed collaboration and coordination between multiple parties, revealed that a deeper empirical understanding of the nature of the work these systems aimed to

support was needed. The sub-field of Computer Supportive Cooperative Work emerged to fill this niche (ibid). Ethnographic methods were adopted and adapted (Dourish, 2006) to better understand the "situated" (Suchman, 2007) nature of collaborative office work with enough nuance, care, and detail to support design innovation. As computer systems became tools for play and leisure, CSCW researchers broadened their scope to understand computer-assisted collaboration and coordination outside of the office, extending inevitably to collaboration and coordination enabled by social media (Schmidt and Bannon, 2013). In this way, social media came to be treated by CSCW researchers as sites of work, albeit "work" broadly conceived.

Empirical studies of socio-technical systems remain a prominent component of HCI research (Wobback and Kientz, 2016). And empirical studies of collaboration and coordination via social media have become a prominent strand of CSCW research (Correia et al, 2018). Some of this research is prescriptive, yielding "implications for design". In many other cases, the emphasis is on unpacking the complexity of social behavior afforded by contemporary technical systems (Dourish, 2006). Aligned with the CSCW approach, Crisis Informatics places a "special emphasis on use patterns, role patterns and perception patterns" (Reuter and Kaufold, 2018) that constitute collaborative action in social media.

Moving from close observational studies of small group interaction in office settings to mass participation in the millions brings many challenges (Lee and Paine, 2018.) One tactic that CSCW researchers have adopted to tackle the problem of understanding social media behavior at scale is to zero in on specific niches within mass participation. This can be accomplished by following either the behaviors of a particular kind of user, for example, or, as in the case of Crisis Informatics, accumulating cases of social media use as they pertain to a specific context. Indeed many case studies in Crisis Informatics scope both to specific context (crisis) and specific kinds of users (such as emergency responders).

Drawing on Mainstream Sociology of Disasters

Crisis Informatics relies heavily on theories of social behavior drawn from what Tierney calls U.S. "mainstream disaster sociology" (2007)—with leading U.S. Disaster sociologists such as R.R. Dynes, Quarantelli, and others frequently cited, influencing Crisis Informatics epistemology. At the University of Colorado, Palen spent four years (2004-2008) affiliated with the Natural Hazards Center— an important center in applied U. S. disaster sociology. This afforded the opportunity to substantively marry the CSCW approaches Palen was trained in to longstanding and ongoing research on crisis response.

When Tierney appends "mainstream" to "disaster sociology" she signifies the influence of a relatively small core group of U.S. disaster scholars and research centers that have strongly influenced emergency management and humanitarian response. The aim of this form of applied, action research is to continuously produce empirical research that can improve response mechanisms (Knowles, 2012; Tierney, 2007). Disaster sociologists have often worked directly with response organizations in the course of their study and/or been funded to produce insights that tie closely to process improvements in response. Thus, there is a strong relationship between the theories of human behavior in crisis one finds in disaster sociology as outlined by the main thinkers in the field (particularly Dynes and Quarantelli) and how emergency and humanitarian response practitioners conceive of crises in much of the world.

Whether information systems researchers come by these theories through sociologists or through practitioners, many theories are consistent across both groups. (Though, one perennial topic of study

in disaster sociology is counteracting false assumptions about social behavior in crises that popular among the public, the media, and emergency management (Knowles, 2012; Quarantelli, 2008).) Among the shared building blocks of disaster sociology and practitioner case studies are epistemological concepts, such as scoping case studies to the emergency phase of an event. Such common building blocks enable individual case studies to be reported with a consistency that particularly lends itself to imagining system process improvements portable beyond an individual case study.

Those who position their work within Crisis Informatics are largely trained in and work within CSCW, HCI, and Informatics contributing to HCI and CSCW venues (particularly the competitive Association of Computer Machinery conferences). But Crisis Informatics researchers also commonly publish in venues that are more closely tied to emergency response practice including emergency management, security, and disaster studies venues. Crisis Informatics scholars and their immediate collaborators have been particularly active around the International Conference for Crisis Response and Management (ISCRAM) which has convened Crisis Informatics researchers and practitioners since 2003. In these venues, work that appropriates and builds upon Crisis Informatics largely concerns the use of social media in crises.

An important aspect of the Crisis Informatics research program is that, like that of mainstream disaster sociologists before them, many Crisis Informatics researchers work directly with crisis response organizations, broadly defined, to improve understanding of social media activity and to make improvements to emergency management based on that understanding. The action research aspect of Crisis Informatics is not always directly visible in the Crisis Informatics publications that make contributions to CSCW, computer science, computational social science, and other more engineering-related venues. Though by no means unique in engineering research, Crisis Informatics' grounding in a core set of established social theories (from disaster sociology) along with some degree of real-world accountability assured by frequent collaboration and interaction with one group of stakeholders (emergency response), distinguishes the field.

Crisis Informatics: The Social Media Experts

By bringing mainstream disaster sociology into CSCW research, Crisis Informatics researchers are contributing to broader knowledge about the evolution of online mass participation as it pertains to one context, crises. By relying upon longstanding theories and practices extant in mainstream disaster sociology, CSCW researchers were able to quickly bridge a pressing knowledge gap that weighed upon emergency response practitioners in the wake of the widescale uptake of social media during crises.

Though conceived as focusing on the behaviors of people rather than specific technologies (Hagar, 2015; Palen and Anderson, 2016), Crisis Informatics most prominently interfaces with other disciplines around social media use (e.g. Hagar, 2014; Palen and Anderson, 2016; Palen and Hughes, 2018; Reuter and Kaufhold, 2018; Soden and Palen, 2018). That is, when other experts call upon Crisis Informatics researchers, it is often for their expertise in social media. This is the case in spite of fact that Crisis Informatics researchers are vocal critics of understanding crises purely through a social media lens (Palen and Anderson, 2016; Soden and Palen, 2018).

From its inception, Crisis Informatics has been following the work of crisis-affected individuals and those who serve them. In this vision, technical systems that support human communication are subject to analysis because they are integrated into the human response to crisis. Crisis Informatics researchers are not interested in social media per se (Palen and Anderson, 2016; Soden and Palen,

2018; Kaufhold and Reuter, 2018). For example, in one of the first studies associated with the term "Crisis Informatics", Hagar examined all avenues by which UK farmers got information about a Hoof and Mouth disease outbreak, including radio call-in shows, in-person meetings, and newspapers (Hagar and Haythornthwaite, 2005; Hagar 2006, 2007).

Yet it seems the trajectory of the Crisis Informatics research community so far has been to help us understand mass participation and collective action made possible through social media. This has largely been through studies that employ computationally-assisted analysis of social media data, leading to a kind of unintended specialization in social media phenomena that shapes the field in important ways.

The tension between a technologically agnostic vision for the field and its recognized expertise as a subset of social media research is apparent in three recent publications aimed at different interdisciplinary audiences. Embedded in the European Crisis Informatics research community, Reuter and Kaufhold's 2018 comprehensive literature review of Crisis Informatics entitled *"Fifteen years of social media in emergencies: A retrospective review and future directions for Crisis Informatics"* appeared in the *Journal of Contingencies in Crisis Management,* a peer-review journal that publishes Crisis Informatics articles among other topics of concern in emergency management. They introduce Crisis Informatics by way of social media: "sometimes summarized under the term Crisis Informatics, a variety of studies focusing on the use of ICT and social media before, during or after nearly every crisis and emergency has arisen." From there, the authors summarize approximately 50 cases studies from across the globe specific to social media use during crises. The corpus they select stretches back to 2001, before the term Crisis Informatics had been coined. Writing for an audience of emergency management researchers and practitioners, Reuter and Kaufhold frame the value of the Crisis Informatics as providing a "special emphasis on use patterns, role patterns and perception patterns" of social media. Characteristic of computer science and information systems research, the aim of Crisis Informatics is stated to be more than simply identifying patterns and roles, but also, "to point out what has been achieved so far, and what future potentials exist." In other words, the value of the field is closely tied to its ability to improve future response. The niche addressed here is in improving response in relation to social media.

The recent disaster sociology primer, *The Handbook of Disaster Research* (Rodríguez et al, 2018) contains three articles that address different aspects of communication during disasters. One of these is by Palen and her long-time collaborator and former student Amanda Hughes. It gives an overview of social media use in crises. In that context, they introduce the field of Crisis Informatics as such: "Researchers of Crisis Informatics investigate the nature of socio-behavioral phenomena in mass emergency mediated by social media environments and devise new methods for its investigation." Similar to Reuter and Kaufhold's, this definition emphasizes "socio-behavioral phenomena." To this, Palen and Hughes add an additional value of the field, its methodological innovations. Like Reuter and Kaufhold, they position Crisis Informatics in service of improving emergency management, first stating the need to do so: "emergency management organizations seek to respond to new content and these new communication platforms." Whereas Reuter and Kaufhold state their goal as helping responders understand roles and patterns of social media use, Palen and Hughes go further by emphasizing the value of integrating social media user data into emergency management: "the initial focus on developing and executing best practices for outward communications is now giving way to discussions of augmenting these efforts with the inclusion of data from the public. The research field *Crisis Informatics* has arisen in response." The path of improving emergency response is therefore twofold: 1) improving social media practices in emergency response and 2) innovating means of capitalizing on social media data to improve crisis response.

Yet even while recognizing the potential of capitalizing on the availability of highly-detailed, large-scale data, Crisis Informatics researchers have also aimed to temper the frenzy around large-scale social media data. For example, in 2016 Palen and her long-time collaborator computer scientist Ken Anderson penned a brief, but high-profile editorial published by AAAS, a membership organization for professional scientists. The editorial positions Palen and Anderson as leaders in large-scale social media research. They then use this position to warn a broader research community about the pitfalls of big social data research. They emphasize the importance of multidisciplinary, multi-method, theoretically grounded approaches in application of social media data. They use Crisis Informatics as an example of how to soundly make use of "big" social data. They make the case that computation-based work applied to human behavior should be strongly tied to sound social science. To establish their standing to make such a claim, they frame their work, and the field of Crisis Informatics, as follows: *"Crisis Informatics is a multidisciplinary field combining computing and social science knowledge of disasters; its central tenet is that people use personal information and communication technology to respond to disaster in creative ways to cope with uncertainty. We study and develop computational support for collection and socio-behavioral analysis of online participation (i.e., tweets and Facebook posts) to address challenges in disaster warning, response, and recovery."*

In this concise bit of boundary work, appropriately and scientifically leveraging "big" social data is equal parts computing and social science. A techno-deterministic frame is resisted by emphasizing an analytic focus on social behavior. Perhaps less apparent to the casual reader is the way the definition aligns with applied research to improve professional disaster response: "Warning, response, and recovery" are specific phases of incident management in the professional emergency management paradigm. Those phases have, in turn, been influenced by decades of disaster sociology research. Though the editorial serves to raise awareness of "the opportunities and limitations of social media research on crisis events," its purpose is to make a broader case that research incorporating "big" social data should be a partnership between sociology and computing. They warn the broader research community against the "fetishizing" of social media data.

These technologically agnostic internal definitions of Crisis Informatics reflect a reflexive understanding among Crisis Informatics researchers that social media systems are not synonymous with understanding information activity writ large in crises. Palen and Anderson's 2016 editorial is meant to raise awareness of this fact. Palen and Hughes (2018) state "the very idea of 'social media' flattens the many meanings of 'crisis' and 'emergency' for which social science fields have worked to provide insight." Soden and Palen (2018) assert Crisis Informatics must look "beyond social media". But these directives belabor the point that Crisis Informatics and social media may now perhaps be irrevocably associated. In interdisciplinary contexts, Crisis Informatics researchers are playing the role of social media experts. Even Hagar, whose work is not particularly tied to social media, spends much of a 2014 editorial about Crisis Informatics in the Journal of Geography and Disasters devoted to social media. Thus, in spite of the core aims of the field, Crisis Informatics is becoming focused on social media though its originators would have it otherwise.

The attention given to mass participation via social media in crises by computer science and informatics researchers has reaped many practical insights in the last 15 years. Yet, the close association of Crisis Informatics with social media does lead to some limitations. Though the intent of Crisis Informatics is to understand social media use in crises, in practice, through case studies based around social media we come to understand crises through the lens of social media. To the extent that information behaviors during crises are broader than what is observable in social media, it is essential that the advice given by Palen and Anderson (2016), Palen and Hughes (2018), and Soden and Palen (2018) is heeded.

In this study, I aim to address the tensions inherent in wanting to broadly understand the information behaviors of a crisis-affected community, the opportunities afforded by observing their social media use, and the limitations of relying on social media data, by heeding this advice: I rely on multiple sources of data, including site visits, interviews, and participant observation, along with social media data, to gain a broader perspective on social media use. I also bring traditional media into the analytic frame.

Social Media as a Lens Into Crises

The Crisis Informatics corpus tracks the evolution of the broad cultural shift that is unfolding before us where social media systems are increasingly important in shaping how we come to know and understand contemporary crises (Soden and Palen, 2018). Finn (2018) calls attention to the importance of how we come to understand crises by giving the process a name: "the event epistemology". As a collection of empirical snapshots from the 2000s on, the Crisis Informatics corpus is a record of the evolution of one kind of event epistemology— a kind shaped by social media. Though questions are increasingly being raised about the role that social media have in shaping our understanding of the world, at present the momentum still seems to be shifting towards an ever more central role in the human response to crises. This appears to be the case, even as we grow increasingly wary of their influence.

As an interventionist science rooted in computer science, Crisis Informatics plays more than one role in shaping event epistemologies rooted in social media. Monitoring social media is now, necessarily, integrated into official crisis response work. In addition to empirical accounts of social media use during crises, one substantive trajectory of Crisis Informatics research involves designing technologies that improve social media monitoring during crises (e.g. Gupta et al, 2014; Johnson et al, 2020; Kaufhold et al, 2020; Stowe et al, 2018; Verma et al, 2011). This is an important strand of research because there are valid reasons for identifying, for example, Twitter users in imminent danger of flood, fire, violence and so forth among "the data deluge" (Cobb et al, 2014) that accompanies the often high-velocity, high-volume use of social media in emergencies.

Supporting those in imminent danger is arguably the most compelling rationale for mass surveillance of social media. However there is also increasing concern about how such approaches could be misused (e.g. Trottier, 2016). Conversely, there are also concerns that when social media is used to understand impacted communities it may distort our view of those communities. Such distortions may occur because of variations in social media use by different demographics groups and/or due to varying degree of disruption that occurs during crises (e.g. Burns, 2014; Crawford and Finn, 2014; Shelton et al, 2014).

Another important set of concerns revolves around the quality of the information that circulates via social media. As unplanned, emergent phenomena, it is inevitable that unsubstantiated information will circulate during crises. The circulation of unsubstantiated information and the process by which it becomes substantiated is a concern in crisis research that considerably predates the advent of social media (e.g. Shibutani, 1966). Such unsubstantiated information, often called "rumors" may ultimately turn out to be either true or false. The process of determining which information is true and which is false is a large part of the crisis information work. "Rumor patrol" is a signature aspect of crisis information work for Public Information Officers, journalists, and digital volunteers alike. Though rumor response has always been a concern in crises, the ability for false information to spread widely and rapidly through social media systems has brought increased attention and concern to the topic.

Speaking to a general skepticism among emergency management practitioners about the capability of social media to be a source of valuable information during crises (e.g. Tapia and Moore, 2014; Plotnick, Starr Kushma, and Tapia, 2015), early Crisis Informatics studies called attention to instances where the public appropriated social media systems to successfully make sense of crises. For example, Pale, Vieweg, Liu and Hughes (2009) showed how college students were able to develop a timely and accurate list of those harmed during the 2007 Virginia Tech shooting event via social media. Such studies were highlighted, in part, the social processes behind substantiating rumors. Another strand of Crisis Informatics research began to look at the propagation characteristics of false information via social media. For example, Starbird, Maddock, Orand, Achterman, and Mason (2014), showed that false information spread wider and faster on Twitter than corrections of false information after the 2013 Boston Marathon Bombing. As evidence of coordinated efforts to intentionally spread false information via social media began to mount, research into online "misinformation" (which results from a misunderstanding of facts) and "disinformation" (where the intent is to mislead) have gained increasing attention among researchers.

This study started before the current concerns about online misinformation and disinformation had reached the heightened (and deserved) levels of interest they are now receiving from researchers, practitioners, and the public. However, the research approach taken here is patterned on early Crisis Informatics studies that aimed to understand how pro-social information work of potential benefit and value to an impacted community may have come about. There are a few reasons for sticking to this form. First, in my extensive read of the social media record around the Oso Landslide, I did find misinformation. Misinterpretation of facts is a characteristic of fast moving information environments and I would expect to find some amount of misinformation in the record of any larger-scale crisis event. Likewise, I found trace amounts of information that I was confident in considering to be disinformation. Importantly, in contrast to other recent crisis events such as the tragic 2012 Sandy Hook school shooting (Sellnow, Parrish, and Semenas, 2019), I found only a small portion of the overall social media content related to the slide could be characterized as misinformation or disinformation. For that reason, these themes are not salient in the analysis here.

Rather, the approach here was to focus on the information that was valued by those who survived, supported the community, and worked the disaster. I sought to understand what information they needed and how they got it. Though I privilege the information work of potential benefit to the community, other research points to fact that what we may consider beneficial and prosocial online information work has much in common with disinformation work in terms of motivations, practices, and collaboration strategies (Starbird, Arif, and Wilson, 2019). That is, if we consider how crisis information work takes place online independent of who is doing the work and the nature of the content, much of the work visible on social media looks the same. With this in mind, the focus of this study on *who* is doing information work of potential benefit to the affected community takes on more importance.

A better accounting of the role of traditional media in relation to social media can bring insight into this high reward, but potentially high risk area of research in at least three ways: 1) A better understanding of the role of traditional media in shaping crisis information on social media can improve big data approaches to social media monitoring aimed at supporting crisis-affected communities. 2) Likewise, focusing on the role of traditional media within social media during crises can also help us to understand the broader information ecology of people, institutions and practices that shape our understanding of contemporary crises beyond what is visible in social media. 3) Traditional media are constituted from a very different set of institutions, arrangements, and practices than those taking shape around social media systems. As such, they offer a set of alternative

solutions that could inform how social media monitoring is performed in the future, including: who does the work, how are they situated in relation to the community, how individual and community privacy is treated and so forth.

Crisis Events as Objects of Study

One important way that Crisis Informatics is bound as a field is by the focus it places on the moment of crisis as the object of study, typically moments of mass emergency. There is a strong practical rationale for doing so: crisis management exists to support society during emergency events. Therefore, research that aims to improve crisis response would, by logic, also focus on emergencies. For this reason, Crisis Informatics studies read very much like the after-action reports written by emergency management organizations, drawing heavily as they do from the language and structure of those reports and their academic counterparts found in mainstream U.S. Disaster Studies case study research. Focusing on the crisis event filters analytical considerations down to those most salient to the emergency period. This focus is an advantage when seeking to, for example, shorten rescue response times to people who are imminently endangered. Constricting the time frame also makes research more tractable as it simplifies data collection and aligns with the conference paper publication cycles where many Crisis Informatics researchers publish.

Yet, when emergencies are the unit of analyses, they become alienated from the often long-standing and often slowly unfolding social and environmental processes that underlie them. All of these play out more diffusely and over considerably longer periods of time than emergencies (Tierney, 2007; Soden and Palen, 2018). The price of focusing on "the event" is less knowledge of mitigation mechanisms, recovery mechanisms, and matters of social equity. Such factors strongly moderate the degree of impact that crises have on particular social groups and localities as well as the extent of recovery they experience. Critics of disasters studies had leveled such concerns about events as the object of study before Crisis Informatics was a field (e.g. Tierney, 2007). Crisis Informatics scholars also recognize this limitation (Soden and Palen, 2018). However the formulation is a potent one. Disaster studies, emergency management, and now Crisis Informatics all struggle between the concision and utility of telling an emergency-focused narrative against the more challenging but also essential work of linking an emergency to what precedes it and follows from it.

In this research, I too give a chronological account of activity around a crisis event. However, I aim to soften the limitation of an event-based narrative by considering a longer period of time than is typically treated in these genres. I examine five years of social media activity after a crisis event, well into the long term recovery phase of the disaster in question.

The Importance of Citizens and Responders in Crisis Informatics

The most reproduced New Yorker magazine cartoon is Peter Steiner's 1993 drawing of a dog sitting in front of a desktop computer, one paw poised on the keyboard. He quips to another dog sitting on the floor by his chair: "On the Internet, no one knows you're a dog." Of all that has been said in the last three decades about the sociality of the internet, this cartoon remains one of the most eloquent and succinct explanations of the rapid growth of internet-enabled technologies. The creative, nuanced and seemingly endless configurations of self-representation, of selective disclosure and non-disclosure, of factual and imaginary that are afforded by networked ICTs remains one of the most important and interesting aspects of these systems.

Yet those who wish to say something meaningful about users, their behaviors and content need something short of endless categories of users. Given Crisis Informatics' commitment to improving emergency response, the field is primarily concerned with two: citizens and emergency responders.

Using these categories as the backbone for analysis is a tractable way to describe online mass participation in terms that make sense to emergency managers and others charged with improving response. Reducing analysis to two key kinds of users is meant to simplify analysis, but doing so is not necessarily reductionist. Social roles pertaining to crises are dynamic and relational (Dynes, 1970; Kreps and Bosworth, 1993; Webb, 2004). Therefore due to the nature of crisis response, a social media user may be either citizen or responder or both. The designation may change over the course of the response. Being designated either does not rule out other potentially important social roles that also may apply.

Writing for disaster scholars and practitioners in the Handbook of Disaster Research, Palen and Hughes synthesize more than 100 Crisis Informatics studies. They explain the most major findings from those works by arranging them around the information behaviors of the citizens and professional emergency responders. Emphasizing the prosocial and self-organized activities of citizens that are afforded by social media systems, citizens can perform as "reporters"[6]. Citizens can coordinate with each other through "online communities" (e.g. Qu et al, 2009) thereby becoming "digital volunteers" (e.g. Starbird, 2013) who can perform as a "collective intelligence"(e.g. PloS, 2012; Vieweg et al, 2008) capable of "distributed problem solving (e.g. Palen et al, 2007)." In the course of those actions, citizens create a "deluge of data" (Cobb et al, 2014) that can be leveraged for improved emergency response. Emergency management can also leverage social media for two-way communication with the public (e.g. Heverin and Zach, 2010, Hughes, 2014).

For practical reasons, the primary distinction for those working in professional emergency management is between those operating within formal emergency management structures and those working outside of them. Many Crisis Informatics studies privilege that delineation: those who are not part of the formal response are "citizens." This, coupled with the methodological challenges of identifying professional journalists in large social media corpuses, means that the activities of professional journalists in many studies focusing on citizens may well include journalists among them. Both in the Palen and Hughes narrative and in many of the social media studies they are summarizing, professional journalists may be folded into the category of "citizen".

Reuter and Kaufhold emphasize the same dyad of actors (citizens and responders) in their selection of Crisis Informatics case studies. By introducing more of the language used in the original case studies into their review, the heterogeneity of theoretical and conceptual lenses that have been applied to understanding mass participation via social media during emergencies comes into view. That is, beneath these two primary ways of describing social media users as either citizens and responders resides a wide range of thousands of distinctive and potentially important combinations of social roles. Looking at those Crisis Informatics researchers have considered in relation to social media use in crises, from just the 50 or so case studies Reuter and Kaufhold synthesize there are social actors (people, relatives, family, friends), internet-enabled technological actors (users, online media, virtual and technical communities, the social media "crowd", information evangelists, Facebook groups, Twitterers, virtual teams, retweeters); and those identified by their actions (moderators; helpers, reporters, repeaters, mapmakers, translators). Political actors (governments,

6 Citizens is often used to distinguish anyone who is not an official responder. As discussed in the Methods chapter, differentiated professional reporters from citizen reporters in social media can be no small task. For example, professional communicators often have multiple social media accounts, those tied to their jobs and personal profiles that may give no indication of their profession. This complicates the task of understanding how professional communicators such as journalists impact social media.

authorities, citizens, activists, the public) have a part to play as do those actors conceived of by disaster researchers (ad hoc crisis communities, flood-affected victims, peripheral response, emergency response, public response, emergent groups). There are a number of actors that represent specific emergency management functions (incident management teams, fire and police departments, emergency management organizations, disaster management, public information officers, humanitarian aid organizations). Occasionally, social categorization is elided by simply naming a specific entity (FEMA, Red Cross; BP, Weibo)[7].

Of all the designations Reuter and Kaufhold note, only one, digital volunteers (Starbird, 2013) can be claimed as originating within Crisis Informatics. The remaining cast of characters are appropriated from a range of other disciplines, principally disaster studies, emergency management, computer science and informatics.

The breadth of distinct social roles described in this body of research reflects the complexity of the human response to crises as well as the difficulty of making sense of that complexity. Characterizing activity that involves literally everyone is no small feat. Individual case studies tend to draw on multiple theoretical lenses to describe who is doing information work through social media. The same appellations may mean different things between one case study and the next. The lenses employed between them may be different. Yet further systemization may be illusive. The human response to crisis is often characterized by mass "social convergence" (def Heide, 2003; Fritz and Mathewson,1957; Kendra and Wachtendorf, 2004; Wachendorf and Kendra, 2004; Wenger, 1994). Many early Crisis Informatics studies helped to establish that social convergence now extends into the digital world, giving detailed accounts of how this fundamental phenomenon was transformed through social media (e.g. Hughes et al, 2008; Palen et al, 2010).

Mass social convergence, being fundamental to both in-person and digital response, is therefore the background of any Crisis Informatics story that can be told. Thus the tractable way of showing the evolution of social media use in crises— one case study at a time— has been to rely heavily on primary categories instantiated in disaster sociology and emergency management: responders and citizens.

The two workhorse delineations of citizen and responder can encapsulate the organizational complexity of social convergence. For those steeped in the social behavior of crises, the complexity will be assumed and understood. For those not steeped in the social behavior of crises, this productive reduction in the number of human kinds that are the apparent objects of study can be a source of confusion. For the categories of citizen and responder are relational and dynamic. The empirically derived precept that "Communities are the first response" is foundational to how emergency response practitioners understand crisis response. It points to a body of related findings with practical implications for response. I've witnessed responders use this phrase on multiple occasions to mean different things. At the micro scale, it is rare for an emergency professional to be first on the scene of an emergency. At the macro scale, the work of recovering from large-scale disruptions such as natural disasters will be, for the most part, taken on by those who are affected (Dynes, 1970). It can also refer to the organizational arrangements between responding organizations. The default emergency response organization is the most local one for many

7 This list does not contain all of the unique terms in the article.

emergencies according to the National Incident Management System, with lead agency shifting to higher levels of government (county, then state, then federal) as needed. The Oso Landslide is an example of this. First on scene were the local volunteer firefighters, including a surge of former volunteers not officially active. These first on scene, were, at once, the official response, the community response, and volunteer citizens. As the scale of the disaster became apparent, the lead agency changed to State Patrol, then the County, who remained lead agency in many senses, though, as a designated Type 1 Incident, with FEMA supported coordination.

What makes the two categories of citizen and responder productive and distinct will depend on the nature of a given crisis. For example, employees of the local cable company had to work on-site at the Oso Landslide to restore internet to those living east of the slide. Working on-site, for some practical purposes such as provisioning supplies and meals, makes a citizen part of the official response. However, in terms of professional training and background they would not be considered professional response. The closest thing to a comprehensive list of official response for the landslide might be the list of government agencies and private contractors reimbursed by FEMA. But the cable company was not reimbursed by FEMA. Thus, the many kinds of work that comprise a large-scale response make it difficult to have meaningful, static, and exclusive categories of responder and citizen. This presents an interesting and difficult problem to anyone hoping to exploit large social data to meaningfully understand crises: relational and dynamic categories bring great complexity to the design of information systems.

An additional constraint in making meaningful distinctions between actors in online mass participation is that certain kinds of activity are easier to identify than others. For example, retweets leave digital traces that can be analyzed to understand how information spreads. Some Twitter users are far more prone to retweet than others. Hence, it can be pragmatic for a researcher to simply identify some actors by the kinds of online activity they perform (retweeters, moderators, reporters). Though it would also be helpful for crisis response to know, for example, whether given individuals were affected by a disaster, the ways they have been affected, and to what degree, such questions are much harder to ascertain.

This research explores, yet is subject to, these same constraints. I too use citizens and responders as a starting point for analysis. I too find the need to move between theoretical perspectives and levels of granularity to adjust to what is visible in the data. I too struggle to do justice to the relational and dynamic nature of who responds to crisis in describing the people who make use of social media in this study.

Where Does Traditional Media Fit in Crisis Informatics?

Historically, traditional media were recognized as important mediators of crisis information between the public and formal response. More recently, the rise of the internet has brought confusion about their role.

A photo on the cover of the 2007 FEMA manual "Basic Guidance for Public Information Officers" illustrates the rapid shift that has occurred in how government information workers approach crises: It shows a press conference with broadcast media at an outdoor location from the point of view of the PIOs- with camera and boom mics on sticks crowding in from all directions. Starting from about the same time this FEMA manual was published, Crisis Informatics has tracked the rise of alternate paths for communication between official response and the public, namely those afforded through social media systems. These alternate paths appear to have softened the need for traditional media to mediate between official response and the public. The dimensions of these changes that have been most closely observed within Crisis Informatics is a two-fold displacement: 1) The uptake of work may have formerly been done by journalists pre-social media, now being done by non-journalist

citizens (e.g. Starbird, 2010) and 2) The uptake of work previously done by journalists being taken on by those within official response (e.g. Hughes and Palen, 2012).

Traditional media frequently appear in the narratives of Crisis Informatics case studies of digital mass convergence and their role within social media has been explored from a number of angles. Key early Crisis Informatics studies brought traditional media into the analysis to help distinguish and differentiate the way that non-journalist citizens were making use of social media to effectively produce and share information in crises. For example, Starbird et al's "Chatter on the Red: What hazards threat reveals about the social life of microblogged information"(2010) is an example of an early study distinguishing citizen work from that of the traditional media. The information work citizens accomplished via Twitter during the 2009 Red River floods is distinguished from that of local media, national media, alternative media and other organizations. Both the means of study and the object of study illustrate Crisis Informatics concerns and commitments: Chatter on the Red employed "virtual ethnographic" (ibid) techniques that enabled analysis of "collective behavior" in multiple Twitter data sets pertaining to the floods in tandem with close examination of the activities of individuals therein. This paper is also an example of an early paper treating social media sites as important sites of work and social media users as important contributors to public crisis information. The nature of the information work citizens were doing on the platform is attended to in great detail, with the respective activity of those identifiable as locals, non-locals, individuals and organizations particularly noted. The study concludes, *"The lesson here is not that agencies need to be everywhere online but rather to know that people have the capacity through social cognition—and individual enterprise motivated by a perceived audience—to re-use data for their local needs."* When the study was published in 2010 this was a novel argument to make empirically. Such collective action was simply not possible in the same way prior to social media.

Hughes and Palen's 2012 interview study with Colorado PIOs gives the complementary perspective on the displacement of traditional media that was underway. PIOs felt pressured to take on work formerly done by journalists, reporting it was necessary to do so because news organizations in their communities had been so decimated by staff cutbacks that they were no longer reliable partners in terms of crisis coverage. As told by these PIOs, it was hard to develop and maintain relationships with news staff in diminished newsrooms as those reporters who remained covered more beats and had less time for each. This, they consensed, made traditional media in their communities unreliable partners. This study makes the compelling case for an argument that is repeated both in Crisis Informatics literature and among some in the response community and elsewhere who view it as necessary to employ social media as a way of circumventing traditional media. Hughes and Palen illustrate this displacement with a diagram showing how PIOs need to communicate directly with the public via social media as well as engaging the media. This was an important argument to make as the work of PIOs is guided by National Incident Management System framework and other policies that define and align emergency response roles and responsibilities. These and other studies (e.g. Hiltz et al, 2014) were important for demonstrating the need to accommodate new forms of work among PIOs within emergency management.

Characterizing, as they are, 15 years of Crisis Informatics research, Kaufhold and Reuter's overview of the Crisis Informatics oeuvre offers some insight into how the field as a whole has treated traditional media. Among their summaries of about fifty case studies, traditional media are considered in several cases, highlighting a range of considerations concerning their role within social media during crises and demonstrating a breadth of variation in their analytical treatment.

A few studies distinguish *content* produced by traditional news organizations as one noteworthy category of crisis information among others circulated via social media platforms. Mendoza et al's

(2010) study is summed as "spread news by the Twitter community". Wiegand and Middleton (2016) address "newsworthy content". Olteanu, Vieweg, and Castillo (2015) are cited for their breakdown of the kinds of content shared on social media after crises.

Reuter and Kaufhold highlight a few studies that *group traditional media within a larger unit of analysis*. For example, Olteanu et al (2015) consider the contributions of "traditional media" in tandem with "internet media". Fichet et al (2016) analyze the combined activity of "citizens and journalists". One of three studies that position news organizations as trusted information sources by the public cited by Reuter and Kaufhold, the authors summarize a 2012 American Red Cross in which "friends, family, news media (or reporters) and local emergency officials are seen as the "most trusted" (American Red Cross, 2012). Such analyses help us to understand that traditional media as related to and part of a larger group of social actors whose combined behavior is of consequence in social media after crises.

Reuter and Kaufhold call attention to two studies concerning the public perception of trusted information sources that *position traditional media as an alternative to social media.* Endsley, Wu, Eep and Reep 2014 found "Credibility of social media information is less than of printed, official online or televised news and information from family, relatives or friends." Similarly, a study by Kuttschreuter et al (2014) is found "Social media can act as a complementary information channel …, but it is neither a substitute for traditional nor online media."

In another approach, traditional media are often invoked *by way of comparison* to better convey what distinguishes the work of citizens who are either presumed or known to be other than professional media from the work of professional media. Citizens can act as "'sensors'— people who detect, measure, and report local emergency information— as well as journalists— people who collect, report, analyze, and disseminate information as news." Citing a study of California mountain communities impacted by wildfires in 2007 (Shklovski, Palen and Sutton, 2008), where "acquiring information about particular locations and neighborhoods from traditional media was difficult," local citizens were able to fill the information gap through social media. In contrast, a study of the 2011 Egyptian uprising (Starbird and Palen, 2012) illustrates that the most frequently tweeted messages among "remote world-wide observers" were "high-level news reports". That pattern differs from those citizens more directly identified as participating locally in Arab Spring. Likewise, citizen reports from the Kenya elections were faster than those of traditional media (Mäkinen and Kuira, 2008; Meier and Brodock, 2008). The first widely available video of the 2008 Sichuan Earthquake is noted to have come from a university student (Wang, 2010). Another important example of citizens filling a gap left by traditional media is the Mexican drug wars (Monroy-Hernandez et al 2013). In this case, those identified as reporting on drug cartels become targets of them. This has led to anonymous citizen reporting.

Conversely, some studies emphasize the similarities between the work of citizens and journalists by *appropriating the language of journalism to describe the information work of citizens.* It follows that work done by citizens that overlaps with that done by traditional media would use the language of traditional media to describe that work: For example, Reuter et al (2013) identify five kinds of prosocial work citizens took on via social media during a European a mass emergency, those of "helper, reporter, retweeter, repeater and reader." These citizen actions include both activities of traditional media (reporting), traditional audience (reader), citizen response (helper) and new activities afforded through social media systems (repeater and retweeter). These conceptions align with the idea of 'produsage' (Bruns, 2008) and similar concepts put forth by journalism and internet scholars grappling in the early days of the internet with the more complicated interactions between

professional media and "the people formerly known as the audience"(Gillmor, 2006) in the context of collective mass action visible on social media platforms during crises.

The strength of Crisis Informatics case study research is the close observation and attention paid to the information work taking place on social media platforms. Reuter et al's 2013 case study is a good example of how the complexity and richness of that work is unpacked. In these details, we can see citizens bridging activities that do not fit well into the old media classification schemes. Citizens can be considered *reporters* for either passing on information from an eyewitness or from a news source. The aggregate of those citizen reporting efforts can be understood as new forms of collective action that can substitute or stand in for work done by traditional media. Writing to journalist scholars in *Journalism Practice*, Crisis Informatics researcher Wendy Norris (2017) makes this argument explicit by arguing that the collective action of digital crisis volunteers, their organizations, and networks together constitute a kind of journalism.

Yet, these stories of substitution and displacement are not as straightforward as they appear at first. Kaufhold and Reuter's 2016 article on self-organized digital volunteers after the 2013 European floods describes the work of citizens working collaboratively: "…typically not only performed the role of the amplifier but also that of the reporter, acting as a news channel that integrated external resources such as traditional media articles, water level services, and links to further specific or regional communities." Citizens are able to perform collectively as a new channel. But that performance is based, in some part, on the curation and transmission of traditional media articles. Once again, the fundamental complexity of social behavior in mass emergencies— of social convergence (Fritz and Mathewson, 1957, Kendra and Wachtendorf, 2004) and mass participation via social media— make it difficult to see these citizen actions in their fullest context. One has the sense that among the locus of activity that is the focal point of these studies, there may be complementary narratives that add additional perspectives to these tales. Since these systems are still evolving, and the social behavior of citizens, responders, and journalists still in transition, many additional case studies are needed to achieve a more complete picture.

This study builds upon and extends the ways that Crisis Informatics researchers have considered the contributions of traditional media to the information work of citizens and responders on social media. Specifically, this work closely examines several instances where the social media enabled information work of these three groups was inter-related, thereby contributing to our understanding how potential interdependencies between each role as well as what may be distinctive to each respective role.

The Crisis in Journalism

Questions about the role traditional media play in contemporary crises play out against the backdrop of a news industry that has been contracting in financial freefall for three decades. Already in 2012, Public Information Officers in Colorado reported to Hughes and Palen that local news organizations in their jurisdictions had become unreliable partners in informing the public. Staff cuts in those communities had eviscerated newsrooms to the point where reporters could no longer be counted on to effectively follow and report on emergencies. Communication between emergency management and news organizations in those areas had become subpar. The situation has not improved in the intervening years. Between 2008 and 2019, newsroom staff in the United States declined by another 23% (Grieco, 2020). Hardest hit have been local newspapers which have seen a 50% loss in newsroom jobs in that period (ibid). Losses have impacted all regions of the U.S. (Grieco, 2019).

These changes all but assure that the role traditional media have played in prior disasters cannot be maintained without substantive intervention. Several important questions remain open: What, if

anything, might be lost or gained in disaster response as newsrooms fade away? Even in their diminished state, might traditional media still contribute something of import to how we understand contemporary crises? Can the role traditional media have played in past disasters be taken on by citizens and/or government responders? By attending closely to the relationship between the information work of citizens, responders, and journalists taking place via social media in the aftermath of a disaster, this dissertation delivers empirical findings that speak to these questions.

Conclusion

To be sure, the lens that Crisis Informatics brings to traditional media is quite specific, given the field's primary focus on improving emergency response by helping emergency management professionals better understand citizens' use of social media during crises. Teasing out what journalists may contribute within a framework that views social media sites as important venues for citizens and responders to do crisis information work may expand our understanding of how crisis-affected communities of the 21st century are (and may be) best supported. Building upon several ways Crisis Informatics researchers have examined the relation how traditional media contribute to social media during crises, this study closely considers the interrelations between responders, journalists and citizens as they evolved across time. This approach adds additional dimension to understanding the relationship between social media and traditional media. Such findings, may, in turn, ground broader discussions of how social media systems and traditional media systems are, or should be, constituted.

3

Methods

Research Question and Approach

This study was initially conceived as an open exploration of the role social media played for a crisis-affected community in the aftermath of a natural disaster, the 2014 Oso Landslide. I was particularly interested in identifying pro-social information work beneficial to the impacted community. Working in a lab focused on the "emerging capacity of online mass participation," I came to the study with particular attention to the role social media played in the information life of the impacted community. My goal was to better understand *how social media fit within community information work* rather than privileging work that happened through social media or treating it as an isolated phenomenon. As the study progressed, the open-ended question of understanding community information work pertaining to the landslide narrowed to a focus on the interrelated activities of three groups: local citizens, crisis responders, and journalists.

Aligned with guidance from disaster studies and crisis response practitioners, my starting stance was (and remains) that community information work is particularly vital to effective crisis response. When I began the study, HCI and Crisis Informatics— the research fields that this work is situated within— had already produced a strong body of work looking at social media use during emergencies. However, few studies in those fields made community information work during crises the analytical focal point. Rather, they focused more on the (then) novel capabilities of networked technologies to enable those outside of an affected region to assist those within it. My initial research question was an incremental and logical extension of that work. Answering it required employing a broad range of techniques in use in HCI and Crisis Informatics.

Placing the social media work of a crisis-affected community into context was a journey with thousands of small steps. Influenced by the HCI subdiscipline of Computer-Supported Cooperative Work – a research community closely tied to Crisis Informatics—I wanted to learn everything I could about the information *work* of the affected community. I most passionately wanted to know: Who was contributing important information work? How were they situated in relation to the community? What skills did they bring? What resources did they have at their disposal? What were their constraints? Who did they collaborate with? What was the nature of their collaborations?

To answer these questions, I first needed to identify instances of interesting information work. In contemporary crises, people communicate through open-ended systems that culminate in large publicly-visible digital records reflecting the activity of thousands, sometimes millions of users. Within this "data deluge" (Cobb, 2014) it is not uncommon to find examples of any kind of content you might look for, any behavior you might imagine, and often quite a few that you did not anticipate. The same reasons that public digital records are valued by researchers—the records are large, yet detailed— also raise challenges to external validity that researchers must negotiate. Selecting which information work in an online mass participation study deserves a researcher's attention

requires a degree of care (and time) that is not always appreciated. In this study, the guiding empirical rationale for selecting certain work over others for analysis was privileged by what evidence I had that the work had some value or import to the impacted community. I triangulated from three sources to make those determinations. I used techniques common in HCI to strategically identify content of interest in social media and to surface interesting behaviors and interactions around that content. These techniques were instrumental in determining the nature of the information in circulation. Interviews and surveys with those impacted and those who worked the response were invaluable to interpreting the digital record and identifying information, work, resources, and collaborations less visible in the public digital record. Participating in training, exercises, and research activities with the regional response community also greatly aided interpretation.

Approaching the question of how social media fit into the work of the community required several different kinds of data (digital record, interviews, surveys, participant-observation) and analytic techniques that could be applied to each kind. The output of those different techniques and types of data then needed to be put into dialogue with each other. Ethnography is one over-arching methodology that can do this. Through ethnography, we can understand sociotechnical systems as they relate to and express a broader cultural context (Blomberg and Burrell, 2009). Ethnography has been used extensively in HCI, particularly for studies such as this one that look in detail at how people engage technology for information work (Blomberg and Burrell, 2009).

As ethnographers have turned their attention to digital life, and social media particularly, some accommodation and expansion of the initial set of techniques associated with the method have been made. This is also true for this study. Canonical ethnographies selected one social setting (a field site) where the researcher could observe and engage people of interest (Geertz, 1973). In such a study, though repeated observations and interactions over time, the ethnographer gains an understanding of a social system pertaining to that site. Having a site— a village, a bar, a newsroom— renders manageable the job of understanding and describing a cultural system. Sites also do important work in delineating the contours of internal and external research validity. Anything that happens in a bar can be said to related to that bar. For these reasons, it is easy to understand why having a site has been so instrumental to the ethnographic method. When virtual "spaces" became occupied in large numbers, "digital ethnographers" naturally took them up as sites of study. For example, by adopting World of Warcraft as an ethnographic field site, Nardi (2010) gave a rich and novel account of the culture of a popular mass multi-player online game.

Sometimes the activity that we wish to relate to a broader cultural context does not occur in toto at a single location. Marcus made a case for "multi-sited ethnography" (1995) where researchers follow activity across multiple field sites. As with many digital ethnographies (Hine, 2017), Marcus is an inspiration for this study because 1) this research follows information work across multiple social media platforms and 2) in doing so, it treats social media platforms as "sites" of work.

For this study, I identified a number of sites of work and engaged with them to varying degrees. For example, most interviews took place at a location where the interviewee had performed information work pertaining to the landslide. These "contextual interviews" (Holtzblatt and Beyer, 1993; Beyer and Holtzblatt, 1997), occurred where tools and artifacts of the interviewee's slide-related work were often readily at hand. This greatly enriched what was learned during the interviews. In terms of virtual sites, I joined public Facebook groups relevant to the landslide. This enabled me to follow long term the evolution of key online information spaces. My only posts in these venues were to recruit interviewees.

However, as other digital ethnographers have noted (Hine, 2017), not all the activity of interest in the digital realm makes sense through the lens of a site. For a number of reasons (algorithms, user customization, differences between mobile and non-mobile versions of a platform, etc.), researchers

cannot naively assume that individuals have a shared experience of social media platforms in all the ways that the word site may suggest. Twitter especially confounds the idea of a site as ethnographers might use the term. This became apparent from the beginning of the study as I had to determine what content to use in a dataset purchased from Twitter of posts starting one day before the landslide to three weeks after. Though these early tweets resided in a single SQL database, the collection of a roughly one million tweets was in reality slices of many different activities, only a portion of which related to the landslide. Having at hand tweets with generic terms like "mudslide" and "landslide", the very popular word "oso" ("bear" in Spanish) and so forth, along with those tweets containing local names like "Arlington" (a common town name in the United States), enabled me to see a much wider range of related activity than I would have been able to see if I only had tweets with event-specific hashtags to look at.

In looking at this wider range of activity it is hard to think of Twitter as a single site or perhaps as a site at all. In the end, informed by the ability to investigate a wider range of activity, I wound up writing up analyses around one of the most common techniques in Twitter research— network analysis (Borgatti, 2009) of tweets containing an event-specific hashtag. Restricting analysis to tweets containing an event-specific hashtag ameliorates some research validity problems because one can be certain that an event-specific hashtag pertains to the event of interest. Meaningful activity patterns within those hashtags could then be identified through what Howard (2002) called "Network Ethnography", whereby the actors that are prominent in a network analyses (e.g. who was most retweeted) can guide the researcher's further investigation. Together, these two techniques approximate what a site does in an ethnography.

As the digital world is increasingly integrated into all aspects of our lives, some researchers have argued that the time may have passed for qualifying ethnographies of digital life with appendages such as "digital ethnography" or "network ethnography" (Hine, 2017). If I were to apply one here, I would choose Geiger and Ribes's (2011) term "trace ethnography." "Trace ethnography" concisely points toward the nature of the work I engaged in during this study. As both verb and noun, "trace" suggest the focus here of "following the work." It also suggests the means by which we follow that work : digital traces. In a cultural moment where the power of "big data" gets increasing (and deserved) attention, though the methods of making sense of big data are often obscured, "trace" humbly reminds us that social data is an artifact of the thing we want to understand (people and their behaviors) rather than the thing in itself. Sometimes digital traces point unambiguously to what we understand. In other cases, the traces are only indirectly helpful. When we say we work with "digital traces" the interpretive work of the researcher becomes more apparent. This is a bit broader use of the term than Geiger and Ribes' application. They introduced it to illustrate how metadata that is indirectly created by user activity on Wikipedia activity logs can help us understand the culture that produces Wikipedia. For the questions I wish to answer about the role of social media in the life of a crisis-affected community, I have come to think of all of social media data as trace data, not just the metadata contained within. Tracing "chains of coordinated action" (see Chapter 6) across multiple sites was a primary means of understanding the digital world around the landslide.

Modeled on Crisis Informatics cases studies, which are, in turn, modeled on U.S. disaster studies, this study revolves around a single disaster event. Beyond HCI, several ethnographers have given attention to disaster events. Three notable examples that inspired this study include Diane Vaughan's *The Challenger Disaster Launch Decision* (1996), Kim Fortun's *Advocacy after Bhopal* (2009), and Eric Klinenberg's *Heat Wave* (2015). All three of these works employ ethnography to shed light on the complex human systems that shaped these disasters and their response.

Typical of ethnography, but less typical for HCI research, is the extended time of study (5 years). More typical of HCI research than traditional ethnography, some data collection and much analysis was done collaboratively. Taking a hiatus from industry to pursue a PhD, information systems

engineer John Robinson was a close collaborator for the first two academic quarters of this study. John was doing his own field study of technology use among the professional regional responders when the landslide occurred. He co-facilitated the first 25 intensive interviews, co-curated and co-explored the digital record, taught me SQL and many other invaluable things about working with social media data, and, not least, drove the 120 plus miles round trip for most of the interviews and early site visits, including a few post hoc observations at the food bank distribution center in Sedro-Wooley.

Through "directed research groups" and independent study, other PhD, masters, and undergraduate students helped to collect and analyze the digital record. Students were involved in all aspects of the research from literature reading groups to writing papers. Having multiple people look at the same data and reflect on it together can make analysis more robust (Charmaz, 2014). That strategy was particular important for this study. Given the obstacles in recovering the lived experience partially represented in social media data—algorithms, personalization, attention high-jackers that aim to game platform systems, etc.— I am grateful to have had the opportunity to be in a department that made it easy for students to participate in research. Having people of different ages, cultures, and backgrounds reflecting together on the digital record around the landslide proved to be a powerful tool to expand the reflexivity and robustness of the study.

Member checks with citizens, responders and journalists were conducted periodically throughout the study as analysis progressed. For example, prior to publication, member checks were conducted with any interviewee whose work was written into the published narrative.

Finally, ethnography means "writing culture." Creating multiple kinds of data documentation and analytic write-ups throughout the study was an important part of the research process. I used the following guides to inform my documentation process: For jottings and field notes, *Writing Ethnographic Field Notes* (Emerson et al, 2011), for writing methods and analytic memos, Miles, Huberman, and Saldaña's *Qualitative Data Analysis* (2013), for getting meaning from data Charmaz's *Constructing Grounded Theory* (2014) and Saldaña's *Coding Manual for Qualitative Researchers* (2015).

Summary of Research Activities

Intensive Contextual Interviews

Most interviews were conducted in spring of 2015. Two researchers co-conducted intensive interviews with 25 individuals from the impacted community, volunteers, and responders. Two additional interviews were done as follow-up later in the research process. Interviewees were selected to represent the range of activity and positions (position sampling). Eight served governmental roles, including five whose job is communicating with the public (two state, two county, and one federal), a federal research scientist and a town councilmember. 23 interviewees did event-related information work within the affected area. 19 were either permanent residents of the county or worked there on a permanent basis. Two of the non-residents grew up near the site of the slide.

Most interviews (23) were "contextual" (Holtzblatt and Beyer, 1993; Beyer and Holtzblatt, 1997)—occurring at a location where the individual conducted their event-related information work. Locations included homes, places of work, and volunteering sites. Doing contextual interviews gave access to personal trace records of interviewees such as photos, private Facebook pages, paperwork and other materials.

The interview protocol employed Critical Incident Technique (Flanagan, 1954; Butterfield, et al, 2005; Schluter, 2008). Interviewees walked us through their information work from first learning about the landslide to the present. Key to teasing out what was meaningful and important to interviewees, the CIT protocol is technologically agnostic. We simply asked what interviewees need to know at a given point and how they found out. This protocol captured details about their

information work (such as procedure) and phenomenological data (such as what information was important to them).

At the end of each interview, John and I orally administered a survey of the information tools and platforms that they used in the event. Complementing the CIT protocol, the survey helped to verify and add additional detail to the information resources interviewees referenced in the course of the interview. Importantly, the survey also helped to confirm what resources, platforms and tools were not used. For example, some interviewees did not mention using social media in their interviews. The post-interview surveys helped confirm whether interviewees simply didn't mention social media and other resources in their interview or actually didn't use them during their slide related information work.

Analysis of the Digital Record

Analysis of the Digital Record began in the fall of 2014 and continued through to the 5th anniversary of the landslide in March 2019. I identified a rich corpus of publicly-available content pertaining to the landslide, including government and media websites, Facebook, Pinterest, Reddit, Twitter, Wikipedia, and YouTube as well as government records. Across these platforms I did periodic searches for a set of search terms identified early in the research. I read, made notes, and took screenshots. More analytic attention was given to the two platforms most frequently mentioned by interviewees, Facebook and Twitter. These platforms also had more overall activity compared to other sites.

Data

In October 2014, we purchased a collection of 986,826 Oso-related tweets posted between March 21 and April 12, 2014—i.e. one day before the Slide until three weeks afterward. As "stitching technology" (Dailey and Starbird, 2014), Twitter was both a site for study and helpful for identifying additional resources of interest. Though recovery and repair occurred over several months, the vast majority of Slide-specific tweets occurred within the first few days, peaking on March 26th at 6000 tweets per day and sloping down to about 100 tweets per day by April 11th. By extending analysis of tweets from before the emergency through the first three weeks, we were able to track shifts in information work through several phases of the response: the initial emergency, rescue operations, and early recovery. As it happened, interviewees were most keen to discuss the first few days and weeks. The collection contains tweets selected for one of fifteen keywords or hashtags that our exploratory analysis revealed would likely be related to the event. These terms include very general terms such as "landslide" and "mudslide"; location names in proximity to the Slide, "Oso", "Arlington" "Darrington" "Steelhead Haven"; and hashtags created after it occurred, e.g. #530slide, #OsoStrong, #HelpOso. It also contains all of the tweets from 30 highly visible accounts that were associated with the event. These are primarily accounts involved in the official response and some regional media accounts. Though these broad search terms led to considerable noise in the data set, this more inclusive approach enabled us to examine parts of the record that are missed by hashtag searches—e.g. early tweets sent before any hashtags had been created. For event-specific hashtags in the purchased corpus, I employed many analytic techniques such as creating network graphs and timelines. I also followed some users and did periodic open searches of key terms.

Because computationally-assisted data collection from most social media sites is either prohibited or a grey area, I had to alter my data collection and analysis strategy for each platform.
On Facebook, I joined several groups and subscribed to several pages so I could get updates automatically. When possible, I did the same on other sites, following several YouTube channels, Pinterest boards and Twitter users. For Wikipedia I periodically examined the page, revision history, authors, and author pages. I purchased subscriptions to the two newspapers most frequently mentioned by interviewees, the Everett Herald and Seattle Times. I used open searches and news-specific data bases to look at news coverage patterns over time.

The remainder of my investigations of the public digital record relied on periodic open searches for a set list of event-specific keywords. I took screenshots and notes for personal use. I reviewed government websites, reports, and new sites. The technique involved repeated searches on the keyword list terms, followed by reading, taking snapshots and making notes.

Participant Observation

The 2014 Oso Landslide was classified as a FEMA Type 1 Incident, meaning that support was needed from across the United States and was coordinated by FEMA. At least 1000 responders from some 30 government agencies worked at the site. In terms of public information work, dozens of Public Information Officers (PIOs) drawn from numerous agencies worked from three locations across the county: the Emergency Operations Center at the county office building and one of two Joint Information Centers set up in the two towns adjacent to the Slide area—Arlington (west of the slide) and Darrington (east of the slide).

This complexity of such a large response is reflected in the social media record. Interpretation of the social media activity of responders was greatly improved by participant observation. Through the UW based Center for Collaborative Systems for Security, Safety, and Regional Resilience, under UW HCDE Professors Mark Haselkorn, Mark Zachry, and Keith Butler, I assisted in research on day-to-day interagency operational information sharing among the Puget Sound regional response community. For two academic quarters, I helped analyze 80 interviews with regional response professionals, culminating in a report for response stakeholders about information best practices from a regional response perspective (UW HCDE, 2014). For two quarters, I worked for two UW-based earthquake researchers, Megan Finn and Scott Miles, on a workshop that convened experts from around the globe on Seismic Cultures. These activities were invaluable for getting a broader understanding of regional response operations and culture.

I trained for and participated in two regional response exercises. To act as an evaluator for the 2016 Cascadia Rising multi-regional earthquake exercise, I completed online FEMA certifications on the National Incident Management System and took 10 weeks of in-person training at UW led by Navy Officer Brian Zito. I observed for two days at the Kitsap County, WA Emergency Operations Center. The report I wrote supported the Kitsap EOC's After Action Report and was also used as data for an academic publication (Ganji et al, 2019). Subsequently, I contributed content for the social media component of a regional volcano event exercise and attended the exercise at the Bellingham, WA Emergency Operation Center. These trainings and exercises helped me better understand responder communications practices during emergency response.

In spring and summer of 2016, I helped to write recommendations made to the U.S. Federal Communications Commission on social media use during emergencies for an FCC working group that convenes responders and security experts to make policy recommendations (FCC's CSRIC V Report, 2016. The process was practitioner led (by the Harris County Emergency Operations Center located in Houston, Texas) and convened many emergency response practitioners and telecommunications experts to consider social media use. Being part of the writing group helped me understand how emergency responders conceive of social media use during emergencies.

Along with the informative activities mentioned above, I participated in a number of standalone activities such as giving expert evaluations of social media analysis tools designed for first responders. I also attended several regional response meetings that either discussed social media use and/or the Oso Landslide.

These activities enabled a much richer interpretation of the digital record than would have been possible otherwise.

Identifying Journalists

A key feature of this study is that it distinguishes the contributions of journalists as their contributions relate to the information work of responders and citizens. Early efforts to make socially meaningful distinctions between different online users proved unsatisfactory. Ultimately, with support from Kate Starbird and Emma Spiro, I spent the summer of 2017 with three undergraduates using a by-the-book Grounded Theory method (the book being Charmaz, 2014) to build up a systematic way of distinguishing "journalists" from "non-journalists" in Twitter data. We sat in a room together pulling up individual Twitter accounts asking each time, "Is this a journalist? Why or why not?" It took about 120 hours of working in this way to arrive at a set of "cues" that could be consistently and systematically applied to distinguish journalists from non-journalists. The remainder of the summer we manually applied our categorizing schema to all users that had tweeted at least once with either of the two most important event-related hashtags (#530slide and #OsoStrong). As we were developing our schema, Katya Yefimova, former journalist at the Everett Herald and current UW iSchool PhD student was an invaluable asset. We reviewed our categorizing problems with her on several occasions.

On a practical level, the manual assignment enabled us to distinguish the activity of journalists within these important hashtags at scale and with detail in a way that would have been difficult to otherwise achieve. At the same time, conducting the process, particularly as a group that collaboratively "argued to consensus", helped me to think through what digital journalism is, what it is not, and what it may be in a productive and systematic way. Two publications have resulted from our grounded-theory derived manually applied categorizations of journalists and non-journalists. By applying the heuristic classification "cues" we derived through working with the Oso Landslide Twitter data to Tweets containing misinformation in other crisis events, our team found several statistically significant differences between journalists and non-journalists in three different crisis events (Starbird et al, 2018). Using both the misinformation data sets and the Oso Landslide data sets, the cues for detecting journalists we derived through a grounded-theory analysis were evaluated through machine learning techniques and reported on at a computational social science conference (Zeng et al, 2019).

CONCLUSION

This ethnography aims to understand the role of social media in a disaster-affected community. It aims to place the information work that took place through social media into the broader context of community information work. And it aims to understand who contributed to information work on social media in terms of the key social roles of citizens, journalists, and responders. Advancing these questions required mixed data from the public digital record, contextual interviews, site visits and participant observation. It required mixed methods analysis, incorporating computational, quantitative and network analyses into an overall interpretivist methodology

4

Methodology

Doing Interpretive Data Science as Ethnography, or Learning Why Cats Tweet About Disasters

Methods texts and trainings for data science emphasize computational and quantitative analyses and for many these skills define the field. The evaluative interpretative steps integral to deriving insights from large-scale social data are often unnamed and unexplained. In this chapter, I give an extended example to showcase how analytic techniques from interpretivist social sciences helpfully add structure to large scale social data analyses at exactly the points where data science texts leave off. When approached with a pragmatic mindset, interpretivist and data science techniques can be combined to good effect. The overarching methodology in this case is a trace ethnography. However, the analytic problem I feature— evaluating and constructing a meaningful classification of a Twitter user— is an analytic task foundational to many computational social studies. Therefore the mindset and techniques I describe are widely applicable to many other forms of large-scale social data analyses.

WHEN IS A DOG JUST A DOG?

At first, the task seemed straightforward: Look at the profiles of the most influential Twitter users who had tweeted about the disaster. Assign each of them to one of several user types such as 'media', 'government response' and 'aid'. We had practiced as a group the week before and departed confident that we would quickly move through this step of "annotating" the data so as to move on to computational analyses. But now nine of us (4 PhD students, 4 undergrads and a master's student) [8] stared at the screen pondering the photo of a dog. How could a Twitter user claiming to be a dog be among the most prolific and influential users tweeting about a fatal landslide?

In four months prior to this moment of perplexion, I had reviewed disaster sociology and social computing literature to select user types that would move the analysis forward. I had tested those types by applying them to the "top 25" Twitter users by several measures of influence who had tweeted about the 2014 Oso Landslide that destroyed a rural neighborhood in Washington state, taking 43 lives. But what had held for the top 25 had broken before we made it through the top 100. @mattiedog described herself as """"Friendly little shihtzu sharing my life stories! Likes: running, playing, snuggling, eating & sleeping. Dislikes: empty dog bowl. Band member of @ShibberingC". Among the 19524 Twitter users who tweeted #530slide— the event-specific hashtag created by the lead agency in charge of the emergency response — @mattiedog was the 71st most retweeted.

8 Eunji, Hannah, John, Luis, Micheal, Miku, Minhyang, Sam and myself.

None of the research I consulted on user types prepared me for a dog tweeting about a disaster. So I encouraged discussion in our group. What kind of user is this? Do we change our categories to accommodate dogs? Or is dog a subset of some other user kind? Do we skip user 71? If so, what consequences does that have for the research? As I dragged the discussion out, I could sense the frustration—albeit polite— mounting in the room. Why give so much attention to one among tens of thousands? What would one odd user matter in the scheme of large-scale computational analyses? Shouldn't we just get on with it?

The question of what we should do next was, of course, tied up in what we wanted to know. In my case, I wanted to understand the role of social media in supporting a crisis-affected community. Because that question was bigger than social media per se, no analyses of social media data by itself could adequately answer that question. Through interviews[9], site visits, surveys and participant observations, we can learn something of how impacted community members, volunteers, and responders integrated (or sometimes did not integrate) social media into their crisis work. What we discovered through this original research was also greatly enriched by domain knowledge from disaster sociology and Crisis Informatics[10].

My goal in inviting these students to work on this research was to assist with computational analyses of social media (Twitter and Facebook). Yet my over-arching methodology was not data science but ethnography. Because my larger question is a how question that concerns the relationship between multiple actors working across many sites, I needed a methodology that could knit very disparate kinds of data (social media data, interviews, surveys, field notes) into an overarching whole. And more importantly, I needed to knit together many disparate kinds of activity (on social media and off of it) into a whole. The constituents of that whole included mapping community information needs, the kinds of information work taking place, where that work was occurring, and, of course, who was doing that work. Therefore, I chose ethnography for my overarching methodology. Ethnography enables us to consider such disparate constituents of human activity and pose how they relate to each other.

Because social media are core sites of activity for my research question, trace ethnography is a particularly productive flavor of ethnography for what I want to understand. Geiger and Ribes (2011) articulated trace ethnography around examples of work they performed on what is arguably the most successful social media site to date, Wikipedia. For Geiger and Ribes, trace ethnography is a

9 On the advice of early HCI industry researcher and emerita professor Judy Ramey, I used Critical Incident Technique (Flanagan, 1954) for the intensive interviews. CIT can uncover both tacit procedural knowledge and phenomenological/experiential perspectives from interviewees (Schluter et al 2008). Thus it is useful in organizational and user research. In combination with personal records shared during the intensive interviews, a post-interview survey of used (and not used) information resources, and the larger digital record of the disaster I was studying, CIT was exceptionally helpful. Additionally, because CIT is a flexible debriefing technique that gives room for the interviewees to direct the line of questioning, it can be sensitive to interviewees who have experienced a tragedy.

10 Named by Christine Hagar in 2007 and expanded by researchers at the University of Colorado, Crisis Informatics is a hybrid field that draws on human-computer-interaction, informatics, and disaster sociology to understand how information is produced and diffused in contemporary crises (Reuter, Hughes, & Kaufold, 2018). Though Crisis Informatics research has never exclusively focused on social media, use of those platforms media during crises is a core strength of the field (ibid). The work I report here was done while working in Kate Starbird's emCOMP lab at University of Washington which specializes in Crisis Informatics.

productive way to discover and articulate information work practices and organizational arrangements in open networked environments. This suited my research question well.

'Trace', here, was a clever choice of terminology on their part because it invokes a tried-and-true technique in interpretivist social sciences of making work processes the primary object of study. "Following the work" has proved productive across many research domains of applied and academic research when the aim is to uncover work cultures, patterns, and practices in human organizations. So it stands to reason this approach might also be useful for understanding the novel forms of organization afforded by social media as Geiger and Ribes had done. They used trace ethnography to understand how tens of thousands of mostly anonymous all-volunteer editors are able to produce and maintain the world's 5th most-trafficked website.

At the same time, the word 'trace' also calls attention to what is methodologically distinct about trace ethnography compared to other flavors of ethnography. The prolific digital traces produced directly and indirectly by social media users can be a primary source of data. Social media digital traces give data of great quantity. At the same time, trace data can give extraordinary detail. Both are desirable data attributes for any science. This kind of data in combination with the method of tracing, or following the work, affords an additional benefit. As Geiger and Ribes point out, following digital traces enables the researcher to come close to a user's view of a system— an important and valuable lens for understanding complex information systems.

In a canonical ethnography, a researcher wishing to understand the social activity of a village, coffee shop, or conference room can directly observe the setting and context of that activity. By contrast, the context of a dog tweeting about a disaster is not entirely observable by looking at the digital traces pertaining to that dog. Rather, the context emerges as we compare the specific instance in question to additional cases and to the overall numerical patterns in the data set. To do that, we need some quantitative and computational analyses. Those terms might sound redundant, but they are not. By quantitative, I mean it is helpful to orient ourselves to the overall numerical patterns across our data. By computational, I mean that our analyses may well require us to do things that aren't usually associated with interpretivist social science such as reading JSON strings, moving files around with Unix commands, manipulating SQL databases, or running Python and R programs to generate statistics and visualizations. Currently, quantitative and computational techniques are being clustered under the header "data science" and are viewed as 21st century skills. Indeed, it was the hope for exposure to such techniques that motivated the engineering students who found their way to the lab. My demand for an extended discussion on about the 71st most retweeted user among 20,000 was waylaying their objective.

BIG DATA, UNSURPRISING RESULTS

What the students didn't know is that John[11] and I had already put the landslide Twitter data through the paces using common data science techniques— to mostly disappointing ends. When most of us think about science, what comes to mind first is counting things. And this must be doubly true for

[11] This project benefited greatly by John Robinson. Paired with me by our PhD advisor Kate Starbird for the first quarter of the study, John brought the computational and quantitative skills to complement my experience as a field researcher. John drove me to more than twenty intensive interviews, most taking place more than 70 miles from our university. He selected the tweets we purchased from Twitter, loaded them into a database I could work with, and patiently taught me much about the mechanics of data science and social media research.

"data science". One of the canonical roots of data science is John Tukey's 1977 monograph *Exploratory Data Analysis*. In it, Tukey introduces several quantitative techniques that he (and several generations of what we now call data scientists) found particularly productive for getting a feel for the overall characteristics of a particular data set. Now "EDA" is a prescribed step in data science.[12] Since the 2000s, social media researchers have developed their own shortlist of quantitative techniques for unboxing a data set.

When John Robinson and I applied these exploratory quantitative techniques to the first three weeks of tweets about the Oso Landslide we were a bit disappointed. Network graphs, which represent the numerical relationships between objects, are widely used for exploring data across many science domains (Borgotti, 2009). Our first network graphs based on who-was-retweeting-whom for prominent event-specific hashtags turned out to be undifferentiated "hairballs" with few surprises. For example, from the retweeting network graph for tweets containing the hashtag #530slide, we could see that those at the center of the conversation were unsurprising to us. Traditional media was in the "middle" of the hairball, followed by the lead agency in charge of the response. With knowledge of prior literature, and our own experience of social media activity during crises, the graphs did not seem revelatory.

Similarly, time series graphs of tweets per day and tweets per hour showed a big spike occurring in the first three days after the landslide. But then activity quickly sloped down to almost nothing within three weeks. The slope of the timeline graph of Twitter activity did not correspond to the on-site response activity. On-site work stretched from March to July, whereas Twitter activity more closely followed the news cycle of a major disaster. Again, we could anticipate this result from prior research such as Kwak, Lee, Park, and Moon's (2010) much cited paper "*What is Twitter, a Social Network or a News Media?"*

Unsurprising but necessary: Using numerical patterns for direction setting and orienteering

These exploratory techniques and their unsurprising results are singled out here for illustration. They are among dozens of exploratory techniques common in Crisis Informatics research that we applied to understand the data set. Despite pursuing many avenues of exploration, very little in our exploratory quantitative analyses would be "new" or "interesting" as defined by our research community. Nevertheless, quantitative analyses are an inescapable and essential part of social media research. Metrics such as most shared content, most viewed content, most prolific users, most retweeted users, and so forth prepare us to make scientific discoveries. These metrics are more often the instruments that lead to the discovery of novel results, rather than novel results in themselves. They have more in common with the thermometers and measuring beakers found in a biology lab, than what is reported in a scientific journal. As Howard (2002) points out, statistics (such as those that describe the interactions patterns between members of an online community) can help guide an ethnography because they can help us to identify actors and activities that warrant further investigation. But there is another reason that having a sense of overall numerical patterns is important in trace ethnography. The big numbers that characterize a data set help us to find what is interesting within the larger context of overall observable patterns. There is no computation I can directly compute from the 100 plus objects in JSON tweet file or even a million JSON tweet files that will output the significance (or insignificance) of a dog tweeting about disasters. There is no

[12] See, for example, Alice Zhao's slide presentation in the context of a tutorial on Natural Language Processing in Python from PyOhio July 2018. EDA is the third of five steps: "1. Start with a Question, 2. Get & Clean the Data, 3. Perform EDA, 4. Apply Techniques. 5. Share Insights."
https://www.youtube.com/watch?v=xvqsFTUsOmc

object that exists in the collected tweets that can tell me "this is important." But those things I can easily compute give me some guidance as I try to determine whether a dog tweeting about a disaster is or is not important. The big, unsurprising numbers can directly guide further investigation. Ethnographers may use those numbers to set a direction for study, as Howard suggests, informing which objects we choose for further study. But whatever those objects may be, the big unsurprising numbers will serve as baselines for comparison, helping us, like GPS, orient ourselves in relation to a larger territory.

In *Doing Data Science* (2013), O'Neil and Schutt define EDA as a set of statistical techniques and visualizations: "The basic tools of EDA are plots, graphs, and summary statistics. Generally speaking, it's a method of systematically going through the data, plotting distributions of all variables (using box plots), plotting time series of data, transforming variables, looking at all pairwise relationships between variables using scatterplot matrices, and generating summary statistics for all of them. At the very least that would mean computing their mean, minimum, maximum, the upper and lower quartiles and identifying outliers."

This definition is well aligned with the contents of Tukey's *Exploratory Data Analysis* where each chapter explains such a technique. However, it becomes problematic if we conflate the goal (understanding our data) with the means (these particular techniques). Tukey, in fact, prefaced the monograph with a boldfaced, capital letters warning that we should not do so. Under "Examples, NOT case histories" Tukey cautions that the quantitative techniques he introduces are "not intended to be complete case histories. Rather they show isolated techniques in action on real data." In other words, the techniques Tukey introduced that are foundational to data science are extracted from analyses that involved more than what Tukey covers in the book. The reader is left to imagine what other techniques would be beneficial to attain a grounded understanding of one's data. Many contemporary data science tutorials and texts follow this pattern: emphasizing EDA, but gesturing weakly at what else might be done. An unfortunate but logical conclusion one might arrive at from introducing data science in that way is that it suggests quantitative techniques define data science. This constrains a data scientist quite a bit. It means we are limited to that science which we can do based on what we can count in our data. Since there is not a JSON object contained in tweets for "is_dog = yes", we are stuck with the choice of either exploring the question of why a dog is tweeting about a disaster through something other than the scientific methods of data science or sticking to the numbers though they cannot help us understand why a dog is in our data. Or are we?

If we are able to inscribe additional meaning upon our data, such as the presumed species of a user, we can begin to explore the question systematically. Is @mattiedog the only dog tweeting about this disaster? Might there be other species besides dogs and humans also be tweeting? By answering these questions, we might, finally, eventually, link back to our big question, what role (if any) does this activity play in the overall response to this disaster?

Of course, the process of inscribing additional meaning on data is an interpretive act– and one that can be done more systematically or less systematically. This is partially acknowledged in data science discourse. For example, Conway's Venn diagram of Data Science skills is often referenced or alluded to in workshops and tutorials introducing data science methods[13]. Conway views data science as taking place at the intersection of "Substantive Expertise", "Hacking Skills", and "Math & Statistics Knowledge." According to Conway, there a "danger zone" where hacking skills and substantive expertise overlap in absence of math skills. Yet Conway does not flag a danger created by statisticians

[13] http://drewconway.com/zia/2013/3/26/the-data-science-venn-diagram

who apply math to poorly constructed categories: The overlap of "Hacking Skills" and "Math & Statistics Knowledge" absent of Substantive Expertise is labeled "Machine Learning." From Conway's formulation of data science, the work of constructing and evaluating meaningful social categories is rendered invisible.

Given that data science is introduced in this way, is it a surprise that some of the most contentious uses of data science concern classifying people? To give but a few examples, concerns have been raised over conflations of sex and gender (Keyes, 2018), those likely to abuse children from those not likely to do so (Eubanks, 2018), and those who deserve credit from those who don't (O'Neil, 2017).

One common way to curb potential problems caused by assigning new meaning to people is to rely on how they describe themselves. On the surface, it may seem ridiculous to take a user's self-description as a dog at face value, but a real validity problem lurks behind how we decide to treat this user. What is the defense for using self-descriptions to classify some users but not others?

Though important to the quality of the analyses we could achieve, I could sense frustration among those students who came to the lab motivated by the opportunity to apply data science techniques when, in their minds, extensive attention was given to issues of labeling the data. For them, "labeling" data was a precursor to the real work of computation, not something integral to the data science but separate. I came to see the disconnect between what we needed to do with our Twitter data to transform it into something useful for our research was often rooted in one of two mental obstacles that can hinder researchers who attempt to do social science with social media data.

The first mental obstacle that hinders us is when we conflate doing data science with the hypothetico-deductive method. "The scientific method", as we learned long ago at our elementary school science fair, is when we have a theory of how something works (a hypothesis) and we collect some data to test that theory against. Many data science primers and tutorials explicitly or inexplicitly define science as the hypothetico-deductive method. But this is only one way to do science, and trying to use the hypothetico-deductive method on data that isn't suited to it can cause confusion. Unfortunately, for us, Twitter users do not tweet to advance science. We did not hypothesize there was a dog among our Twitter users, nor did we set out to collect tweets by dogs. To account for the many, many things that show up in data repurposed for science (data such as tweets), we need to broaden our mental model of what a scientific method can be. For repurposed data, we would do well to first look at it the data, then develop theories based on what we see, then test those theories against different data. We repeat this process until we have what we deem to be an empirically sound insight. In contrast to what we learned in grade school, this approach is— in many scientific fields— a very legitimate way to do science. This less brittle, "abductive" formulation of a scientific method was first articulated by scientist/philosopher Charles Peirce (1839-1914) and is sometimes called Peircean Pragmatism, although it goes by many names in different settings. EDA can be seen as set of techniques that *enable* us to perform Peircean Pragmatism on quantitative data. EDA is a good fit for social media and many other kinds of data that do not lend themselves to straight-forward hypothesis testing.

In introducing EDA techniques Tukey does not explicitly state they are a piece of an abductive process. However, O'Neil and Schutt argue for the importance of an "EDA mindset" which suggests an overarching process beyond applying a sequence of statistical manipulations. In *Going Pro in Data Science: What It Takes to Succeed as a Professional Data Scientist* (2016), Overton states more directly that data science is best considered a process of "practical induction" and "agile experimentation". Yet many data science texts and tutorials default to the hypothetico-deductive method. Thereby, they perpetuate a disconnect between the process by which we can productively derive insights from certain kinds of data (like tweets)— which is abductive— and a mental model of that process—

hypothetico-deductive. If, instead, we conceive of data science as an abductive process we can avoid this mental obstacle.

CONSTUCTING DOGS FROM TWEETS

Our second mental obstacle concerns the vagueness about how to approach the interpretive work of data science. How, exactly, do we fill the blank occupied by 'and other stuff' that expositors of data science methods such as Tukey, Conway, and many others gloss? Beyond statistical manipulations, what other work do we need to do in data science? To be sure, a lot of interpretive work relies on relations between things that can be intuited. Yet, if we only work from intuition, how will we know when our intuition is off? If we are unaware of how to systematically approach the work of interpretation, we stray into that "danger zone" unnamed by Conway. But even if we concede more interpretive work needs to be done, how do we go about doing it?

The danger of poor interpretation is heightened in this case by what we aim to interpret. Science scholars have been long aware that constructing solid scientific categories that sort people into meaningful groups is more difficult than other kinds of classification work (Hacking, 1995). How we characterize people or, in this case, presumed people, can have profound real-world consequences. This is being discovered anew as data science methods are broadly applied across many domains. The news is rife with examples of decision-support systems relying on data science that have poorly conceived of the humans involved such as a predictive policing system in Chicago that conflated those at high risk to be crime victims with those at high risk to be criminals.

Fortunately, just as Tukey set a foundation of prescribed techniques to assist us in deriving meaning from our data, so too have interpretivist social scientists. Interpretivists offer us practices, processes, and progression of steps that give us structure exactly where Tukey and Conway leave off. Here, I can only gesture at what this rich tradition can lend to data science. To give but one example of how interpretivist social science techniques can enrich data science, let's consider the steps an interpretivist social scientist might take to inscribe new meaning on a data set through the task of "annotating" or "labeling" data (in data science terminology) or "coding data" (in social science terminology). The interpretivist tradition lends much greater precision to this task. For interpretivists, the process of moving observation to new meaning follows a progression with particular steps. For example, Miles et al (2014) distinguish "First-Cycle Coding"— a step that takes us from observation to descriptive labels— from "Second Cycle Coding" where we look for patterns in what we have labeled. "Coding"— the interpretivist word for labeling data— is but one kind of inscription in the interpretivist toolkit along with "jottings", "field notes", "diaries", "logs", and "memos" (Madden, 2010; Emerson et al 2011, Miles et al 2014). Each of these forms of inscription does distinct work in the interpretivist process. Likewise, interpretivists offer great specificity into the nature of a label. For example, Saldaña (2013) lists 39 different kinds of qualitative coding schemes that have been used productively to label data. He then offers 42 different analytic frameworks that can assist us to identify and make sense of patterns in the labels we have applied. A researcher who is adept at these techniques has a lot of options for systematically and productively addressing problems of categorization.

Appropriating the exact forms of inscription that evolved over decades of interpretive work done by social scientists in real world settings to large amounts of trace data split apart in SQL tables remains, at present, a great challenge. As large scale data sets are manipulated and transformed, the task becomes greater still. Though challenging, this practical obstacle can be overcome if one understands the intent behind each step and each delineation that interpretivists make as they move from observation to new meaning.

One system for interpretation that is particularly well suited to our investigation of a dog tweeting about a disaster was given to us by Glaser and Strauss (1967) who describe how the process they

used for a qualitative study on the experience of patients dying in hospital. They called their method Grounded Theory. The name emphasizes two signature aspects of the method: 1) New theory is a goal/outcome of working with the data. 2) Theories old and new should be tested against data. In other words, Ground Theory is an abductive process rooted in Peircean Pragmatism" (Charmaz, 2014). In this sense, the term could be interchangeable with "the EDA mindset"[14].

The over-arching process of Grounded Theory suits the kind of data we have and integrates well with the process of data science as described by Tukey, O'Neil and Schutt, and Overton. Charmaz's take on Grounded Theory— "Constructivist Grounded Theory"— is suited to social media analysis. The sheer number of manipulations that must be made to social media data between capturing a data collection through to reporting final results heightens a social media researcher's awareness of their active role in rendering meaning at each step in the process.

To give a sense of the process in action, let's pick up the analytic trail where we left off after the first unsurprising round of quantitative analyses. When our initial quantitative analyses showed little of note, I did not give up, I leaned in. My next move was informed by Charmaz's prescriptions of first steps in exploration according to Grounded Theory methodology. I took several samples of the most influential users by several standard measures. I selected a set of socially meaningful categories derived from prior research then tried to place each top user in one category. In the act of evaluating a user for each category, I learned much about the characteristics of the most influential users. At the same time, I was testing the validity of each category for these users. Each labeling event served as a tiny test to probe meaning and fit. This is a systematic way to "dialog" with the data. Charmaz calls this "initial sampling" to emphasize that the we don't usually discover the most salient findings in this early round of exploration. Because my initial samples were selected on the same descriptive stats we used for EDA, the process of labeling these top users was a productive way to deepen my understanding of the overall numerical patterns that characterized this data. Glaser and Strauss call this process "constant comparison" and it is a core technique of the Grounded Theory method.

After several attempts at applying one of several social categories derived from prior research to each user among a set number of the top most influential users, I then reviewed the categories that I had I applied to them. Of the 25 I had started with, I deemed about 10 to warrant further testing. The next step was then to test more users against these categories. An additional test of categorical appropriateness and fit would be to ask other researchers to independently apply the categories. The more of us agree that a particular label is a good match in a particular instance, the more sound we deem that label to be (Saldaña, 2013). Thus, I invited students to join me in trying to apply the 10 remaining social categories to additional users. In similar studies, it is not unusual for researchers to outsource labeling to crowdworkers on Mechanical Turk (e.g. Tang and Lease, 2011; Nowak and Rüger, 2010). This works well for certain kinds of problems, but the kind of coding practice I am describing here is not easily outsourced. One advantage of not outsourcing coding is that it affords us the ability to reflect on problems of fit ("There is no category for dog!") and disagreements in interpretation ("Dog is or is not a meaningful category.") Such reflection can be potent when it is a group process. Working collectively to come to a consensus on category formation is another technique from the interpretivist toolkit (Saldaña, 2013). Though write-ups of computational social science sometimes report statistics for inter-coder agreement (the statistics suggests how stable or

[14] Charmaz points out there is no reason that Grounded Theory could not be applied to quantitative data, but in practice the method is strongly associated with qualitative research. One supposes this is for historical reasons. Glaser and Strauss (1967) illustrated the method on interview transcripts.

reliable a category might be) they rarely discuss how or why categories break. This puts the work of how we arrive at stable and sound social categories mostly out of sight.

I too am guilty of reproducing this problem. The two quantitative and computational papers (one of each) I co-authored that rely on identifying journalists in Twitter by the processes I touch on here also gloss them. The reality is, it takes so many manipulations to move from raw social media data to report-worthy findings only a select few can make it into a publication. This has consequences for both the research and the researchers. When steps that make the difference between quality computational social science and junk social computational social science are left off the page, it disincentives resourcing that work. Those who learn science by way of data science bootcamps, practitioner focused books and so forth, may lack the capability to identify the analytic problems obscured by the often truncated discourse of computational social science methods.

TRAILING A DOG, HUNTING PATTERNS

The patterns I thought I saw in my initial samples of top users offers a cautionary tale. As it happens, the most retweeted, replied-to, mentioned, and prolific users in this collection had more in common with each other than they did with users further down in the rankings. Therefore, the patterns that held for top users soon broke. This underscores the importance of testing our understanding of social media data through additional samples and tests that are intentionally designed to break our assumptions. My next step was to look more closely at the users my categories could not contain.

For this step, I took a detailed look at all the digital traces available to me for @mattiedog. At this micro-level of analysis, constant comparison involves oscillating between looking at the numerical traces attached to @mattiedog's tweets in comparison to the numerical patterns in the overall tweet collection in comparison to what is generally understand about numerical patterns for user interactions on Twitter. Observing numerical patterns is interspersed with reading tweets, user names, and profiles. By oscillating my observations between qualitative and quantitative information, I can build up a set of inferences that ultimately gives me a picture of this user's role on Twitter for this event.

Tracing one dog among thousands: Applying constant comparison

At the time of her first tweet in our collection, @mattiedog had 8640 Twitter followers and 4493 users that she followed. This suggests a fairly high level of engagement through Twitter prior to tweeting about the landslide. @mattiedog first tweeted about the landslide 3 days after it occurred. This is interesting because peak Twitter volume was within the first 3 days. But @mattiedog was only getting started. She contributed 121 tweets between March 24 and April 9. This is a very extended length of engagement. Compared to the 19524 users who tweeted the event-specific hashtag #530slide, she is among the top 4% who tweeted it in the first week and who were still tweeting it 14 or more days after the landslide. This is substantive engagement compared to the 66% of users who tweeted #530slide only once, mostly in the first week. Only 11 of @mattiedog's tweets in our collection are without this hashtag. Two-thirds of @mattiedog's tweets are retweets, but a comparatively high 41 were authored by her. All of these contain #530slide. Together these stats show an exceptional adherence to using #530slide. This is interesting because several other hashtags emerged around this landslide, and more tweets lack any hashtag, yet @mattiedog chose to make extensive use of the one that the official response created, used, and requested others use.

Both descriptive statistics and qualitative data suggest @mattiedog's role in this information space is one of curation and amplification. She retweeted 48 different users. Interestingly, these are a mixture of official government accounts (Washington National Guard, the state governor), aid organizations (the local Red Cross and United Way), traditional media, community response, and animal related accounts. The retweeted_status_retweet_count for the tweets she retweeted are mostly in the single digits, which suggests she is choosing to retweet tweets she thinks might get lost. This view is

strengthened by looking at the tweets she authored herself, most of which attach the hashtag #530slide to information about fundraisers and other germane community response and aid activities.

Several digital traces suggest that @mattiedog's efforts were attended to and supported by others. She was retweeted 73 times. Among her originally authored tweets are both requests to specific users to share certain bits of information along with salutations and shout outs to specific individuals, mostly in the informal response. In contrast to those who @mattiedog retweeted, the 49 users who retweeted her are more of a kind than a heterogeneous mix. Only 3 give a professional association: Two business owners in the region and one AP journalist. About 2/3 (33) of these individuals associate with animals— as owners, lovers, or advocates. Of these, 10 take on the identity of a dog, 4 the identity of a cat.

Assigning a dog to a pack: Applying domain knowledge to a set of inferences

Combined with other points of inference, these stats suggest to me that @mattiedog was probably aware that the public information officers activated for this event were reading tweets with this hashtag and when she attached it to a tweet she was intentionally raising the visibility of specific content to those within the official response and others who were closely following the official response. Combined with qualitative review of her content and sharing patterns, I begin to suspect @mattiedog is familiar with official incident management procedures and organization. At the same time her user description (Friendly little shihtzu sharing my life stories! Likes: running, playing, snuggling, eating & sleeping. Dislikes: empty dog bowl. Band member of @ShibberingC) unequivocally places her outside of the official response.

From this combination of quantitative and qualitative analyses, Crisis Informatics researchers will likely recognize @mattiedog to be a digital volunteer. As social media gained popularity throughout the 2000s and 2010s, researchers have tracked the evolution of this kind of volunteering. Originally these efforts of the online crowd were ad hoc such as the spontaneous online collaborations that took place after the 2010 Haiti Earthquake (Sarcevic et al, 2012; Zook et al, 2010). Crisis Informatics researchers saw in the spontaneous online collaborations that aimed to help earthquake victims an extension of a fundamental behavioral pattern identified well attested by disaster sociologists— the tendency of humans to spontaneously converge on sites of a disaster. This pattern of social convergence (Fritz and Mathewson, 1957; Kendra and Wachendorf, 2004) in which individuals alter normal routines to address a large scale disruption is well attested in disaster sociology. Over time, digital volunteering grew into a self-aware form of information work (e.g. Starbird and Palen, 2013), increasingly coordinated among volunteers who recognize each other, work together, and learn from each other (ibid; Soden et al, 2016), some as unaffiliated individuals, some through digital volunteer organizations (e.g. Norris, 2017; Starbird and Palen, 2013), and some integrated into official response (e.g. St. Denis et al 2012). The aim of their work is to help orient people who converge digitally on a disaster to actionable information through curation, cross-posting, offering additional context, and direct communication.

Returning to the data again to test this interpretation, I see several of the animals lovers who retweeted @mattiedog associate with animal rescue and adoption. This is a clue to how the social convergence on disasters works. It makes sense that individuals who use social media on a daily basis to advocate for the welfare and adoption of unwanted pets would be sensitized to how a disaster might impact animals. They have or can quickly forge relationships with local animal welfare organizations and can quickly mobilize aid toward them. These informal activities are important because, though it is well understood by professional disaster responders that animal welfare is an important consideration in disaster response (Farmer et al, 2017; Travers et al, 2017), professional responders must prioritize the safety and welfare of humans. Thus, one focal point of informal

response work concerns the welfare of animals. Filling the response gap around animal welfare has become a niche for digital volunteering (White et al, 2014; White et al, 2015).

Finally, another sample makes me more confident of this interpretation. Reading @mattiedog's tweets as a corpus completes the picture of her as digital volunteer who bridges two strands of volunteer work. The few tweets (11) that don't mention animals promote volunteering and donation opportunities, including plugs to support the local Red Cross and United Way and a request to support funeral arrangements via a GoFundMe page. But the preponderance of @mattiedog's tweets amplify aid messages concerning animals— spreading word of the local veterinarian who is a point of contact for animals injured in the disaster, promoting fundraisers geared toward local animal adoption groups, and sharing news items about animals involved in the response.

BUT WHY DO CATS TWEET ABOUT DISASTERS?

By comparing at @mattiedog's interaction patterns to the overall interaction patterns in the data, and, in turn, making inferences about those patterns based on broader knowledge about the Oso Landslide and prior research, we have arrived at a defensible argument that @mattiedog is a digital volunteer. And, by the observable metrics, she seems to have been pretty successful in that role. But what we don't know yet is how @mattiedog's role as digital volunteer was modified by taking on the identity of a dog. To understand that we need to take a theoretical sample. I call it a theoretical sample because I am making an inference here that is yet untested: I pose that taking on the identity of an animal might have some sort of modifying effect on how Twitter users interact with each other. In the grand scheme of things, this a small theory. But in Grounded Theory logic, we build toward big theories by constructing and testing many small theories.

To test my small theory, I look for more dogs, more cats, more animals. After a few hours of querying my database for user screen names and profiles containing "dog", "puppy", "canine", "K-9" and so forth, I am surprised to find 222 users in a sample of roughly 20,000 users who tweeted about the landslide who semantically associate with a dog and 101 who semantically associate with cat. Thereafter, this line of inquiry runs cold. Aside from one horse and one ferret, I could find no other users identifying as animals in the collection. Of these, only 22 fully adopt the persona of a cat (10) or dog (11) by making use of user names, profiles, profile images and tweet language to full effect. However, read in comparison to the larger group of 325 users who strongly associate with animals, the delineation cats, dogs, and humans blurs into an infinitely graduated spectrum of associations that reflect the myriad relationships humans have with their fellow creatures.

Users incorporate animals into their online identity for many reasons. The preponderance of users in my 325 sample are businesses and organizations that work with or for animals: pet chefs, veterinarian, rescue shelters, trainers, pet journalists, pet shops and so forth. This explains most of the user names with a semantic association with an animal. Within that group are a handful of users like @mattiedog whose profile image, user profile description, and name all coherently work together to suggest that the user is an animal.

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I'm a red tabby housecat offering commentary on cat matters. I'm a
polydactyl Catcadian Cascadian and a Rose City kitty.
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"I am a puppy in training. Work at News Denver."
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In these cases the descriptions seem to give a clear signal that the purpose of this user account is to engage with information about animals. Except in other cases, animals are invoked because of their euphemistic associations with humans, like "cool cat" or "news hound." Confronted with these data, the idea of an online animal identity serving one purpose begins to slip away. Rather, invoking a

relation to an animal appears to fall along a set on independent continuums: from literal to metaphorical, from serious to playful, from primary to tertiary. For every user that strongly identifies with animals, thousands more incorporate an association into their identity claims as owning, loving, or advocating for animals.

Looking at the larger corpus of all users who incorporate a reference to animals into their profiles reveals something interesting about this particular association: it is an association that crosses all other human divisions. NRA moms, soccer moms, and liberal moms love their pets. So do politicians, firefighters, and journalists. Associating with an animal has a humanizing effect. It is a bridge-building identity, a neutral offer in a medium criticized for creating and perpetuating bubbles.

Likewise, content about animals was produced, read, and shared across all meaningful ways of distinguishing Twitter users. This, in turn, tells us something about the nature of the event and something about the nature of information sharing for this event. Just hours after the fatal landslide, regional search and rescue teams including dogs descended on the scene. The 8 people extracted from the slide that Saturday would be the last humans to be rescued alive. On day three, Blue, a German short haired pointer, was rescued from under a tree, the last live rescue. Donations efforts sprung up pay his vet bills. Incredibly, some 12 days after the slide, another dog was discovered on-site. News of the "rescue" was widely circulated. This news was too good to be true. In fact, Boomer wandered onto the site from a home 2 miles away. But the story arrived at an emotional turning point when the unstated reality was settling in that it was unlikely any of the 43 missing humans would be found alive. To recover the missing, FEMA brought dozens of search and rescue dogs and handlers from around the U.S. with specialized training in this grim task. Often working in the rain, handlers suited up in Tyvek suits each morning and together with their dogs waded through caustic mud that was in some places 20 feet deep. At the nearby Oso firehouse and other locales, therapy dogs gave emotional relief to responders, survivors, and community members. The work was not only taxing for the humans, but also for the rescue dogs. FEMA arranged for therapy dogs to provide relief to the many stressed recovery dogs working the site. Meanwhile, outside of the one square mile disaster site, a nearby horse farm became one of several donation collection centers run by community volunteers. Pet food was a popular donation item.

This is obviously not the entire story of the Oso Landslide. It is not all that was tweeted about. But it is one veridical account of response work on the ground for this disaster. At the same time it is one veridical account of what is visible in the Twitter data for this event. Examining the interaction patterns around animal-centered users and animal-centered tweets, we have an exemplar of how social convergence occurs in disasters and what social convergence can achieve. This exemplar parallels other response activities that unfolded around this event. And it aligns with and confirms patterns described in Crisis Informatics literature.

Yet, in reading the tweets about animals for this event as a corpus, reviewing the associated images and embedded links, I also see something particular about the story the social media crowd gravitated to on this occasion. The morning of March 22, 2014, Steelhead Haven was a neighborhood. On March 23, 2014 it was a mass gravesite. Of all the stories that could have been told about the grim work on-site, of all the images that could have been shared, the animal-centric one is among the most humane. A photo taken at sunset of a mud-drenched responder kneeling down to hug a mud-drenched dog against the backdrop of a debris field is informative. It conveys the essentials: the status of the response, the status of the responder, the likely outcome for the missing. And yet, it leaves out the grimmest details. Tweets about animals were among the most shared. Reviewing this collective curation by thousands of individual Twitter users, I see caritas. It is hard not to imagine that the intent of tens of thousands of users who made this one of the most prominent narratives, was to soften the lens on the tragedy without turning away.

The formation of this theory of a collective sensibility manifesting through collective curation of the connected crowd is also informed by the difference between what I saw in the digital record compared to what interviewees conveyed. Several interviewees spontaneously emphasized the intensity of the emotional labor involved in recovering human remains along with precise details of that work. Though this information is not entirely missing from the digital record, the digital record, overall, reflects a sensitivity around discussing and sharing explicit details. For example, I know of no images of remains recovered from the site being shared. It seems that the collective sensibility of the Twitter crowd producing and sharing tweets about this landslide was to soften the light on a situation that was emotionally challenging for participants and witnesses alike. Just as therapy dogs on-site offered relief, so too, tweets about dogs offered a gentle way to mark the progress of a difficult event.

A MATTER OF INTERPRETATION

In this chapter, I have followed the steps from early exploration of a data set through to the formation of several small theories that characterize or "fit" the data. This culminates in a theory that characterizes all of the tweets about animals for this event. It is important to note, that this theory is the outcome of all of the steps I describe above. By describing these steps in interpretivist terms, I showcase the analytical value of steps that are often demoted in data science to "cleaning" and "preparation" or simply not described.

In this telling, I have demoted the emic categorization of a Twitter user who identifies as a dog (what she calls herself), while laying out a rationale for why an etic categorization is a better fit to explain her role in tweeting about a disaster. This was both a reductive and evaluative move. In doing science of the social, it may not be possible to create universal, non-reductive categories (Hacking, 1995). However, in accounting for where, how, and why I made evaluative moves, the reader is informed of the benefits and limitations of my choices. I made use of ethnographic narrative to make clear the link between process and outcome. I gave context to EDA techniques and numerical relationships by weaving them into the narrative. Had I instead foregrounded numerical relationships between cats retweeting dogs and so forth, I would run the risk of reifying a category that, in my view, was not the best fit for interpreting this data. Emphasizing these numerical relationships may have led to spurious and insensitive conclusions (Martin and Lynch, 2009) about the information work these users engaged in for this disaster, the meaning, intent, and effect of their efforts sidelined. The interpretivist practice of ethnographic write-up solved a problem here that perpetuates in contemporary data science. When large scale data of the social is aggregated, transformed, and passed along from analysts to analyst, the history of evaluative moves are easily distorted or lost.

CONCLUSION

In this extended example of how meaning was inscribed and extracted from tweets about a landslide I have shown that techniques drawn from several different kinds of science— approaches sometimes seen in opposition— were in fact complementary, necessary, and deeply integrated into each step in the process of inscribing and extracting meaning from the data. EDA and other data science techniques can tell us much about the world. When what we want to know concerns singling out people and describing their behaviors, interpretivist social science provides a complementary set of robust techniques that can help us achieve a more solid and refined grasp of the social worlds we wish to understand.

5

Social Media Seamsters

Stitching Platforms & Audiences into Local Crisis Infrastructure

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Abstract

This paper examines social media use after a tragic disaster in a rural community in the United States—the 2014 Oso Landslide. Drawing upon interviews with community members and digital traces from multiple platforms, we explore how affected locals, government responders and journalists utilized a broad range of social media in their work—assembling different platforms to meet the information needs of their audiences. We borrow the analytical lens of stitching suggested by Vertesi, which allows us to see where these infrastructural alignments are seamless vs. seamful—highlighting some of the emergent and persistent challenges for those responding to disasters with and through social media. We demonstrate how this work is extremely dynamic, as the technical affordances of these platforms and the evolving practices of users shape how crisis communication occurs. Simultaneously, the pervasive and in some places institutionalized use of these platforms across a wide range of local actors suggests they are performing as critical infrastructure during crisis response. This raises questions of what it means to have so much local crisis information work occurring through platforms that mediate from a distance.

Author Keywords

Crisis Informatics; social computing; infrastructure studies; policy

ACM Classification Keywords

H.5.3 [Groups & Organization Interfaces]: Collaborative Computing, Computer-Supported Cooperative Work; K.4.2 [Social Issues].

INTRODUCTION

Social media use is becoming an established feature of crisis response, both formal and informal. Following observations and forecasts by early Crisis Informatics scholars (Palen et al, 2010; Palen et al, 2009), social media and other networked ICTs are now consistently appropriated by citizens, journalists and responders for sharing information (Palen and Liu, 2007), monitoring for situational awareness (Vieweg, et al, 2010), organizing response efforts (Starbird and Palen, 2011; Vieweg et al, 2010) and more. During the last decade, accounts of the use of these technologies in the crisis context have shifted from the exotic to the mundane. And this movement from foreground to background suggests that social media are sinking into the infrastructure of crisis response.

When technologies become infrastructure, they deserve a different kind of analytical attention (Star and Ruhleder, 1996). Creating infrastructures that can support both local information needs and long distance communication has been a focal point for design interventions in each successive wave of telecommunications infrastructures, including the postal service, telegraph, telephone, and terrestrial broadcasting (Davies, 2014; John, 2010; Starr, 2005). Aligned with a growing body of research, this study shows how social media are becoming a critical component of local crisis response infrastructure.

The term infrastructure is a reflexive one (Star and Ruhleder, 1996) . It turns our attention to a socio-technical system's value to users: They rely on it to perform work. Soden et al (2015) have called for an inductive evaluation of the tools employed in crises to determine what constitutes "critical infrastructure." Because crisis communication is undertaken by a diverse set of actors, we must gain multiple perspectives on these systems (ibid).

It is through the (often temporary) alignment of multiple infrastructures that information work gets done (Vertesi, 2014) . In this paper, we use the analytical language proposed by Vertesi (2014) as a lens to explore multiple perspectives on social media use in a recent disaster. Social media have been described as "stitching" technologies (Bennett et al, 2014; Dailey and Starbird, 2014) because they make accessible and/or index disparate audiences, content, and platforms. Vertesi demonstrates that the language of sewing can be a productive framework for unpacking the work individuals do to piece together multi-infrastructural environments. This lens can also help us better understand a user's perspective in these multi-infrastructural environments, and this, in turn, can help us better understand social media's status as a type of critical infrastructure, and the challenges that presents.

This paper examines community response to the 2014 Oso Landslide, a tragic mass-casualty event that occurred in a rural community in Washington State. We argue here that social media were a pervasive and integral part of the information ecology around this disaster. Though previous research suggests social media are not as salient in rural areas as they are in urban ones (Gilbert et al, 2010; Gilbert et al, 2008; Hecht and Stephens, 2014; Johnson et al, 2016a; Johnson et al, 2016b), we provide evidence that social media were broadly used by people who occupy different roles including government officials, journalists and members of the public. Among these local players, social media introduce a layer of infrastructure that shapes use—and perceptions of use in important ways. In relation to these various uses, social media are in different stages of infrastructural emergence. In some cases, they appear to seamlessly align with the needs and expectations of users. In others, more effort is required to make them align.

Our findings show social media performing as a form of critical infrastructure. This raises numerous questions. On one hand, as we demonstrate, social media stitch together a patchwork of resources that contribute to an effective response—a more heterogeneous set of social infrastructures are ably connected. On the other hand, these platforms introduce a layer of mediation that occurs at a

distance—contributing to a possibly less heterogeneous technical infrastructure from a local perspective.

BACKGROUND

The Evolving Role of Social Media in Crisis Contexts

Social media can help to maintain and repair the relationships within crisis-affected communities and even foster the formation of new support structures (Semaan and Hemsley, 2015). Social media have influenced the way that government responders (Hughes and Palen, 2012) , journalists (Dailey and Starbird, 2014) , and the public respond to crisis (Semaan and Hemsley, 2015) . Further, they have enabled entirely new communities of practice including digital humanitarians (PLoS, 2012) , Virtual Operation Support Teams (Saint Denis et al, 2012), and crisis mappers (Soden and Palen, 2016).

Building on this corpus of research, this paper examines the breadth of social media use in a recent U.S. disaster. By considering the range of uses and range of actors together, we help to place social media use in a larger context. In this way, we can begin to evaluate social media as a form of crisis information infrastructure. We can ask how social media relate to each other and to other infrastructures in the crisis context. We can consider where they might be auxiliary support structures and where they may be re-forming, supplanting, or displacing what people rely-on.

Crisis Informatics has only begun to amass enough empirical cases to answer such questions. In a recent example that attempts a broader analysis of this kind, Soden and Palen (2016) observe that the once novel work of digital crisis mapping taken on by GIS professionals and volunteers after the Haiti Earthquake in 2010 had—by the time of the Nepal Earthquake of 2015—become an anticipated and relied-upon resource for the larger humanitarian response community. Practices that evolved from one event to the next have gradually stabilized, enabling crisis mapping to fold into institutional policies and practices. This has paved the way for integration of crisis mapping into the larger response community. This suggests that social media vis-à-vis crisis mapping have arrived as a form of critical infrastructure.

Piecing Together Heterogeneous Resources

Heterogeneous Helpers and Imagined Audiences.

Semaan and Hemsley theorize that the ability to activate heterogeneous networks of actors has a positive impact on the resilience of crisis-affected communities (Semaan and Hemsley, 2015) . As "stitching technologies" (Bennett et al, 2014; Dailey et al, 2016), social media may be particularly helpful in this regard. Each social media platform can be considered a somewhat different set of actors united around specific tasks, engaging each other through platform-specific practices (Sleeper et al 2016; Zhao, 2016). Therefore, looking at a broader landscape of social media use should help us to better see the potential for resilience that forms around specific crisis-affected communities.

We make decisions based on imperfect knowledge of who we are interacting with on a social media platform. It is our perception of who is using a platform—the *imagined audiences* (Bernstein et al, 2013; boyd et al, 2007; boyd et al, 2010; Litt, 2012; Marwick and boyd, 2011) that we contrive for each social media venue—that drives how we interact in these mediums and when (and how) we choose to initiate interaction on them.

Seamless and Seamful Multi-Infrastructural Patchworks.

Cross-platform work has been shown to be an important component of crisis information work. And researchers have argued that design interventions targeted at supporting cross-platform crisis work may be particularly fruitful . Researchers have begun to piece together how individuals perform information work across platforms in crises. For example, government workers may use Twitter to push notifications and Facebook for community engagement (Saint Denis et al, 2014). Social media

have been shown to stitch together the actions complementary sets of actors during crises including citizens and responders (Hecht and Stephens, 2014), remote and local citizens (White and Palen, 2015), and journalists and citizens (Dailey and Starbird, 2014; Janoske, 2014).

Though we might expect that working in a multi-infrastructural context would multiply the issue of the "socio-technical gap" (Ackerman, 2000), Vertesi (2014) tells us it is by employing "multiple, coexisting, and nonconforming infrastructures" that much work is accomplished. Vertesi proposes an analytical vocabulary to call attention to the work involved in aligning heterogeneous multi-infrastructural environments: Individuals may creatively "patch" together multiple infrastructures to "work with and across their seams." Borrowing on the language of Ubiquitous Computing (Chalmers and McColl, 2003; Weiser, 1993), gaps between infrastructures may appear to users as either "seamless" (non-intrusively blending into the environment) or "seamful" (standing out to the user). In either case, gaps can be exploited by a user who can creatively align a multi-infrastructural "patchwork" to meet their needs. Unlike a stationary assemblage of tools, patchworks are ephemeral alignments that are achieved "effortlessly" or "effortfully" (Vertesi, 2014) .

METHODS

The 2014 Oso Landslide

On March 22, 2014, a major landslide occurred in the Stillaguamish Valley in Washington State. It rapidly demolished the rural enclave of Steelhead Haven, some 49 homes and cabins, covering a square kilometer with mud and debris. Sadly, forty-three lives were lost. The Slide buried the Valley's only thruway, State Highway 530, effectively cutting off the town of Darrington (population 1347), and blocked the Stillaguamish River, which necessitated swift water evacuations. Recovery efforts continued for months. At least 1000 formal responders from some 30 government agencies as well as hundreds of media and thousands of community members converged on the scene during recovery efforts. Dozens of Public Information Officers (PIOs) worked from three locations across the county: the Emergency Operations Center at the county office building or one of two Joint Information Centers set up in the two towns adjacent to the Slide area—Arlington (on the west side) and Darrington (on the east side).

Tracing Information Needs in a Rural Crisis

In this study, we combined in-depth on-site contextual interviews (Holzblatt and Beyer, 1993; Beyer and Holzblatt, 1997) with a trace ethnography (Geiger and Ribes, 2011) of the digital record. This enabled us to follow information work across multiple platforms.

To emphasize the importance of locality in disaster response, disaster practitioners are fond of saying, "All disasters are local." This paper investigates a rural disaster. Numerous studies find that rural and urban people use social media differently. In particular, across multiple platforms, rural users consistently produce less user-generated content than their urban counterparts (Gilbert et al, 2010; Gilbert et al, 2008; Hecht and Stephens, 2014; Johnson et al, 2016a; Johnson et al, 2016b). Therefore inferences about rural populations based exclusively on social media data may be subject to "urban bias". This exacerbates the challenge of discovering if and how rural disaster-affected communities employ social media to meet their information needs. While some social media studies distinguish "seeker behavior" from "supplier behavior" (e.g. Purohit et al, 2014), we are not aware of rural social media studies that do so. To address this challenge, we combine the analysis of the digital record with in-depth on-site interviews and participant observation. By combining these, we place social media use during this crisis into the context of meeting specific information needs among users who may choose among many types of communication tools.

Interviews with Government, Media, and Citizens

We selected interviewees who represented a breadth of roles in relation to public information sharing in the region: government communicators, media, community response volunteers, and affected community members. We also sampled for platforms used. For example, we sought out people who showed prominence on the two social media platforms that had the largest public digital footprint—Twitter and Facebook. From an initial group of interviewees who were selected to represent a range of experiences, we then chain sampled additional interviewees whose information work overlapped with one or more of the initial interviewees. This enabled us to attain multiple perspectives on specific information resources and activities. For example, we interviewed individuals who made use of three hyperlocal sites hosted on Facebook, and followed up with interviews of individuals involved in running two of them.

In total, we interviewed 27 people. Of these, eight served governmental roles, including five whose job is communicating with the public (two state, two county, and one federal), a federal research scientist and a town councilmember. 23 interviewees did event-related information work within the affected area. 19 were either permanent residents of the county or worked there on a permanent basis. Two of the non-residents grew up near the site of the Slide.

23 of the 27 interviews were contextual, taking place in the interviewees' homes, places of work, or volunteer locations. The contextual interviews gave us access to personal trace records of interviewees such as photos, private Facebook pages, paperwork and other materials. At the end of interviews, interviewees completed a survey of the information tools and platforms that they used in the event.

Due to the ethical and practical considerations involved in conducting interviews after a mass-casualty event, interviews took place between nine and fourteen months afterward. Though interviews that take place over such a period of time provide a rich phenomenological account, the length of time that passed between the event and the interviews may have affected how interviewees recalled details about the event. We therefore utilize supporting sources such as the public digital record, interviewee's personal records, or other interviewees' responses, to corroborate information shared by interviewees.

Public Digital Record

This research incorporates multiple types of public trace data with interview data in a complementary and iterative way. We identified a rich corpus of publicly-available content pertaining to the Slide on numerous social media, government and media sites. Web searches, interviews, and analysis of Twitter helped us to identify a number of publicly visible Facebook pages and groups. Interviewees also discussed their semi-public and private use of tools, often reviewing their personal records with us in the course of the interview.

We purchased a collection of 986,826 Oso-related tweets posted between March 21 and April 12, 2014—i.e. one day before the Slide until three weeks afterward. Though recovery and repair occurred over several months, the vast majority of Slide-specific tweets occurred within the first few days, peaking on March 26th at 6000 tweets per day and sloping down to about 100 tweets per day by April 11th. By extending the sample out to the first three weeks, we were able to track shifts in information work. As it happened, interviewees were most keen to discuss the first few days and weeks. The collection contains tweets selected for one of fifteen keywords or hashtags that our exploratory analysis revealed would likely be related to the event. These terms include very general terms such as "landslide" and "mudslide"; location names in proximity to the Slide, "Oso", "Arlington" "Darrington" "Steelhead Haven"; and hashtags created after it occurred, e.g. #530slide, #Osostrong, #HelpOso. It also contains all of the tweets from 30 highly visible accounts that were associated with the event. These are primarily accounts involved in the official response and some regional media

accounts. Though these broad search terms led to considerable noise in the data set, this more inclusive approach enabled us to examine parts of the record that are missed by hashtag searches—e.g. early tweets sent before any hashtags had been created.

Analysis

The publicly-available digital record of the Oso Landslide spreads across several social media platforms including: Facebook, GoFundMe, Instagram, Pinterest, Reddit, Twitter, Wikipedia, and YouTube. Among interviewees, some reported using social media in the course of their information work concerning the Slide while others did not. Those who did use it most commonly reported using Twitter or Facebook, thereby justifying our focus on these two platforms for the analysis in this paper. No two interviewees employed the exact same complement of information resources. An incomplete list of information channels includes numerous websites, radio, TV, cell phone, landline, in-person, emergency radio, amateur radio, email, phone conference, public meetings, and door to door.

Triangulating data from multiple sources enabled us to identify chains of coordinated action (Dailey, Robinson, and Starbird, 2016) that occurred across multiple platforms among individuals who collaborated directly or indirectly. We analyzed our data inductively. Through memos and affinity diagrams, we identified salient themes (Miles, Huberman, and Saldaña, 2014). Researchers met regularly to analyze findings. We explored trace data and interview data in tandem. Integrating findings from an early set of interviews with insights from the Twitter data and more general web searches revealed that Twitter and Facebook were just two among many online tools used by government, media, and citizens. However, they were by far the most commonly mentioned social media among our interviewees and each left a comparatively large digital record. Through these exploratory investigations, we identified several Facebook pages and groups active around the Slide. We selected four for analysis, reading through them and conducting follow-up interviews with people who either created them (Oso Mudslide Memorial Page and Skagit Breaking) or used them (OsoStrong and Darrington Readerboard). Exploratory investigations also led us to focus on two Twitter hashtags: #530slide and #OsoStrong. #530slide was introduced by the affected county's PIO 40 minutes after the Slide occurred. In our dataset, #530slide had the largest number of unique participants and most tweets of any hashtag. We also chose to focus on tweets with the hashtag #OsoStrong because of it traversed platforms and had a very visible presence in the built environment of the communities around the Slide.

FINDINGS

A Heterogeneous Patchwork of People and Platforms

In this section, we briefly summarize the breadth of social media activity visible in the public record.

A Broad Patchwork of Platforms. Content related to the Oso Slide appeared on several social media sites. The donation platform GoFundMe was used for at least 15 fundraisers specific to the Slide both for affected individuals and local response efforts. Instagram was populated with images of community members, memorial images of victims, and responders working at the site. 22 publicly visible Pinterest boards generated and curated a visual record of the event (while responders mentioned private Pinterest boards as particularly good way to share images for damage assessments). Posts and comments about the Slide spread across at least 26 sub-reddits. Two days after the Slide, when news reports had begun to establish the severity of it, Wikipedia editor MONGO started the "2014 Oso Mudslide" article. 9300 videos come up from a search for "Oso Mudslide" on YouTube, somewhat less in a search for the more proper geological term "Oso Landslide" (which yields 7170). Approximately 100,000 Oso-related tweets were shared in the first three weeks after the Slide occurred.

On Facebook, there were at least 11 event-specific Facebook Pages and at least 16 event-specific groups ranging from memorial pages to fundraisers to pages coordinating donations. Countless existing pages and groups representing informal interest groups, hyperlocal news hubs, non-profit organizations, businesses, and government organizations posted about the Slide on their Facebook pages.

A Broad Patchwork of Actors. Though sometimes the traces are thin, the public digital record on Twitter and Facebook represents nearly every configuration of distinctly identified actors that have been documented in previous Crisis Informatics and disaster research. This includes government organizations, media, remote digital volunteers, businesses, non-governmental organizations, blogger moms, citizen journalists, and the like. Social media were used for within-group interactions (responder to responder) and across group interactions such as survivors and their supporters.

These interactions typically followed patterns observed in other events. For example, as described by Starbird and Palen (2012) , Twitter was a mechanism for remote actors to voice support for locals. The forms of social media support we see after the Slide follow repertoires of action now seen across many events. One example of this is the broad uptake of the hashtag #OsoStrong. An out-of-state journalist with local ties was the first to tweet #OsoStrong, but it caught momentum with 3,285 accounts generating 5,793 tweets using the hashtag, linking remote and local people together in a joint expression of support. The meme "Oso Strong" appeared soon after the disaster and was physically visible throughout the area on placard signs in front yards of homes and windows of local businesses (then t-shirts and bumper stickers). This hashtag is a variation on a meme that now moves between tragic events, a portable piece of the patchwork that is regularly reworked to show support when tragedies occur such as #BostonStrong. Likewise #PrayforOso was used after the Slide just as #PrayforSydney and #PrayforParis were used after terrorist attacks in 2014 and 2015.

Contradictory Claims: Social Media Used by the Affected Public?

If it is true, as Semaan and Hemsley (2015) propose, that access to heterogeneous sources of aid is a measure of community resilience, then the publicly-available record of social media suggests that the response after the Slide was quite a robust one. A potential obstacle to these heterogeneous helpers succeeding in their mission would be if the crisis-affected community was absent from these channels of aid. On this point, our evidence somewhat conflicts. In this section we attempt to unravel the contradictions. In addition to a simple explanation based on scale (far fewer people were directly impacted than responded and communicated about the Slide), we also see evidence that a disconnect between how the affected community used social media and how others anticipated they would use it contributed to the perception that locals did not use social media. After accounting for these contradictions, we see that the impacted community integrated social media into their information work in important ways. This adds yet another dimension to the view of social media as critical infrastructure in this event.

Obscured Visibility of the Affected Community. The breadth of communication work across social media was wide: seeking and sharing information, coordinating aid, expressing emotional support, donations, and promotion of events such as memorials. Yet, the general impression among government Public Information Officers (PIOs) was that the local community did not make much use of social media. We will now examine several factors that contributed to this perceptual disconnect.

First it is true that not all community members used social media. Not all of our interviewees did. In some cases this may be attributable to demographic factors such as age. In other cases, interviewees who normally use social media reported not doing so because they were busy with response work. Similar to how government responders curb information overload (e.g. Ley et al, 2014), we found

several community members who were busy with response efforts intentionally restricted their communication channels and contacts (Dailey, Robinson, and Starbird, 2016).

Compared to other disasters with a strong presence on social media, the Oso Slide affected a relatively small rural area (one square mile). There were only a handful of survivors and the extended zone of impact around the Slide had only several thousand residents. Given that the Slide was a national disaster and an international news story, even if all residents in the vicinity were prolific social media contributors, their contributions would be dwarfed by the retweets of accounts like the Associated Press which has a million followers. Therefore, as has been found elsewhere (e.g. Keegen, et al, 2013 and Starbird and Palen, 2012), much of the information work apparent on social media was likely taken on by individuals and organizations outside of the immediately impacted community.

We looked for local accounts based on the content of their tweets, their self-described location and geo-tags. We found several, but relative to all accounts tweeting about the event, they did not appear in large numbers. For example, only three of 19,508 accounts tweeting the most used event-specific hashtag (#530slide) identified themselves as from the nearest town in their account description or location.

Three people from the county created the "Oso Strong" Facebook group, which grew to 889 members and was used to share news about response efforts. The meme was employed in many community efforts. For example, the Oso Strong 5k walk/run Facebook page garnered 4,971 likes. But, following a pattern we saw across many grassroots events and discussions, the run generated only a handful of tweets, just six over two days, all by different accounts. With so few traces of activity, many community-driven activities were only discoverable to us because they were first mentioned by interviewees. In many instances, local tweets only obliquely indicate a connection with the event. In short, if you do not already know what locals were talking about, it can be hard to discover in a social media corpus. Thus *visibility of use* likely contributed to the perception of non-use by the rural community.

Expectations of Social Media Use (and Non-Use). In addition to the above factors we also see indications that differences around expectations of use may have contributed to the perception that the local community was not using social media. Several PIOs told us that the local community "out there" by the Slide did not use social media. However, comments that at first appear to deny use, upon closer inspection tell a slightly different story. Rather they seem to suggest the stickiness of mental models particular to one platform (Twitter), that may obscure a recognition that the community was making use of Facebook. For example, a Public Information Officer (PIO) who works for a state agency deployed to Darrington, the small rural community directly east of the Slide, for several days after the Slide. When she arrived, a PIO from another agency who is also a resident explained to her about social media use there:

"One of the things that she told me about immediately— so I kind of noticed, you know, because I use social media, obviously, for my job—and I noticed that social media was not really a thing out there—not Twitter—much more Facebook."

At first, this PIO explains, according to her observations and her colleagues, locals are not using "social media." She then corrects herself to say that Twitter was "not really a thing out there," but Facebook was. This hints at two competing mental models of social media. One is synonymous with the platform she uses in the daily course of her work—Twitter. The other includes Facebook. In the first model, locals are non-users. In the second model, they are "much more" users. We have observed the same tight linking of Twitter to "social media" among several Washington state information workers who routinely use Twitter for their work.

The Private Patchwork of the Affected Community

Arguably some of the most important information work that occurred through social media took place outside of what is visible in the public digital record.

One dynamic that is not apparent from the public digital record is the importance that the affected community attributed to Facebook. Interviews revealed that community members found the popular social-networking platform to be particularly helpful for intra-community communication after the Slide. A town council member explains how the community came to rely on Facebook:

When you think about it, there was a lot of communication on Facebook. …The rescuers, the volunteers [working at the site of the Slide] out there were letting us know what was happening during the rescue, they were letting us know what they needed down there, stuff like that. Then every evening, especially after the town meetings, Facebook was pretty much a-buzz. […] Facebook played a huge role, especially at first. People were letting people know about the meetings. There was a lot of, "What happened at the meeting?" People became [Facebook] friends during that time too, so you could get information.

Similar to Tadic et al (2016), much of the meaningful information work that occurred on Facebook was out of the view of the general public. As reported by local interviewees, much coordination and information sharing took place through messages and posts shared among Facebook friends. "Friending" on Facebook is a two-way, agreed-upon arrangement between both parties. Typically, posts are visible to Friends and Friends of Friends. Messages are private between those selected for inclusion. As described by the council member above, private and semi-private Facebook messages extended conversations about the community meetings that convened officials, responders, and community members to discuss the progress of the recovery each day. From the community perspective, Facebook seamlessly supported the intra-community information work.

Facebook integrated seamlessly with other intra-community activities such as the town meetings that occurred daily. This nearly organic integration was achieved because privacy settings enabled community members to tailor clear boundaries around who could contribute to and/or view in-community discussions. This highlights an important characteristic of social media as a form of infrastructure—the "infrastructuring work" (LeDantec and DiSalvo, 2013; Pipek and Wulf, 2009) that shaped visibility and participation in the intra-community conversations was fluid, dynamic, and in the hands of the users.

Facebook was not the only venue for meaningful information work outside of public view. Though he does not have a Twitter account, one man searched for news about the Slide using Twitter's website. He then copied and pasted links he discovered this way to an event-specific Facebook Page he created. A woman who tragically lost several family members in the Slide first learned of it from a friend's Facebook post shortly after it happened. While trying to contact her loved ones, she spent several hours searching for news on Twitter. When she encountered a tidbit, she direct-messaged (through Twitter) a reporter for more information. Later, as her information needs shifted to what was available from local contacts involved in the community response, Facebook became her information source. In both of these instances, Twitter was employed to connect with journalists and/or media content, while Facebook was a venue for getting and sharing information with community members and personal contacts.

In considering the use of social media by the affected community, the publicly visible record reveals a proportionally small amount of data. But raw numbers alone do not capture the importance that the community placed on the work carried out through social media and Facebook in particular. The meaningfulness and value affected community members placed on this work adds another dimension to the consideration of social media as crisis infrastructure.

From Emergent to Established: Use of Social Media by Government Workers

Among government information work, we see several places where social media meet the criteria to be considered infrastructure, having become routine and institutionalized in crisis response. In other instances, social media are less seamlessly part of a greater whole.

In a crisis, government information workers have many responsibilities and social media were integrated into several of them after the Slide. Government workers used social media in particular ways depending on the tasks they were engaged in, selecting specific platforms to reach different sets of actors. Social media integrate more seamlessly to support some tasks than others. They are no longer merely an emergent infrastructure, but are becoming formalized into routine policy and procedure for various tasks—e.g. receiving eyewitness accounts from citizens, media monitoring, and media relations. However aligning social media to support other government information tasks remains "effortful." PIOs expressed uncertainty about using social media to diffuse emergency alerts—in spite of doing so. For government workers responsible for community relations, reaching the community in community-controlled social media venues required a realignment of professional and personal boundaries, and an adjustment of work practices to conform to the norms of the platforms. Yet even these more effortful integrations of social media into the work appear to be driven by a sense of need, thereby underlying the increasing importance of social media throughout response work.

Over 30 government organizations responded to the Oso Slide. Following emergency management protocols, each had designated people who provided information to the media and the public. For example, Washington State Department of Transportation (WSDOT) had at least twenty staff members who worked on public information after the Slide. PIOs from various organizations worked together to support different aspects of the response. These government communicators described their work in terms of three different functional roles: media relations, reaching external audiences, and community relations. Across these different functions, social media were a set part of their strategies, plans, and activities. Interestingly, they associated each function with different social media. Similar to Sleeper et al (2016) and Zhao et al (2016), their social media strategies were tailored to different audiences, in this case differentiated as elected officials, "external audiences", the affected community, survivors and families of victims, and the media.

Eyewitness Information. Minutes after the Slide, a woman driving on Highway 530 tweeted the first photo of the obstructed road to the state highway department, WSDOT. With permission, they reposted the photo to alert others. These tweets were concurrent with the early response activity, thereby speeding up the public sensemaking process.

The practice of getting information via social media from citizens who are on the scene is no longer unusual in crisis response. These interactions are seamful. Responders remain skeptical about information from the public. Yet with caution (confirming via trusted sources), social media are becoming more accepted for communication with eyewitnesses. Government organizations may even repurpose citizen generated content, as they did in this case.

Media Monitoring and Relations. The effectiveness of government information reaching journalists through Twitter is apparent in the digital record. The first tweets about the Slide came from unofficial sources and were slow to find traction, but when local and regional media began to participate by retweeting tweets by government accounts, it set off an information cascade. With these early messages, media also adopted the event-specific hashtag created and promoted by the response PIOs. #530slide became the most used hashtag associated with the event, generating 75,209 tweets from over 19,000 accounts in the first three weeks after the Slide. Twitter appears to seamlessly stitch together the information work of journalists and PIOs. This likely contributes to

timely, credible information becoming available to the public. For this task, Twitter is placed neatly into response operations.

The complementary and rapid actions of journalists and responders on social media is less ad hoc than it appears. All PIOs reported regularly using Twitter to monitor and communicate with journalists and media organizations. This has become institutionalized in response organizations. For example, at the state Emergency Operations Center, potential hazards are monitored by two staff, 24 hours a day. Among the monitors that display tsunami warning systems and detection systems for volcanic flows, one screen is always dedicated to TweetDeck, pre-loaded with media and government accounts.

Response organizations in multiple countries have come to recognize that the citizen-generated content available through social media can support "situational awareness", though it can be challenging to integrate into operations (Hughes and Palen, 2012; Ludwig et al, 2015). The strategy of integration described above at the State Emergency Operations Center is similar to that described by Tapia and Moore (2014). The TweetDeck in the alerts monitoring room represents one of the "pockets of use" (ibid) for social media that have been integrated into response operations. Preloaded with Twitter accounts of media, elected officials, and government agencies that have been selected for the alert center staff monitoring by state PIOs, social media are used "within their known community and extended network (ibid) ." Twitter especially supports interactions between PIOs and media. At a recent emergency operations training for state agencies, the head of external affairs explained that reporters and editors now prefer communications through Twitter over press releases: "We follow them and they follow us. It's the fastest way to get in touch with them."

The Ambiguous Reach of Emergency Alerts. Yet another way government workers used social media was to push out emergency alerts after the Slide— though they were less certain about their effectiveness for this purpose than for other uses. Similar to St. Denis et al (2014), the county's Facebook Page proved useful for less time-sensitive community engagement. Their first Slide post reached 6,500 people within two hours. The Page grew from 160 followers to 3,200 over the first few weeks. However, its value as a platform for disseminating information is relative to the kind of information being shared. Local jurisdictions now use Facebook for time sensitive emergency alerts including flood evacuations. When the Slide damned a river causing flooding that necessitated evacuations, county responders used all available channels to issue an evacuation notice including Twitter and Facebook. In the eyes of the county PIO, the value of sending the message over Facebook was uncertain. Comparing interactions on Twitter and Facebook she described Facebook as "less immediate." The county PIO who issued the alert through Twitter felt certain that the tweet disseminated quickly, but viewed it as unlikely to have reached the impacted community. Facebook, she believed, had a greater reach among the affected. Yet she was uncertain about whether messages she posted via the county's Facebook Page would be seen in a timely way: "Facebook keeps changing their algorithms because they want me to pay. I'm not sure if we were reaching."

For time-sensitive alerts, both Facebook and Twitter seemed effortful. From the perspective of the PIO, neither platform seamlessly, unambiguously, and definitively diffused alerts to the affected community. In this case, they are one more means for attempting to get the message out among many.

Engaging the Affected Community: Government Work through Personal Facebook Accounts. Contemporaneous with recovery operations, decisions needed to be made about rebuilding and mitigation. Understanding that some local community conversations on these topics were taking place on Facebook through Friend messages and in locally controlled Facebook Groups and Pages, government information workers at one state agency who were tasked with getting community input on rebuilding and mitigation felt that they needed to follow suit. Some Friended local "influencers"

and joined community-controlled groups in order to reach the community where the private and semi-private community conversations were occurring on Facebook. This became "a real big way for us to interface with the community."

On Facebook, government organizations cannot Friend individuals because only individuals can have accounts. Community liaisons used their personal accounts to do so. This strategy may violate user expectations of Facebook, which is seen as a platform for personal communication (Zhao et al, 2016). The strategy was made more normative by three key decisions made at an organizational level:

1) Those who engaged the community through Facebook were the same individuals who were "the face" of the organization at formal and informal "continual meetings" that occurred in person.

2) These liaisons remained in that role for the duration. Fully one year after the Slide, one community liaison was still posting to local Pages and Groups (based on community interest) and reported maintaining individual interactions with community members about once a week.

3) The communication strategy was one of "listening" and "facilitating conversation"—a strategy that was well aligned with normative use of Facebook and with the overall goal of aiding community decision making.

Professional Work, Personal Risk. Though the engagement strategy described above was well received by the community, it was controversial among some government information workers from different agencies. Some we interviewed feared using their Facebook accounts as part of their job. From a legal standpoint, personal accounts used for government work may be considered official government communications and therefore can be subject to public disclosure and Freedom of Information Act requests. Thus, government employees strive for clear boundaries between personal and professional communication. One county information worker described being "glued to Facebook" for news of the event. To alleviate risk of blurring personal and professional boundaries, she fastidiously separated personal and government information work by exclusively using her personal phone to follow Facebook while using government issued technologies to do her job.

One community liaison we interviewed weighed the risk and decided using her private Facebook account to reach the local conversation where it was occurring was worth it:

> "I just basically had to make peace with the fact that my Facebook could be subject to public disclosure. You know, that's not my ideal because, obviously, it's my personal Facebook, but that was the only option and frankly I felt like we got so much value out of that that I just sort of made my peace with it."

This suggests that the evolving role of the Public Information Officer (Hughes and Palen, 2012) is still being pushed by social media usage patterns that are themselves still changing (Zhao et al, 2016) . In this case, those tasked with doing community relations on behalf of their agencies faced a dilemma of blurring the boundaries between government and private communication or violating Facebook's terms of service by creating multiple accounts. What appears to be a seamless patchwork from the community's perspective remains a seamful one for a government information workers.

Local Journalists Mediating through a Distance

In relation to crisis infrastructure, the question of who is producing and sharing key information remains an important consideration. Historically, local and regional news outlets played a major role

in community information work after disasters. It has been argued that networked ICTs enable others such as the "former audience" (Gillmor, 2006) or perhaps government information workers to take on the work of journalists. In this instance, separating social media from traditional local media is no simple task. From a social perspective, local and regional news organizations are prominent. From a technical perspective, networked services including social media were integrated into nearly all aspects of producing and disseminating local news.

This suggests a potential dichotomy in viewing social media as critical information infrastructure. On one hand it seems to handily foster heterogeneous social activities. On the other hand reliance on social media and other forms of networked ICTs may indicate a technological convergence is occurring that supplants more locally autonomous information infrastructures.

Media Organizations: A Strong Presence on Social Media. Separating information sources (a news organization or journalists associated with one) from the means of dissemination (which was often through social media), local and regional media outlets were the most commonly mentioned information resources across all interviewees. The same outlets mentioned again and again by interviewees also appear prominently in the public digital record: CBS affiliate KIRO, ABC affiliate KOMO, NBC affiliate KING, Fox affiliate Q13; the Everett Herald Newspaper (which serves the affected county) and the Seattle Times Newspaper (the largest circulated paper for the greater region). All of these have a presence on multiple ICT platforms. Most interviewees associated the broadcast outlets with "TV" though each of these outlets also has a presence on radio either through shared ownership or syndication of content.

These six outlets also maintain a strong presence on Twitter with accounts for individual reporters, photographers, cameraman, anchors, editors and even interns as well as content-specific accounts such as weather and traffic. In total, 578 Twitter accounts associated with one of these outlets contributed to the #530slide conversation, a contribution that adds up to 30% of all accounts using the hashtag and 12% of all tweets containing it. Combined with a long tail of other local, regional, national, and international reporters covering the event, a sizeable portion of the #530slide conversation was generated or circulated by accounts associated with legacy media. This is not just evidence of local outlets making contributions to the Twittersphere, it is also evidence of journalistic outlets investing significant resources in tweeting. Given the ties to other infrastructure that these journalists have, they perform much of the patchwork tying together audiences spread across many platforms and channels.

Social Media: A Strong Presence in the Newsroom. **As** the "most local" news outlet, the county newspaper the Herald played a singularly important role in its reporting, according to community members and government workers. Integration of social media in its newsroom, in many ways, runs parallel to the integration in government response organizations. Social media are more than tools for disseminating information. They have become profoundly integrated into the reporting process, and institutionalized in the newsroom. The day of the Slide, when the reporter on duty in the Everett Herald newsroom heard reports of a landslide on the police radio, he quickly opened TweetDeck on his newsroom workstation which he uses to follow emergency agencies. He saw WSDOT's retweet of the house-in-the-road photo on the first page. From there, he could scroll through the recent activity of accounts the Herald follows (other media outlets and locally influential individuals). In this case, he was looking for recent tweets from a handful of local tweeters who monitor and live-tweet what they hear on police scanners. In a way, those citizens who live-tweet police scanner activity and the social computing platforms by which they do so have folded into the institutional practice of the newsroom, contributing to how reporters make sense of a crisis; they have become an element of infrastructure with a physical presence in the newsroom.

While Twitter has made a seamless entry into newsroom practice, according to one journalist at the Herald, Facebook remains seamful. His description of his use of Twitter and Facebook while reporting about the Slide for the Herald echoed many of the issues brought up by PIOs. Like their public counterparts, institutional policies at news organizations mandate use of social media as well as how to use it. He actively works to maintain a distance between his personal and professional personas on social media. He does so by maintaining separate accounts on Twitter and Facebook. His personal Twitter account is pseudo-anonymous. He posts Herald stories to his work-specific Facebook account, though like the PIOs, he wonders about the audience he reaches through these posts. He explained that frequent changes to Facebook's interaction design and an uncertainty about how the News Feed feature works made it difficult for him to predict the visibility of specific items. He was uncertain whether his articles would be seen by anyone on Facebook. Though he is committed to maintaining the work account, he described the effort as "pro forma." Perhaps his resistance to using Facebook is due to the normative use on the platform found by (Zhao et al, 2016) , where engagement is expected to be for personal reasons, not work. In contrast to his very active personal account, he had only gathered a "small circle" of Friends for the work account and he found that few people commented on the stories and discussions tended to be "circular." Though Twitter also optimizes now what is visible to users, he believed information on Twitter was more discoverable and therefore viewed it as a more valuable reporting tool.

Local News Mediated at a Distance

Journalistic practices are being transformed by social media, but the physical transformation of infrastructure supporting these changes is no less profound. Networked services, including social media, represent a very different network configuration than did previous technologies employed for local coverage. This raises questions of what it means to have local crisis coverage dependent on services that mediate from a distance. The legacy infrastructures that supported crisis journalism in the past were arranged as networks of local exchanges. Local telephone systems, printing presses, broadcast radio and television stations all had local personal and technical capabilities to perform independently when disaster disrupted networked communications. Integration of technologies that act from a distance complicates what was formerly an arrangement of multiple infrastructures that could perform as locally autonomous patchworks when needed.

The Herald's reliance on Twitter is, in a manner of speaking, the tip of the social-technical stack. The phone lines in the newsroom are VOIP. Google productivity tools are the back-end of reporting. Print production and website production both happen through web-based services. Excluding the bodies of the journalists and the printing presses, almost everything else of the "most local" newspaper is mediated by software-based networked services. By adopting these services, the Herald fits the very image of a lean and modern news organization. However, reliance on so many tools that function from a distance raises questions about how a local news organization might perform their role as local communication infrastructure in the absence of these tools— for example—if networked ICTs were disrupted in a large scale natural disaster.

DISCUSSION

Social Media as Critical Infrastructure for Crisis Response:

A Dynamic Patchwork of Patchworks

Through an inductive examination of how social media were used after a disaster, we have shown that they supported a heterogeneous array of social actors, mediating many kinds of important information work after this crisis.

By juxtaposing the distinct ways the affected public, government, and media employed social media in this response, we extend the arguments about social-media-as-infrastructure that have been applied to crisis mappers, remote digital volunteers, and other social-media-empowered actors.

Perhaps different from other infrastructures, social media are particularly good at supporting dynamic information flows in disasters, and many different kinds of actors are coming to rely on them to do so. Social media and the repertoires of action they support have in many cases become a routine part of crisis response. Memes of support that appear from one event to the next such as hashtags and memorial pages or the tight follow/following relationship between government information workers and media are just a few of the signs that social media is no longer novel. It's use can be anticipated.

Though we have focused on two prominent social media platforms, Facebook and Twitter, we have placed them in a larger context of use, illustrating that a wide range of social media are part of crisis work. The particular configurations of social media platforms (including their users' practices and expectations) have fostered not *one* infrastructure, but *many*. Together, these combined activities form a patchwork of patchworks. Each holds together a somewhat different piece of the overall information space. Woven together, they form a nascent and dynamic (almost unsteady) information ecosystem. This tapestry of activity likely contributes to the community resiliency and response effectiveness. It is within these multi-infrastructural contexts that information work gets done.

A Seamster's Lens on Social Media as Infrastructure

Taking up the analytical perspective suggested by Vertesi, we foreground the work—and workers—involved in aligning social media with other socio-technical systems to perform important crisis information work in a recent disaster. This perspective allows us to see how individuals stitch platforms and audiences together into arrangements that support their particular information needs As information needs change, they reconstitute these configurations, for example, using Twitter to engage journalists and Facebook to engage local community members.

By bringing users' perspectives to the analysis, we can see that these configurations are in various states of infrastructural development—exposing the value of social media to multiple parties as well as some of the challenges its use presents. In the Emergency Alerts room at the state EOC, social media (Twitter) is a seamless and non-intrusive element blending into the whole. It is one more way to monitor potential hazards. As journalists and responders make Twitter a primary tool for communication, other means of communication such as press releases are becoming a less prominent part of the toolset that aligns the work of responders and journalists. In this instance, it appears social media have become central to stitching these complementary groups together.

In other instances, social media are a less settled part of the mix—i.e. the space between audiences, platforms, and practices is more prominent, requiring more effort for users to piece together. This is the case for government workers and journalists who strive to maintain boundaries between their professional work and their personal lives even as they try to engage publics "where they are." These more "seamful" alignments mark unsteady gaps that are at once both desirable and undesirable, the ultimate resolution of these tensions, unknown.

Seamful gaps can reflect the intentional boundaries that occur when a cluster of individuals carve out an information space particular to their needs—as the affected community did. Facebook enabled community-controlled intra-community conversations about the response outside of the general purview. From the community's vantage point, Facebook was a seamless extension of the in-person conversations they were having at in-person forums and informal gatherings. And this was perhaps possible because the seams could be drawn so precisely others weren't even aware of they were occurring. From the vantage point of those outside the community, including some government workers and journalists, the way the community used social media rendered the community's use of them into the category of non-use.

The way local interviewees described using Twitter indicates a potential tension between day-to-day use and its use as crisis infrastructure. By turning to Twitter in an emergency, we might consider it to be part of the local community's crisis communication infrastructure. But this use was intermittent and because they produced little (and sometimes no) content for the platform, these users may not count as part of Twitter's infrastructure.

A Diversity Dichotomy: Social Heterogeneity, Technological Convergence

As social media become more pervasive and integral elements of crisis response, questions concerning their technical configurations and their relation to other communications infrastructures become increasingly important. This research (along with the growing body of literature demonstrating the increasing reliance upon social media tools and social media-enabled activities for disaster response) suggests there are some open questions about the relationship between social media infrastructures and local communication infrastructures. From a social perspective, social media enabled heterogeneous social actors to productively and intentionally interact in productive ways. Yet, with respect to local technical information infrastructures, they introduced a layer of mediation that occurred at a distance. This differs from network configurations of previous communications infrastructures. We need to consider the implications of where "infrastructuring" work occurs (LeDantec and DiSalvo, 2013; Pipek and Wulf, 2009). For example, is it important to assure some systems—that are not dependent on mediation at a distance—remain? Is it even possible to do so if social media are where the public convenes? As social media become part of the critical infrastructure of crisis response, these questions become critical.

CONCLUSION

We follow crisis information work across multiple platforms and across groups with different roles within a recent U.S. disaster. Across all groups we see that important information work occurred over social media, sometimes seamlessly, sometimes seamfully. This approach helps to identify the affordances of specific social media platforms and to uncover tensions around performing crisis information work through them. By demonstrating the depth and breadth of crisis information work that was supported by social media in a single disaster, we provide further evidence that social media are performing as infrastructure in crises. Their increasingly prominent role in crisis work suggests the need for more examinations of how they are situated in relation to other communication infrastructures.

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6

Sharing Food, Gathering Information

The Context and Visibility of Community Information Work in a Crisis Event

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ABSTRACT

This paper describes ICT use after a disaster, connecting the stories of various community responders and tracing their activities across sociotechnical networks. Drawing on contextual interviews and the digital record, we reveal how information work, food work, and emotional labor intersected. At the most superficial level, we find that many community responders continue to rely upon face-to-face communication and "real simple" technologies to coordinate their activities. This research also speaks to the visibility of community response work—offering a method for surfacing less visible work given the social complexities of a disaster. This approach provides a complementary perspective to research that relies solely on digital traces.

Keywords: Crisis Informatics; emergency response; volunteerism; emergent collaborations

Acknowledgements: We thank the interviewees and their organizations.

INTRODUCTION

Concurrent with widespread adoption of information and communication technologies (ICTs), researchers have turned attention toward their use in disasters, spawning a genre of research known as Crisis Informatics (Hagar, 2010; Palen et al, 2010). Researchers initially noted how the ability to study crisis events through digital traces opens up new possibilities for understanding events and their responses, both formal and informal (Palen et al, 2010). Social media soon became sites of analysis for studies of informal response, with research often focusing on information sharing and interaction within a single site, including Twitter (Vieweg et al, 2010; Starbird and Palen, 2011), reddit (Leavitt and Clark, 2014; Tapia et al, 2014), Facebook (Palen et al, 2009; White et al, 2014) and Wikipedia (Keegan et al, 2013). Associated research on informal response has often focused on supporting new forms of work made possible by ICT (e.g. Palen et al, 2009; Starbird and Palen,

2011). A few studies have examined social media use within on-the-ground, community response efforts (Dailey & Starbird, 2014; White and Palen, 2015), but researchers are only beginning to attend to community responses that span multiple platforms (Dailey & Starbird, 2014) and to examine the intersection between offline community response and online volunteerism (White and Palen, 2015). This paper describes ICT use within community response efforts after a tragic event, tracing response work across sociotechnical networks and provides in-depth analysis of the diverse tools and systems employed by various community responders. At the most superficial level, we find that many community responders continue to rely upon face-to-face communication and "real simple" technologies to coordinate their activities. We reveal how information, food provision, and emotional labor intersect in interesting and important ways. This work also speaks to the visibility of community response work—offering a method for surfacing the less visible work given the social complexities of a disaster.

BACKGROUND

Volunteer Work in the Context of Disaster Response

Recent research in philanthropic studies suggests that the relationship between volunteer work and formal organizations is a complicated one. For example, Voida et al (2015) find that 72% of volunteer activities taken on by college students were not affiliated with or coordinated through an organization. When aid is channeled through volunteer-driven organizations, these organizations are said to be "shapeshifters" with "ill-defined" organizational boundaries (Voida, 2014). Some researchers prefer to sidestep the challenge of describing aid in relation to organizations, instead foregrounding "coordinated collective action" (Campbell, 2005), which can account for work taking place within organizations or outside of them. In disasters, volunteer work occurs within, between and outside of organizations (Dynes, 1970; Fritz and Mathewson, 1957). Disaster work calls upon some to steadfastly maintain predefined roles (Quarantelli, 1988), while others improvise to meet emergent demands. The scale of activity is another consideration. The sheer number of people and groups who converge in a disaster adds to coordination challenges (Fritz and Mathewson, 1957; Kendra and Wachtendorf, 2004). The intersections between these different kinds of work structures have been long been viewed as problematic by formal response organizations. For example, the first major study on convergence behavior in disasters took place upon request of the US military and characterizes convergence as a "problem of social control" (Fritz and Mathewson, 1957). Since that time, sociologists, and more recently Crisis Informatics researchers, have taken a more neutral stance on convergence (Palen et al, 2010; Tierney, et al., 2002). Addressing the tensions between informal, unofficial, volunteer, and community response (and their respective organizational approaches) with those of formal response motivates much work in the field (e.g. Harvard Humanitarian Initiative, 2010; Hughes and Palen, 2012).

Crisis Informatics and the Examination of ICT Use during Disaster Events

Increasingly, people (including emergency responders, affected members of the public and the global audience) are turning to ICTs, especially social media platforms, to seek and share information during disasters (e. g. Hughes & Palen, 2012) and to offer and coordinate assistance (e. g. Starbird and Palen, 2011). Given the complexity, diversity and scale of work in disasters, it should be no surprise that a genre of research, Crisis Informatics, has developed devoted to studying how information work occurs within them. Researchers in this emerging field have made good use in recent years of public digital records that can alternatively yield a rich and detailed picture of micro-interactions on a given digital platform and/or describe mass participation within digital platforms. Many of these studies focus on new forms of participation enabled through digital means such as "digital volunteerism" and "digital humanitarianism." Many of these studies examine online convergence through the lens a single online platform (e.g. Vieweg et al, 2010; Starbird & Palen, 2011, Leavitt and Clark, 2014; Tapia et al, 2014; Keegan et al, 2013).

Using Digital Traces to Understand Disaster Communication

Given the practical and ethical challenges of collecting data in concurrence with the onset of a disaster, digital trace data has become a rich resource for empirical research on disasters. Yet, it is increasingly recognized that the public digital record is an imperfect lens for understanding disaster communication. Several epistemological and ontological critiques have been made of studies that exclusively explore a single digital platform. For example, not all digital platforms have been equally explored (Tufekci, 2014) and we do not understand enough about the user groups who populate specific platforms (Hargittai, 2015). In relation to the disaster content, further critiques have been made about what is discoverable from online sources. Particularly in terms of ICT use by the disaster-affected, the public digital record leaves a troubling gap. One platform studies may be of limited value given that a single information activity in a disaster may be mediated through many different ICTs (Dailey & Starbird, 2014) or none at all. Burns (2014) finds that areas most affected by a disaster are least likely to leave digital traces, while Crawford and Finn (2014) raise the concern that those who leave digital traces are not necessarily representative of affected populations. Thus, while Crisis Informatics has made great gains in raising the visibility of digitally empowered crowd work in disasters, concurrent information work of those in affected communities remains potentially (and quite problematically) obscured.

As disaster scholars, we are concerned about the possibility that the most affected may be lost in the crowd. By tracing information work of those affected and responding to a tragic disaster in a relatively small community, this study helps to characterize the digital gap. Using contextual interviews combined with digital trace data we situate specific platforms within the overall information landscape that formed around a disaster. We uncover how work took place across several community-situated volunteer efforts. To account for the diversity of work arrangements that occurred, we focus our analysis on chains of coordinated action. Following a particular chain of coordinated activities, we can examine the interplay between actors who were organized and resourced in different ways and positioned differently respective to the affected community.

EVENT BACKGROUND

On March 22, 2014, after a season of exceptionally heavy rain, approximately 8 million cubic meters of earth slid off one of the hills that line the Stillaguamish Valley in Washington State. The resulting landslide moved quickly and with tremendous force across a square kilometer of the valley, demolishing the rural enclave of Steelhead Haven, some 49 homes and cabins, and covering them in mud and debris. Tragically, 43 lives were lost. Volunteers and emergency responders rescued survivors. Recovery efforts continued for months. The slide also buried hundreds of meters of the Valley's only thruway, State Highway 530. Because Highway 530 is the only road that traverses the Stillaguamish Valley, the slide cut off travel between the east and west, requiring those on the east side to make an 80-mile detour. This, divided response efforts into two sides and had an adverse economic impact on the town of Darrington (on the east side of the slide). One primary activity for community response became feeding affected families, responders, and members of the nearest communities of Oso (population 180) and Darrington (population 1347) on either side of the slide. Among many spontaneous efforts, we follow the work of community-based collaborations that respectively operated on either side of the slide.

METHODS

Through exploratory interviews and review of digital record of the event, we sought diverse examples of information work, spanning different kinds of ICT platforms and different sets of actors. We then identified and interviewed individuals involved in these activities, including government employees, community responders and volunteers, affected family members, remote volunteers, and media. These interviews revealed additional activities of interest and additional interviewees. This paper draws on interviews with 25 people. All took place nine to thirteen months after the event. The first

two authors conducted all but one interview jointly, and with one exception (a remote volunteer) all interviews were conducted in-person. Using a semi-structured protocol, we probed for details on the information behaviors and practices pertaining to the personal actions and perceptions of interviewees during the event. To improve accuracy of self-reported information and to improve depth of detail, the interviews were conducted contextually (Holtzblatt and Beyer, 1993; Beyer and Holtzblatt, 1997) in the location where the interviewee conducted their information work during the event. 22 interviewees consented to interviews in their workplace, volunteer location or homes. In many cases, we were given access to personal records (digital and analog) within tools of the event such as notebooks, photos, Facebook pages, and website administration pages. At the conclusion of the interview, we prompted interviewees with a comprehensive survey of information tools and resources they may have used.

This study also relied on the digital record of online information sharing respective to this event. In exploratory analysis, we looked at all prominent information platforms (websites of national and regional media, Facebook, Twitter, Reddit, Wikipedia, government websites, et al) to get a feel for the overall information landscape. We then explore specific digital record for observational data. Aligned with Geiger and Ribes' Trace Ethnography approach (2011), we also used the digital record to identify actors who played a particular role in information sharing during the event, including potential interviewees. We then use the digital record to contextualize and affirm (or disconfirm) interviewees' statements and to elaborate on what we learn from interviewees.

Researchers met regularly to analyze findings. We identified salient themes inductively through memoing and affinity diagramming (Miles, Huberman, and Saldaña, 2014). We inductively grouped interviewees and those with whom they coordinated their activities into networks of coordinated action. Each network of coordinated action became an object for analysis in which we could then examine what human, social, and technical infrastructures came into play in supporting the activities engaged in by the network. Though other researchers have reported on convergence around food in a disaster context (Kendra and Wachtendorf, 2004), we were surprised when several of our initial interviewees—including Public Information Officers, an affected family member, and several community volunteers—independently connected food work with information work. This encouraged us to seek out additional interviewees and to review the digital record respective to these intersecting themes. For this paper, we spotlight three networks of coordinated action. Each was involved in the collection, preparation, and/or distribution of food after the emergency. To compare incident-focused communication to day-to-day communication we used the digital record and participant observation. Two researchers spent a total of three days each at two sites featured in this paper (Sedro Wooley Distribution Center and a Funeral Dinner Committee event).

FINDINGS

Feeding the Community: "It's Just What We Do"

As news of the slide spread throughout the community, and (according to those we interviewed) without any instruction from anyone, community members throughout Darrington just started cooking. For Sheila Ashe, co-owner of the local grocery store (the IGA), this meant making sandwiches and sack lunches for responders. She began "immediately" after hearing of the slide and continued for "weeks and weeks." After delivering sandwiches to the fire house—something she had never done before—she made her way to the Community Center to touch base with the "funeral dinner ladies". For a month following the slide, a diffuse set of community members, volunteers and aid workers worked together at the Darrington Community Center to serve free meals, twice a day. Professional and volunteer responders sat side-by-side to eat with aid workers, community members, and even media. In explaining this mass production of meals, Ashe said, "That's just what Darrington does."

Leveraging Existing Social & Organizational Infrastructures

Dana Cannon (pseudonym) a community member who lost loved ones in the slide, stated it this way: We have an infrastructure in this town called the Funeral Dinner Committee. They're a bunch of ladies... if something bad happens they get together.

In responding to the horrific and catastrophic event, community members in Darrington began to do what they knew best, what they always do—to prepare and serve food to those affected. The work utilized existing physical infrastructures such as the facilities of the Community Center, which already served as a location for preparing food and accommodating people during times of mourning. It also leveraged existing social infrastructures, including informal community norms and practices around food sharing as well as the structure of established "organizations" like the Funeral Dinner Committee.

The Funeral Dinner Committee (or Funeral Committee as it is alternatively called) has been active in Darrington since 1950, offering a memorial dinner for anyone who passes away in the Stillaguamish Valley. One of its founders, "the funeral lady" Janet Cabe, is still in leadership. Memorial dinners take place in the Community Center, which was built a few years after the Committee formed. There are 150 seats in the Center's dining room, and most dinners are attended at capacity. Funeral Committee members arrange the dinner, local high school students set up the tables, and community members provide the dishes potluck style.

In terms of internal coordination, the Funeral Committee is formally activated by a phone tree. Cabe lives across the street from the Community Center, and people regularly drop by her home to communicate with her face-to-face. To communicate with the broader community about a dinner, the family of the deceased typically places an event notice in a regional newspaper, the Everett Herald.

Membership in the Funeral Committee is quite diffuse. When asked how many members they have, one person said 19, referring to those who attend meetings. Another said 60, referring to those currently active in the phone tree. But, when asked who brought food for the dinners, Cabe responded, *"Just about everybody over a certain age has cooked for us."* The

The Funeral Committee's activities are highly visible within the community of Darrington— all of the interviewees we talked to from the eastern side of the slide mentioned the committee. These factors, combined with the decades of continuity for this practice, may explain why so many community members independently and spontaneously brought food to community center on the day of the slide. Cabe explained: *"[and on the day of the slide] no one had to be told to bring food to the community center."*

Multiple interviewees—including Ashe at the IGA and Catherine Lyons, the owner of the town's only pizza place—described how they began to cook immediately after the slide. Though these individuals were not formal members of the Funeral Committee, their work eventually converged with the Committee's efforts to feed people at the Community Center. Through a combination of established and emergent collaborations, the Darrington community quickly established a practice of serving three meals a day to "the community at-large." As increasing numbers of people converged on the town, it became hard for the community members to meet the demand. After a few days, the Red Cross contracted an outside organization to cook. The Funeral Dinner Committee continued to be a presence at the Community Center, serving coffee and laying out some dishes provided by community members.

Physical Convergence of Food and Information

Serving meals at the community center was integral to how information was shared by those in Darrington. In contrast to the shelter on west side of the slide, which was restricted to displaced persons, the Darrington Community Center was a point of convergence for all in Darrington. For the first six nights after the slide, responders, officials, and community members gathered for meals at the center. This was followed by a community meeting at 7pm that often lasted until 10pm. Meetings continued several times a week for about a month. Meals were served every day. Diane Boyd, who is the longtime director of the Community Center (a volunteer position, she is also the school librarian) explained, "everybody came here for information." Thus the Community Center became a place for formal convergence, including town meetings run by officials, and informal convergence, such as community meals. This aided the flow of information in all directions. Though the focus of these efforts was on supporting the community, even members of the media were allowed in, provided they left their cameras and recording equipment outside. Because the Community Center (and its meals) were open to community responders, FEMA officials, the National Guard, media, town people, contractors, affected families and others, the Community Center became an optimal location for face-to-face information sharing.

Another site interviewees recalled as an important location for getting information in Darrington was the IGA, another food hub. Inside, cashiers and signs at check-out stations updated people on information— e.g. the day and time of the next community meeting. Outside in the parking lot were two 4x8 bulletin boards. At the end of each day, official information was posted and people would gather around to get the latest. Community members posted their own messages there as well. For example, condolence messages and tributes to the victims were shared. Interviewees suggested that the boards were also just places to hang out, where people would congregate and talk. Just as community members reported relying on the boards, media also converged en masse in the IGA parking lot. Even formal responders relied on the IGA as an information outlet. A public information officer (PIO), Kris Rietmann, who worked in Darrington during the first week, explained how the IGA's dual roles as information hub and food hub were related:

"It's kind of a clearing house for info 'cause it's the grocery store. So I'd send it to the owners [...] People in Oso and Darrington like the actual boards where you put up the old school lettering. We would put up stuff on that, make sure that they had the flyers, [...] 'cause those are just kind of the places where people went."

As Rietmann explains, PIOs produced flyers electronically then forwarded them to individuals near the bulletin boards who could print and post them. Community members reported sometimes taking photos of these flyers and circulating them through Facebook.

IGA employees and owners were also viewed as an important informational resource, a role they fulfilled primarily through face-to-face interactions. By communicating with a volunteer of a Facebook news group that was widely relied on by those in the affected area, Ashe indirectly became a "big resource" for keeping the online community abreast of the situation in Darrington as well.

The (In)Visibility of Community-Based Social Infrastructure

The two physical infrastructures where people converged for information in Darrington left distinct digital footprints behind. Online, the Funeral Dinner Committee has a low profile, with no website of its own or social media accounts. Only a handful of references appear in a web search. And, though the slide received widespread media coverage, the Funeral Committee, though clearly central to the community response to the event, received limited attention in the regional and national press.

On the other hand, digital traces from the event leave a record of the IGA as a key information hub. According to a news report from a major Seattle-area media outlet, "The IGA was a hub during the

Oso landslide, acting as a center for information and donations, as well as providing free food and water for rescue workers. Employees even took time off to help in the search and rescue effort" (Wilkinson, 2014). And several tweets acknowledge the IGA as an information hub—e.g. this one from a journalist in the region:

(2014-03-25 12:48pm PDT) @lindsaycohen: The Darrington IGA remains a focal point for the community, for people to check in, show support, get info. #530slide http://t.co/nlYx2PbWZO

To sum: The seemingly spontaneous work of preparing food in this community was shaped by long-standing community practices. Implicit knowledge of community norms reduced explicit coordination and information work around preparing food, perhaps contributing to less visibility in digital trace data. Yet, the sites of this work became important information grounds for staging information work within both formal and informal response. These information grounds were an expression of the value the community placed on gathering all social types together in the same physical spaces.

Supplying the Community: The Darrington Food Bank

Another volunteer-driven community organization that mobilized to meet emergent needs after the slide was the Darrington Food Bank. Each week the food bank distributes free food to under-resourced people, typically serving about 30% of households (considerably higher than the national average of 14% (Weinfield et al, 2014). In the weeks after the slide, when round-trip commutes to work and school were four hours longer, increased costs of gas and childcare drove a surge in demand, and some 65% percent of homes in the district sought relief at the food bank. In addition to meeting this increased demand, food bank volunteers also arranged the collection and distribution of literally tons of food for the meals at the Community Center, dropped off groceries at the doorstep of those who lost loved ones, and brought needed supplies in for responders. They extended their typical capacity to meet these new demands by drawing on the capabilities of the regional "food bank network" and by collaborating with "key individuals" at the Darrington Community Center, the Fire House and other locations.

Leveraging the Regional Food Bank Network

The food distribution system for the needy in the U.S. is a complex web of independent charities each staffed and resourced differently. Donations may come from businesses, individuals, government or other nonprofits. Larger organizations may have paid staff, but many, like Darrington's, are all-volunteer. Collection and distribution of food in this network is not one-directional, nor are the chains of distribution static. For example, the Darrington Food Bank is an "unofficial distribution center," regularly supplying two other rural food banks.

In the hours after the slide, the lead volunteer at the food bank, Catherine Lyons, recognized two things: 1) the closure of Highway 530 would cause increased demand at the food bank, and 2) it would disrupt arrival of food into town. She called Cole Bitzenburg, the coordinator at the Skagit Distribution Center—the most "geographically logical" food bank distribution center—and made a request for "a lot of food right away." Through emails and phone calls, Bitzenburg activated the regional food network, some of whom regularly support the Darrington Food Bank, and many more who do not. Through his coordination, dozens of charities in the region provided logistical support including transport and "staging areas" for food distribution as well as provisioning donations for Darrington. As Lyons explained: "Tap into the food network then you've got a whole lot of people to distribute the work across the community." By the end of the first week the network had brought in half a dozen trucks and two semi-trailers of food and other supplies.

Dropping Off Food, Collecting Information

For three days after the slide, phone lines were down. Likely due to congestion, cell service was also not always reliable. The Darrington Food Bank did much of its communication work face-to-face. Somewhat surprisingly, we were told that even if phone lines were intact, face-to-face communication would have remained the modus operandi for the food bank. Even in its day-to-day communication, the food bank employs very little technology and in spite of its surge of activity after the slide, that remained the case. In terms of personal use, Lyons has a laptop and tablet, but she prefers to coordinate with the food bank's 20 volunteers by phone or in person. Though she uses email, she stated that after the slide she had no time to look at email or other online resources.

During the slide response, Lyons used her pizza shop for food bank business and off-loaded phone communication to a volunteer who worked the phone there. She appointed another volunteer to collect information at the food bank. This freed her up to make "rounds" in person about three times a day to the Community Center, the fire house, the food bank and several other locations: "I sort of had this unofficial route, so I checked in on anybody who would be needing food at that time." At each location she sought out specific individuals who could reliably relay the information she needed without giving her information overload:

The way it was set up, I would have probably set it up that way anyway [...] with key people in certain spots. Because I knew they would filter it, all the information, and only give me what I needed. And I could trust them to do that, instead of [...] going on Facebook and [reading] 50 posts and only one's something that's of any value...

Lyons viewed face-to-face communication with "key people" as a more efficient means of understanding community needs than going through platforms like Facebook. This preference for "legacy" communication methods extends to other groups in the food bank network. Describing how they coordinate with volunteers from the various food banks that rely on their services, an interviewee at the Skagit Distribution Center explained:

They are not all great with email. Some aren't great with technology. Others have problems with computers breaking down, etcetera. Only three or four of the 19 [food banks] could you reliably communicate primarily through email.

Instead, most communication with the food banks takes place in-person when they arrive for their weekly pick up. Coordination between the distribution centers and larger organizations that support these food banks occurs through other channels. These supporting organizations regularly correspond via email and many use the same online ordering system. To support the slide response, these supporting organizations used email and conference calls to coordinate with each other. Though, we were told, the online ordering system was circumvented. During the event response, Lyons relayed requests in person to Bitzenburg during daily delivery. He then phoned or emailed the request to the major regional food bank supplier.

To sum: Food distribution occurred through chains of coordinated action that took advantage of an established emergency food distribution network. Because the network is decentralized, information work was decentralized. Though the whole regional network was activated, individuals associated with specific nodes communicated directly with "key" actors through email, phone, and face-to-face. These actors were cognizant of working within "the food bank network." Yet, some groups in the network publicized their work (often naming their direct collaborators in the network) on websites or Facebook. Others did not. Thus digital traces give an incomplete account of the coordination that took place through the network.

Feeding the Responders: The Soup Ladies

We first learned of the "Soup Ladies" in an interview with a PIO for the US Geological Survey (USGS) of Washington State, John Clemens who worked on the side of the slide opposite from Darrington. Like many responders on the western side of the slide, USGS geologists had partaken in several meals provided by the Soup Ladies, an organization that provides mobile meals to responders of major crisis events. Regular deliveries of free "home-made" hot soup made an impression on those working long hours in cold rain and mud. During the event, Clemens tweeted (from @USGS_W A) his appreciation, mistakenly attributing their efforts to "caring Oso residents." However, the Soup Ladies were actually not from Oso, but from Black Diamond, two hours south.

Founded in 2005, the Soup Ladies is a 60 member volunteer organization focused on feeding first responders. Based out of a restaurant owned by its lead volunteer, Ginger Passarelli, the group has a mobile kitchen for traveling to any extended emergency response. They have the capacity to feed up to 600 people every 90 minutes from their mobile kitchen. They are regularly called to crisis incidents around the area, and occasionally mobilize to disaster-affected areas outside the state. Like other response organizations, Soup Ladies arranges their work in order to respond quickly: "When they call us, we can be out the door within an hour with food for 100 or more people."

Unlike the Funeral Dinner Committee, Soup Lady meals are not open to the entire community. They focus solely on feeding responders at events. This does, however, include community members who are not part of official response organizations but are helping during an event. Along with several rural fire departments and King County Search and Rescue, Soup Ladies are one among many all-volunteer organizations that deployed to the slide. The group may be considered a specialized kind of emergency response organization, as all Soup Ladies (and Stew Dudes, as male volunteers are known) are trained and certified in the National Incident Management System (NIMs). All undergo background checks.

Leveraging Existing Social & Organizational Infrastructures

Though when mobilized under the hat of Soup Ladies, they are "Soup Ladies first," many volunteers— including Passarelli—have overlapping memberships in other emergency response organizations in the region, including additional certifications and training. Several volunteers also have day jobs in formal response, including some police officers and firefighters.

Similar to the other community response efforts described above, to communicate among volunteers and to coordinate with other emergency responders, the Soup Ladies employ communications tools and practices that Passerelli describes as "real simple and real precise." When volunteers of King County Search and Rescue got the text to mobilize to the slide, Passarelli also received it. Following incident management procedures, she contacted the Emergency Operation Center by phone and offered assistance. She then quickly rounded up her Soup Ladies through text and email chains, prepared food, and drove to the Arlington Fire Department, where they fed fire fighters working on the western side of the slide. Understanding the event's magnitude, Passarelli reached out to a fellow police chaplain, and got access to a kitchen at a local church, eventually preparing 6,655 meals over 16 days. However, being two hours north of their home base, it soon became apparent that they needed more help. Because Soup Ladies fed responders at the recovery site (a restricted area), they were limited in who they could accept as volunteers. An emailed call-to-action circulated to members of the Behind the Badge Foundation enabled the Soup Ladies to get volunteers with established emergency response ties who lived closer to the slide.

Distributing Food and Information

Twice a day the Soup Ladies packed up their truck and headed northeast to the slide. Along the way, they would make six stops where they would serve all the responders in the area. At each stop,

responders would stand in a circle near the truck, eating and talking. When Passarelli was asked by another Soup Lady why they did this, she responded:

We're making the dining room table. That's what brings people together is food. The dining room table is like an altar. [...] You're providing them with a place to communicate and be together.

While serving meals, the Soup Ladies coordinated in person with the command about the next meal service, working out such details as the best time to serve given the projected work flow and number of meals. Collecting plates and garbage became an opportunity to have one-on-one conversations with responders about their needs. In this way, Soup Ladies were able to provide personalized service to individual responders, provisioning specific requested food and drink to workers as well as sundries like sanitary napkins and pain relievers.

Communicating on behalf of the Formal Response Community

The Soup Ladies worked directly with emergency responders on the western side of the slide within the chain of command established by the response. In contrast to the other community response efforts described, this positioned them to give a public face to the formal response effort. In keeping with the official incident management procedures, Passarelli only granted media interviews that were approved by the PIOs working the event. Talking points were discussed with the PIOs in advance. This yielded several stories from local and regional press and at least one spot on national TV. Beyond media coverage, the Soup Ladies maintain an online public presence that spans multiple platforms. They have a website which provides basic information about the group, but contains only ten blog entries posted between 2009 and 2014. The @SoupLadies Twitter account has just 85 tweets since 2009. The 195 accounts they follow and their 234 followers appear to be a fairly tight network of their own volunteers, local responders, and response organizations along with a handful of media organizations. They are most publicly active on Facebook with 4654 likes and 463 posts since 2009. Posts include event announcements, photos of the group, shares of news articles, calls-to-action and occasional invitations to donate. While their social media is publicly accessible, those interacting with Soup Ladies via social media, the followers and followed, the posts and comments are largely comprised of regional emergency response workers and their supporters.

To sum: Though geographically and therefore socially separated from the community response efforts described in [the sections above], the coordination work of the Soup Ladies shares similarities with those other efforts. Information work for coordination occurs through "real simple" means. Likewise the site of prepared meals became important information grounds intended to provide both sustenance and emotional support. The information work represented in Soup Ladies public trace data represents is distinctly different than the communication work they staged around the meals they served.

DISCUSSION & CONCLUSION

We traced community efforts after a disaster, connecting the work of responders across sociotechnical networks. While focusing on food, these particular efforts set a context for in-person information spaces that the community and responders valued. More superficially, many community responders continue to rely upon face-to-face and "real simple" technologies to coordinate their activities. This work also offers a method for surfacing the less visible information work that takes place within the social complexity of a disaster, thus helping to account for potential biases from focusing solely on digital traces.

Examining Community Response Work through Networks of Coordinated Action

We have demonstrated how coordinated work in this disaster took place within, across, and between organizations. The coordinated activities we have described included the spontaneous actions of

individuals and the planned activities of groups. Improvised work was shaped by existing social infrastructures and practices including community traditions that leave little trace. Further, each coordinated activity took place through a distinct constellation of ICTs. We were able to account for these complex arrangements by tracing the path of work through networks of coordinated action. Analyzing networks of coordinated action can account for the fluid and multi-sited nature of how work—including information work—occurs in disasters. By integrating multiple strands of evidence, primarily overlapping contextual interviews combined with analysis of the public digital record, we were able to document how information work occurred within each of the efforts as well as how each effort contributed to and is represented in the public digital record. In this manner, we were able to provide an empirical account of the placement of ICTs within a rural community's response to a tragic event. We thereby help to situate ICT use within actual practices and demote any specific technology or platform from the site of research to one tool among many, used by people. Therefore, this research complements and extends the many recent studies that primarily make use of the public digital record, especially those that focus solely on single platforms.

ICT Use by Community Responders: Focus on "Real Simple" Tools

Although the digital record of this event is overall a rich one, spanning many online platforms including traditional and social media, government and non-profit websites, a common feature of networks of coordinated action who took on the community response food work is that each of these efforts relied very little on online public platforms for their coordination work. Several among them preferred face-to-face communication; phone and email were also used to some extent. Far from viewing themselves as communication have-nots, this limited palette of "real simple" tools was considered an asset. It helped curb information overload and was viewed as more reliable in the context of a disaster. It also assured that volunteers and organizations with less technical expertise were not excluded from the response.

Food Work and Information Grounds

We began this research by trying to understand the information needs and behaviors of individuals affected by a disaster. Consistently, interviewees linked their personal information work to the larger social context in which they worked. In this case, interviewees connected "information foraging" (Pirolli and Card, 1999) to a more literal form of foraging that took place at the sites where community-based actors offered food. The community center, grocery store, and even the temporary "dining table" responders arranged themselves into at the recovery site were all viewed as important vectors for information sharing and communication. Official information, condolences, and messages of hope were posted on bulletin boards outside of the IGA (the town's grocery store), drawing people each day to see the new posts. Photos of flyers posted at physical locations like the IGA circulated through social media, and in some cases individuals near these physical places were encouraged to print flyers created and shared electronically and to post them at these sites, essentially cross-posting (White et al, 2014) or bridging technological gaps in the information space (Dailey & Starbird, 2014). The food-oriented "information grounds" (Fisher and Naumer, 2006) at the Darrington Community Center and IGA parking lot were sites of both formal and informal information sharing across multiple "social types" (ibid.): affected family members, community members, responders, volunteers, and the media. These sites supported more fluid multilateral communication across social types than would have been possible without them. It is important to note that this open arrangement to different social types within a single convening space is something that the local community actively strove to create (according to those we interviewed). In other disasters, information grounds may remain more segmented, for example, with convening places only open to responders or only open to displaced persons, etc.

These food-oriented information grounds were gathering points that fostered face-to-face communication, enabling people to congregate and talk, something our interviewees valued. Response work is accompanied by a high degree of emotional labor (Mastracci et al, 2014). While

pragmatically, as one interviewee put it, "everybody needs to eat," the efforts we describe were shaped with an intention of expressing emotional support—e.g. not just giving food, but giving "home-cooked" "comfort food". The needs of individuals were addressed through personalized service such as door-step deliveries to affected families. Perhaps confirming the success of the food-related efforts in manifesting their intention to comfort, multiple interviewees brought up food-related locations and the food-related activities led by others as personally important to them. It was in this sensitive and responsive context that information was meaningfully shared by the several social types who occupied these spaces.

7

It Takes Three to Make a Thing Go Right

Journalist, Responder, & Citizen Contributions to Social Media Crisis Information

ABSTRACT
Social media are widely used during crises. Researchers have tracked their rapid adoption and evolution, showing they are not only paths for diffusing crisis information, but also sites of collective sensemaking and collaborative work performed by an emergent, connected crowd. In this chapter, I highlight the relation between particular kinds of crowd workers— citizens, responders, and journalists— and the respective contributions each make via these platforms. By examining the public social media record over a five year span, we are able to see how behaviors seen early on in social media changed as information demands pertaining to the 2014 Oso Landslide evolved. Thus we gain a more thorough account of the respective contributions of citizens, journalists, and responders to information work taking place through social media.

Whose Information Work Serves a Crisis-affected Community?

Social media have been shown to be important sites of information work during emergencies. A wide variety of people have been shown to contribute helpful information about crises via social media platforms. An incomplete list of those featured in Crisis Informatics studies of social media includes "bystanders" , "citizens" , "citizen-journalists" , "crisis mappers" , "digital volunteers" , "digital humanitarians", "emergency responders" , "eyewitnesses" , "family/friends" , "government agencies" , "journalists" , "local residents" , "public information officers", and "students". To wrestle order from this large cast of characters, many studies focus on one of two over-arching social roles: citizen or responder. A preponderance of Crisis Informatics studies examines the social media work of either citizen, responder, or both (Hughes and Palen, 2018; Reuter and Kaufhold, 2018). This study builds upon and extends the ways that Crisis Informatics researchers have considered the contributions of traditional media to the information work of citizens and responders on social media. Specifically, this work closely examines several instances where the social media-enabled information work of these three groups was inter-related, thereby contributing to our understanding how potential interdependencies between the groups as well as what may be distinctive to each respective role.

In this chapter, I consider the information work of citizens, responders, and journalists that took place over social media for a period of five years following the deadly 2014 Oso Landslide that tragically took 43 lives in Washington state. Each instance has been selected based on the importance and quality of the information and its potential to support the affected community. It will be shown that information relevant to the impacted community culminated from the complementary and combined efforts of each three social roles. Their work in these instances was inter-dependent and not entirely interchangeable.

RESEARCH APPROACH

Distinguishing Meaningful Characters among the Connected Crowd

A first step toward understanding the relationship between journalists, citizens, and responders in contemporary crises is distinguishing these groups from each other in a systematic manner. Doing so in social media data is a non-trivial task. To understand the complexity of the task, let's start by imagining a more straightforward case of applying a social role to a social media user. Imagine we have a set of tweets tagged with the hashtag of a fan fiction group. We want to understand what users who associate with this hashtag are saying about a certain book. Helpfully, each tweet in our hypothetical collection is associated with a user's screen name, profile description, and other sundry details designated by Twitter engineers as part of each Tweet's "User Object". We first identify tweets about the book that also contain the hashtag and then we analyze this content for each user. If the preponderance of the content for a given user is overall positive, we confidently designate the user as a "fan" of the book. Having distinguished these fans from other users, we can now review "fan's" tweets pertaining to the book more closely to answer many practical questions either about why people like the book or about the characteristics of those who like it. Because we inferred a "user" to be a "fan" based on the observed content, we can be fairly confident that our designation— though tautological— is, nevertheless, a meaningful social construct. Through this meaningful social construct of "fan", we not only make better meaning of the content we are interested in in this instance, but can also tie this particular instance of "fan" activity to other instances of that same social role, therefore advancing knowledge of fandom.

But delineating social media users by the social roles that are meaningful in disasters takes more effort. Whereas in our hypothetical fiction forum, a single meaningful social role ("fan") can do a lot of analytical work for us, by contrast, there is not one inherently meaningful overarching social role that obviously ties to disaster-specific social media content. Rather, social media activity around disasters is the product of an untenably long list of social roles. This is due to the basic human behavior in disasters which is characterized by the social pattern known as "mass convergence." (def Heide, 2003; Fritz and Mathewson,1957; Kendra and Wachtendorf, 2004; Wachendorf and Kendra, 2004; Wenger, 1994). The tendency for humans— irrespective of their normal day-to-day social roles– to physically converge, en masse, at a disaster site is well attested. Early Crisis Informatics research identified a parallel phenomenon to physical mass convergence during emergencies of online mass convergence (e.g. Hughes et al, 2008; Palen et al, 2010). For this reason, social media content about a medium-to-large scale crisis event is typically the joint product of an expansive range social actors, occupying of social roles. Because of the phenomenon of mass convergence, content about a disaster cannot, by itself, readily tell us much about social roles beyond that of a social media user. One of the early popular designations of social media users, "the connected crowd", points to this breadth of social roles that comprise the kind of online mass convergence seen during emergencies.

It is not only the very wide range of potentially meaningful social roles that we are confronted with that poses a challenge to understanding disaster behaviors on social media. The inherent instability of the social roles associated with disasters adds another dimension to the challenge. There is often a discontinuity between roles and behaviors we have in a non-crisis state and those we exhibit in crisis state. In our hypothetical example of the fan forum, the designation of the social role "fan" is congruous with the observable favorable content about a given book. By contrast, during mass-emergencies, individuals often take on (to them) novel work which they achieve in often novel (to them) collaborations in order to respond to the crisis (Dynes, 1970; Kreps and Bosworth, 1994). For example, our hypothetical local fan fiction forum may for the duration of an emergency be re-appropriated by its users to respond to the crisis in some manner. Therefore, it is common to see abrupt changes occur in both user behavior and user content during emergencies. The adoption of new activities and the blurring of social roles applies to individuals and organizations alike (Kreps and Bosworth, 1994). These sometimes quite abrupt and sometimes quite large shift in social

positioning and behavioral activity pose a methodological challenge[15] for researchers in terms of understanding social media roles and behaviors during crises because pre-crisis roles and behaviors are not necessarily indicative of emergency-related roles and behaviors.

These are among the reasons why Crisis Informatics case studies have a very wide range of social roles that researchers overlay on the social media users who are active around emergencies. Among these, two over-arching social roles are applied far more than any others: "citizens" and "responders" (Palen and Hughes, 2018; Reuter and Kaufman, 2018). These are invaluable categories to apply to social media users because they are drawn from empirical disaster studies and professional emergency management. Therefore these social roles reflect how professional responders conceive of the social space around disasters. Naïve readings of Crisis Informatics case studies may give the impression that these social roles are static and stable designations. No professional responder would make that assumption. The professional chain of command varies with every crisis depending on the kind of the emergency (terrorist attack, tornado, oil spill) as well as the degree of impact. A sizeable portion of professional emergency management training in the U.S. is devoted to learning the National Incident Management System[16], a set of plans that helps responders understand the contingencies that shift chain of command from one entity to another and the professional roles and practices pertaining to each kind of incident.

In other words, due to the nature of the social behavior that characterizes disaster response (mass convergence) and due to the contingent nature of response work, the social roles of responder and citizen are dynamic and relational. More so, they are not even exclusive categories. Volunteer firefighters from the nearest neighboring communities were the first on scene at the Oso Landslide. The county became the lead agency, but for a short period of time Washington State Patrol was the lead agency. By the end of day one it was clear that the landslide was a "Type 1" incident, meaning it was of a scale and magnitude that the Federal Emergency Management Agency would need to coordinate assistance to come on scene from around the country. Yet, even when FEMA took up response coordination, local community members continued to work the disaster site. That is how the incident management system works. Professional take on the work that is complementary to the community response, and citizens are often integrated into the professional response.

Therefore, to understand disaster behavior on social media, we need to think of social roles of citizen and responder (and journalist) as provisional and dynamic rather than fixed and static. To answer a question such as, "Is the work formerly done by journalists in previous disasters now being successfully taken on by citizens and/or responders?", social roles, user behaviors and user-generated content need to be co-interrogated and iteratively interrogated.

At a high level, we can apply these provisional social designations to key corpuses of social media data using computationally assisted analyses. For example, in another study to which I applied the same Constructivist Grounded Theory (Charmaz, 2014) process used in this study to distinguish "journalists" from "non-journalists" who had been associated with several false rumors, we were able to identify statistically significant behavioral differences between the two groups in multiple crises (Starbird, et al 2018). However, the inevitably static and Boolean categorizations employed to understand overall larger-scale patterns of social media activity across entire data sets can easily miss

[15] This is also a design challenge for social media platforms that aim to support normal activity and crisis activity.

where social roles are most dynamic and changing. The points of instability in roles and behavior are instrumental for improving crisis response. But they can be hard to see through the application of static categorizations to large data sets. Therefore, it is helpful to combine selected network analyses with closer examination of smaller subsets of activity that enable us to consider some of the social complexities inherent in but hidden by the uber-designations of citizen, journalist, and responder.

Even though this study employs several techniques used in computational social science including network analysis and much sampling by and consideration of common network statistics, the quantitative techniques in this study are ultimately in service to an interpretivist approach. Adopting an interpretivist approach enables us to derive what meaning we can from the roles of citizen, journalist, and responder while enabling consideration of where those categorizations break. In this way, we can better understand online social behavior in disasters as that behavior relates to social roles that inform that behavior.

Methods

In October 2014, we purchases a collection of 986,286 tweets posted between March 21 and April 12, 2014 from Twitter. To capture the widest amount of activity related to the event, we requested several very general terms including all tweets in this time with that contained either "landslide" and "mudslide"; several locations in proximity to the slide: Oso, Arlington, Darrington, Steelhead Haven; event-specific hashtags: e.g. #530slide, #HelpOso, #Osostrong; and all tweets from 30 highly visible accounts associated with the event. This collection enabled different kinds of analysis, including a timeline of early tweets prior to the creation of any event-specific hashtags, as well as hashtag-specific analyses.

Table 1 reviews the multi-step process of tying social media activity to social roles. Initially, one researcher applied social roles used in disaster research, emergency management practice, and network studies to users of the two most prominent event-specific hashtags selected for influence on common network attributes such as most retweeted and most prolific. This resulted in about 25 social roles identified.

Multiple researchers then attempted to independently apply these 25 social roles to additional user profiles. Few categories were consistently applied by independent coders. For example, coders with no training in emergency management could not reliably identify responders. Therefore, plans to apply computational analysis based on simple heuristic categories were abandoned.

One of the few categories multiple researchers were able to independently apply with consistency was "media". Taking those accounts that had been identified as such, two researchers then reexamined the "media" accounts to create a heuristic keyword-based classifier distinguishing "journalists" from "non-journalists". When the heuristic classifier was applied to multiple data sets from this event and others, statistically significant behavioral differences were observed between journalists and non-journalists However, the simple classifier lost journalists at both the "top" and "bottom" of the journalism hierarchy: The largest authentic news organizations had been inadvertently excluded to avoid inclusion of news aggregator bots. Small news organizations also fell away because their profile descriptions overlapped with citizen produced media. Thus, the team again changed approaches: taking on a ground-truth analysis of hand-detecting journalists and "non-journalists." In this iteration, Wenger's theory of a "community of practice" (2011) applied to journalism to delineate the two, seeking cues visible in the data that suggested a particular user was associated with the "community of practice" of journalism.

Five researchers in consultation with a former journalist reviewed Twitter user profiles and deliberated collectively on the rationale for making a determination in each case. In this way, we arrived at a set of cues that distinguish journalists from non-journalists. This process enabled

researchers to identify journalists systematically, and because the rationale for making decisions was articulated, the process aided rigor and transparency. Researchers then sought used these cues to identify journalists among 33,054 user profiles, of which 20,440 were users from the Oso Landslide. These included all users in our collection who had tweeted one of the two event-specific hashtags (#530slide and #OsoStrong). Two researchers independently reviewed each account. A third researcher arbitrated disagreements in assignments.

One result of the ground-truth grounded-theory-derived delineations was that a higher statistical significance of behavioral differences between journalists and non-journalists was achieved and reported in Starbird et al, 2018 on a different set of data. At the same time, this process also enabled more granular analysis of journalists and non-journalists for this study.

To further understand the kinds of the journalism that were important on social media after the landslide, two researchers distinguished additional attributes of journalist accounts (locality; organization, individual affiliated with an organization, individual not affiliated with an organization; broadcast-affiliated, print-affiliated, digital-first/digital-only, et al).

Non-journalists were then hand-identified as either responder or citizen by one researcher using a list of organizations provided by Snohomish County as a guide. In this way, the interactions and behaviors of journalists, responders, and citizens can be explored by both computational and trace analyses per social role—enabling analyses to bridge different analytic scales. The social roles defined in this way were then applied to analyses of activity on other platforms beyond Twitter as described below. The review of the social media record described here is also informed by 27 interviews with individuals who shared information about the landslide and other research activities.

The incidents that are highlighted in this chapter were selected for several reasons. First, they represent a range of different kinds of information needed by the public after an emergency of this kind. Second, they are all cases were the citizens, responders, and journalists played a part in the information work visible online. Therefore, each of these cases enables a close examination of the how the online information work of these groups may relate to each other.

As is usual with larger-scale crisis events, the online information space around the Oso Landslide contained some misinformation and "rumor patrol" was an activity that responders, journalists, and citizens alike engaged in around this event, as in others. Though an important element of the information work pertaining to the landslide, that work is not directly addressed in this chapter. Rather, the focus of this chapter is to look in some depth at the different ways that the work of responders, journalists, and citizens relates online across several examples that took place at different points in the crisis.

Applying Meaningful Social Roles to Social Media Data					
Pre-Coding	**Iteration 1**	**Iteration 2**	**Iteration 3**	**Iteration 4**	**Iteration 5**
Coding Process					
Tweets are selected for analysis based on keywords, hashtags, and select users from one day prior to the landslide to ~ 3 weeks afterwards.	1 researcher attempts to apply meaningful social roles from disaster research, emergency management practice, and network studies to the Tweet samples	Multiple researchers test the application of the social roles identified in the previous iteration.	Two researchers use the "media" accounts to create a heuristic keyword-based classifier distinguishing "journalists" from "non-journalists"	5 researchers review Twitter user profiles to derive a set of cues that distinguish journalists from non-journalists in consultation with a former journalist. The cues are independently applied by two researchers to 33,054 users, of which are 20,440 from this event.. A third researcher arbitrates when the first two determinations disagree.	Two researchers distinguish journalist accounts by additional attributes (locality, organizational, broadcast-affiliated, et al). Non-journalists are hand-identified as either responder or citizen by one researcher
Result					
Samples such as "top 100" most retweeted, most prolific, etc. are selected for close analysis based on Howard's "Network Ethnography" techniques, et al.	~ 25 categories emerge from applying social roles to these samples	Few categories can be consistently applied independently. E.g. coders with no training in emergency management cannot reliably identify responders. Plans to apply computational analysis based on simple heuristic categories are abandoned. "Media" is one of the few categories multiple researchers can independently applied.	When the heuristic classifier is applied to multiple data sets from this event and others, statistically significant behavioral differences are observed between journalists and non-journalists. However, the simple classifier loses journalists at both the "top" and "bottom" of the journalism hierarchy.	Cues that enable researchers to identify journalists are arrived at systematically, and articulated, increasing rigor and transparency. Higher statistical significance is achieved for the computational analyses. More granular analysis of journalists and non-journalists can now be done.	The interaction and behaviors of journalists, responders, and citizens can be explored by both computational and trace analyses per social role—enabling analyses to bridge different analytic scales. Social roles defined in this way can inform analyses of other data beyond Twitter.
Concurrent research activities	→ → → Interviews, site visits, open exploration of the public digital record, participant observation of regional response through auxiliary research, trainings, exercises, etc. → → →				

Table 1. Steps taken to link social roles meaningful in disasters to social media data.

FINDINGS

Community as the First Response: Early Awareness and Sensemaking on Twitter

Figure 2. The first hour of tweets about the Oso Landslide by social roles. Each mark represents an individual tweet. Each color within a row represents a single user.

When a mass casualty event occurs, fast mobilization can save lives. Via Twitter, awareness of the slide spread rapidly and widely. As shown elsewhere, early tweets not only diffused information, but were also instrumental in "collective sensemaking" (Heverin and Zach, 2012; Vieweg et al, 2008) as individuals converging via Twitter minutes after the landslide pieced together disparate snippets that incrementally illustrated the severity of this particular landslide. In this case, citizens, responders, and journalists each contributed to early collective sensemaking, making distinct contributions that raised awareness and warnings about the life-threatening emergency as it unfolded.

To see the earliest activity, we purchased tweets from 24 hours prior to the slide to three weeks after that contained generic terms such as 'mudslide' and 'landslide' along with relevant location names and event-specific hashtags, as well as all tweets from certain accounts such as the lead response agency. Then two researchers read through the first two hours of tweets chronologically to identify those about the slide. By doing so we identified the 593 accounts who contributed the 927 tweets within the first two hours after the landslide. We then categorized them as either journalists, responders, or citizens. Figure 2 shows event-specific tweets per social role for the first hour of tweets. Each mark represents one tweet. Marks of the same color in a given row represent an individual users.

Citizens Earliest Tweets: Initiate, Sensemake, and Alert. The first event-related tweet posted 26 minutes after the slide:

> **11:03** Sounds like there may be a major mudslide on 530

Posted by a citizen (@snocoscanner), this tweet exemplifies a kind of crisis information work performed by citizens that was not possible before social media. Like digital humanitarians (Norris, 2017; PLoS, 2012) and crisis mappers (Soden and Palen, 2016), "scannerheads" are an entirely new category of crisis information workers. Scannerheads monitor emergency radio communications used by police and fire professionals, then post to social media interpretations of what they have heard on emergency radio. Using either radios or websites like InterceptRadio.com, scannerheads monitor emergency radio communications in an unofficial capacity. They then selectively share what they hear

on social media. The information work that scannerheads performed here can be considered to be "citizen-to-citizen" communication according to Reuter and Kaufman's model of social media use in emergencies (2018; Reuter et al, 2012). Yet, scannerheads achieve this by capitalizing on responder-to-responder communication. Because emergency radio is primarily a tool to coordinate field work between responders, radio communication can be quite difficult to interpret by those listening in. Response professionals and journalists we interviewed expressed discomfort with scannerheads because emergency radio communication lends itself to misinterpretation. More so, when scannerheads post, responders and journalists feel pressure to communicate publicly even as they are sensemaking themselves. Yet in several cases, local journalists and responders maintained follower-following relationships with local scannerheads.

As requests for assistance radiated out to nearby jurisdictions, scannerheads across the region tweeted what they heard. The six regional scannerheads active in the first two hours after the slide were essentially live tweeting the sensemaking taking place among responders. The 31 tweets scannerheads contributed in that time show an evolution of understanding as the magnitude of the slide became apparent. As calls for mutual aid went out over emergency radio to firefighters in neighboring areas, scannerheads following their local emergency communications added to the Twitter conversation. Nearly simultaneously, through emergency channels and Twitter, awareness of the emergency radiated from the impacted county to neighboring counties.

Two minutes after the first scannerhead tweet and minutes after the slide, another citizen contributed to public awareness about the slide in a different manner. At 11:05 @traciroo54, an eyewitness on scene, tweeted the first public image of the road blockage caused by the Slide (Tweet 2):

The message's inclusion of the account name for the Washington State Department of Transportation, @wsdot, can be seen as an example of the citizen-responder interaction enabled by social media as described by Reuter and Kaufhold (YEAR) and Hughes and Palen (2012), among

others. Retweets of this tweet could support Gillmor's vision (2006) of the "the people formerly known as the audience" publishing information of public value absent of the involvement of journalists, news organizations or other gatekeepers. As one of the most followed government organizations in the region, @wsdot's retweet of the eyewitness photo (at the time) would have brought news of the slide to many citizens, responders, and journalists in the region, while acting as confirmation that the landslide had occurred and was significant enough for WSDOT to be involved.

Responders Earliest Tweets: Alert, Engage. Nine emergency response accounts contributed 39 of the 927 earliest event-related tweets. Though few in number, these contributed to early awareness and sensemaking about the slide by informatively *alerting and engaging* the public. The first responder to tweet about the slide was a Public Information Officer for Washington State Patrol 46 minutes after the slide (Tweet 6) letting people know that a road was blocked and a response was in progress:

> **11:09** Mudslide completely blocking SR 530 MP 37 near OSO. Fire advises someone calling for help, can't confirm. WSP sill en route

Though public via Twitter, this notification follows the concise formula used in interagency communication during emergencies: We learn from it what the state patrol viewed as a confirmed fact at the time: A mudslide has occurred. It is completely blocking a state highway. And also what they deem as unconfirmed but of potential import: someone is calling for help according to the firefighters on scene. The tweet ends with the status of WSP's response: they are still en route to the scene. To these basic facts, the tweet carries additional meaning for responders. Highway 530 is a state highway. Based on the information available at this point, according to pre-existing incident management plans Washington State Patrol would be the lead response agency at this point. For those involved in emergency response, the tweet not only tells us what is happening but would also suggest specific courses of action for individuals and agencies: what kind of resources might be needed, who might be involved in the response, and with whom they should coordinate (WSP).

Just 38 tweets (4%) in the first two hours employ @ mentions that directly address another Twitter user. Though few in number, these tweets point to the importance of cross-group engagement between responders, journalists, and citizens in early sensemaking about the slide.

In Tweet 9, a responding firefighter (@fireneyre): directly *engages* major regional TV news outlets:

> **11:09** @KIRO7Seattle @KING5Seattle @Q13FOX @komonews Major mudslide in Darrington, people trapped...calling for S&R as well as navy choppers

Thirty-two minutes after the slide and six minutes after the initial tweet, Tweet 9 more confidently asserts that a major landslide has taken place and that people are in imminent danger. Coming directly from the firefighters referred to in Tweet 8, this tweet assigns the location of the landslide as "in Darrington" the nearest town to the east— a precise enough location at that moment though the slide was several miles out of town. The rest of the tweet is a stark declaration: People are in imminent danger. A slide has occurred and it is a major one.

From just the first few minutes of tweets we see how citizens and responders were engaged in early collective sensemaking on Twitter in multiple ways. Each message carried some new information that could be interpreted in light of the preceding messages and individuals converging on Twitter could piece together a more accurate understanding of what was happening by following these messages.

This rapid sensemaking took place nearly simultaneously as those responding to the scene were ascertaining the situation and mobilizing further support, and could therefore be considered "hypertemporal" (Palen and Hughes, 2018).

The initial tweets were by local citizens listening to radio scanners in Snohomish county where the slide occurred and an eyewitness on scene. But within a few minutes it became a regional conversation as scannerheads in other counties and county and state responders began posting.

Journalists Early Tweets: Confirm and Amplify.

It is interesting that minutes into a response when lives were actively at risk, a firefighter working the response would stop to tweet to regional TV news organizations. It suggests that doing so was viewed by this responder as supporting the response work at this point.

The specific journalists tagged by the firefighter are regional TV news organizations. By this time the landslide response organizations viewed Twitter as a primary means of reaching journalists as Twitter was the primary way that journalists wanted response organizations to contact them. By publicly tweeting to the organizational accounts of the largest news organizations in the region, @fireneyre mobilized the entire journalism community in the region. For organizational accounts are tied to the editorial hierarchy of news organizations.

The absence of tweets by journalists at this stage could be read as an absence of attention. In fact, interviews revealed that journalists from a number of regional news outlets were aware of the slide concurrent with regional response learning of it. Several major regional news outlets were attending a Washington DOT press conference on another matter when the slide occurred. The press conference abruptly ended when WSDOT emergency radios went off alerting the WSDOT officials at the conference about the slide. The journalists attending—what one WSDOT PIO referred to as "my media"—would have also have turned their attention to the cause of the interruption. Elsewhere, journalists were monitoring emergency radio in their newsrooms as part of routine news operations. Therefore, the delay in tweets by journalists compared to other citizens and responders is significant. It was only after the responding firefighter's Tweet 9 mentioning them that regional journalists tweeted publicly about the slide. By 11:11 (34 minutes after the slide) all of the news outlets @fireneyre tweeted at (via @ mentions) had posted about the slide (Tweets 14: @komonews, Tweet 15: DavidRoseQ13FOX, Tweet 16: @grlopez4 KOMO4 News Mgr., and Tweet 17 @KIRO7Seattle). In part, this reproduces the relationship that media have had in publicly communicating crisis information prior to social media: journalists' earliest tweets are information confirmed from an official source.

Journalists played a particularly outsized role in raising public awareness about the slide. Each of the primary organizational accounts for the regional news outlets @fireneyre mentioned had at least 60,000 followers—more than four times the number of followers that all the accounts that had tweeted prior to them combined. So it's not surprising the journalists' tweets were succeeded by a rapid increase in the number of accounts tweeting about the slide. In this case, Brun's (2003) claim journalists are now more "gatewatchers" rather than "gatekeepers" is softened. Tweets by regional journalists precipitated an "information cascade" (around Tweet 141) as the number of citizens retweeting journalists quickly grew. Continuity of the traditional role of journalist in informing the public about emergencies is also reproduced by the delay in this case of journalists posting about the emergency until after there has been confirmation from official response, and indeed, in this case, a particular alert made specifically to journalists via Tweet 9. This aligns with the particular set of relations between regional journalists and response organizations that pre-dates social media. In this case, alerting the larger public about the landslide can be viewed as the result of the respective efforts

of responders and journalists. Different from historical arrangements, the work of responders and journalists was shaped by the early information work of citizens who initially brought awareness of the landslide into the public sphere.

The amplifying influence of the regional news organizations spread beyond the region. All of the regional TV news organizations are affiliated with national broadcasting networks that originated in the early 20th century. The regional news organization accounts while primarily serving those in the region, are also followed by other journalists, particularly those in their own their own extended networks. Thus the landslide became an international news story at the same time that the broader regional community became aware of it. The amplification of the awareness was not entirely benign. Tweet 18 (just 34 minutes after the landslide) appears directly after the first tweets by regional media. It is the first tweet from an automated "News Aggregator" bot account. Claiming to be "news" but with no evidence of a curatorial hand, I found scant evidence of interaction or influence. For example, the first new aggregator two tweet @WAI5 had just 377 followers (a tiny number for a news service). Yet, News Aggregator bots were prolific and numerous. @WAI5 tweeted about the slide 1816 times in our full collection. And 60 news aggregators were active in the first two hours alone. Appearing just 8 minutes after the first slide tweet and 49 minutes after the slide, @WAI5's first tweet is in itself a benign retweet. Yet this first bot tweet illustrates how quickly unhelpful (and potentially nefarious) actors can insert themselves into public crisis communication. Several citizen accounts that piled on directly after the first tweets by regional news organizations were also likely bots triggered by the regional news organization tweets.

Who Is Missing? Finally, in considering who played a role in early awareness and sensemaking on Twitter, it is worth mentioning groups that did not seem to play a significant role in the first two hours. Absent here are celebrities and professional media of the non-news variety. Of the 145 tweets by journalists in the first two hours only two were associated with a digital first outlet (Vox and MyEverettNews), whereas 99 were broadcast-associated and 23 print-associated. Journalists who did not state an affiliation contributed 21 tweets. Also scantly represented were citizen bloggers, vloggers, and podcasters. Only 7 accounts contributed 12 tweets, all retweets of responders or journalists.

In these early tweets, we see that citizens, responder and journalists were all instrumental in raising early public awareness about the landslide, quickly mobilizing public attention even as responders were mobilizing. Hyperlocal citizens first brought the event to public attention. Official responders were direct and indirect sources of information on the platform. The sequence of early citizen and response tweets shows a progression of a more precise understanding of the event. Aligned with journalistic best practice, in this case, journalists did not tweet about the slide until after it was publicly confirmed by responders, though they were likely aware of it beforehand. Once journalists did begin tweeting they played an outsize role in confirming, curating, and amplifying early information about the slide.

Mass Convergence: Following the Response Status in the First Three Weeks

The destruction of a neighborhood, the loss of life, the drive to rescue victims and the need to rebuild a vital transportation thoroughfare demanded a complex response with an on-the-ground presence extending some four months. Shortly after the slide, the lead response agency, Snohomish County, introduced an event-specific hashtag (#530slide) to share response information (Tweet 279, of the 927 Tweets we identified in the first two hours):

> **12:17** Huge landslide on SR 530 at mp 37-38. Fire/rescue on scene. @SnoCo_DEM coordinating. Please avoid area. Follow us here for updates #530slide

As the response unfolded, #530slide tweets kept those who followed it up-to-date on official

information of road closure, flood warnings, rescue progress, and recovery of human remains. Additionally, the hashtag was attached to information about the broader community response such as fundraisers, donation opportunities, volunteer efforts and expressions of support.

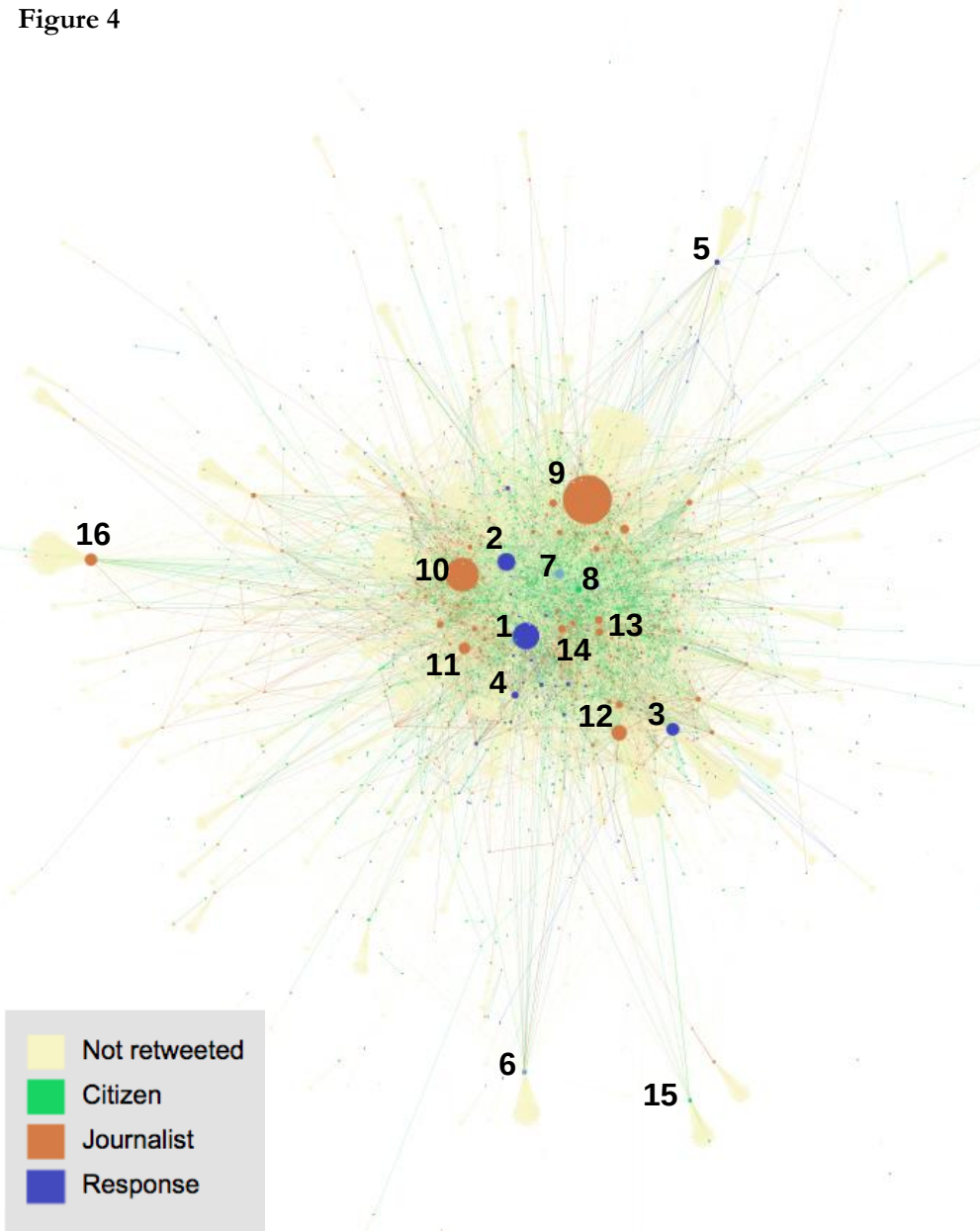
The corpus of tweets with this hashtag is information-rich, representing the diverse aspects of official and volunteer response work in this period. It is relatively light on misinformation. For example, of the 186 tweets identified in the full Oso collection that link to a known fake news site, none contain the hashtag 530slide. Thus the hashtag seemed to foster the kind of information space intended by the PIO who created it.

Figure 3. The volume of #530Slide Tweets rapidly declined over the first three weeks though on-site work continued for some time thereafter.

From the time it was suggested 40 minutes after the slide occurred until the end of our collection three weeks later, the hashtag was used by 19508 accounts who contributed 75,209 tweets. A timeline graph (Figure 3) shows that the hashtag was quickly and widely adopted after the slide, peaking on the third day at 9492 tweets. The peak of activity two days after the landslide reflects a "mass convergence" (Hughes et al, 2008; Palen et al, 2010) online when both an international public and international news and response organizations across the globe took an interest in what turned out to be the largest mass-fatality landslide in U.S. history. Yet the amount of activity associated with the hashtag quickly declined. This follows patterns seen in other examples of mass online convergence and digital volunteerism after crisis events (Park and Johnson, 2017). To Kwak et al's (2010) often cited question, "Is Twitter a news platform or a social network?", the answer in this case would be, "Yes.". The timeline evokes the news cycle for a major international story. Peak activity and mass interest around the hashtag was closely tied to the emergency period when the focus was on rescuing survivors. This was also when many community and unofficial volunteer efforts were happening in the community assisted by individuals and organizations near and far. Peak activity only partially reflects what was happening on-site. Recovery and rebuilding extended into July, though activity around the hashtag notably declined prior to our collection cut off on April 12 at 172 tweets. The relatively small amount of tweets after that time were largely contributed by those within citizens, responders, and journalists within the region.

Citizens, Responders, and Journalists in the #530slide Twitter Conversation

Figure 4



This network graph represents those who were retweeted two or more times in the first week using the hashtag created by the lead response agency (#530slide). Node size corresponds to the number of times each user was retweeted. Nodes closer to the center were retweeted by a more heterogenous group of users.

With a few notable exceptions (7 and 8), those most retweeted in the #530slide conversation were regional news organizations and government response organizations. However, citizens played an important role in diffusing and curating information from these sources. Though the graph is only based on retweet patterns, proximity to the slide and organizational role in the response are reflected in who is central in the graph and who is peripheral.

Government Response

1.	@snocounty	County government (response lead)
2.	@SnoCoSheriff	County Sheriff
3.	@wsdot	WA State Dept. of Transportation
4.	@GovInslee	WA State Governor
5.	@RedCross	American Red Cross
6.	@NASA	U.S. Federal Agency

Citizen Media

7.	@nwfireblog	Firefighter blog, unofficial
8.	@BreakingSkagit	Scannerhead /citizen journalist

Traditional Regional News Media

9.	@KING5 Seattle	NBC affiliate, Seattle, WA
10.	@komonews	ABC affiliate, Seattle, WA
11.	@KIRO7Seattle	CBS affiliate, Seattle, WA
12.	@SeattleTimes	Regional newspaper
13.	@EverettHerald	County newspaper (“most local”)
14.	@Q13FOX	Fox subsidiary, Seattle, WA

Peripheral Professional Media

15.	@AlyssaMilano	Hollywood actor / celebrity
16.	@AC360	CNN NY-based news program

To understand who performed information work associated with this hashtag, we focus on the 2034 Twitter accounts that were retweeted using it. This helps us to differentiate, at a high level, those who introduced or significantly transformed information on Twitter (those who were retweeted) from those who took an active role in diffusing that information (by retweeting). A directed retweet graph of who is being retweeted in the first week (Figure 4) helps us see the distinctive and complementary contributions of different kinds of actors in the #530slide conversation. Color represents the different kinds of actors participating: Orange for journalists, blue for response, green for citizens, and yellow for those who were not retweeted. The size of each node indicates the number of times an account was retweeted. Those in the center of the graph were retweeted by a more diverse set of users scattered across the graph.

Most Central Sources: Local Responders and Journalists. In this case, those Twitter users whose #530slide tweets were retweeted by the most diverse set of users (and therefore are at the center of the network graph), happen to be local responders and journalists. Though geography was not an input in making the graph, the graph nodes are essentially arranged by proximity to the Slide.

Among responders, most central in the graph are the lead response agency, Snohomish County (@snocounty) (Figure 4, 1), and their on-site collaborators @SnoCoSheriff (Figure 4, 2). Other collaborators with more specified roles such as the WA Department of Transportation (@wsdot, Figure 4, 3) and the American Red Cross (@RedCross, Figure 4, 5) are prominent but less central in the conversation, indicating that specific subsets of individuals engaged more deeply with their content, whereas the lead agency's tweets were interesting to a broader public.

Radiating out from this core are accounts that were less directly involved on-site and/or had a more specific scope in the response work. Of the 346 organizations that the lead response agency lists as collaborators, 78 have accounts that were retweeted with the #530slide hashtag. Most of these were government accounts (308 retweets from 58 accounts). For example, numerous U.S Congressional Representatives tweeted condolences. But the government affiliated users prominent in the retweet graph are primarily organizational accounts such as @NASA (Figure 4, 6) rather than individuals. In this way, the graph is a reflection of the official chain of command, inter-agency coordination, and communication protocol. Because disaster response work is arranged by proximity, so is the network graph of retweets.

Similarly, the regional journalists are most central in the graph. In this case, regional television Q13 Fox Seattle and several accounts associated with the "most local" newspaper, the Everett Herald—the county seat newspaper— are at the center. Conversely, around the edges are national news such as CNN's Anderson Cooper 360 (@AC360, 16). International media is not represented in the graph at all. The same journalists central in the graph were also most commonly mentioned by interviewees.

Most Retweeted Sources: Regional Legacy Media. The response created the hashtag #530slide. Dozens of response organizations used it consistently. And their #530slide tweets had good uptake in terms of retweets. Yet the narrative that this is an example of direct mediation between response and citizens is complicated by the fact that journalists are the most retweeted #530slide accounts , with 18075 retweets originating from 644 accounts. Among the most retweeted are the organizational accounts of regional legacy media outlets such as Figure 4, 9 @ King5Seattle (NBC affiliate), Figure 4, 10 @komonews (ABC affiliate), Figure 4, 12 @SeattleTimes (newspaper). These accounts are surrounded by smaller dots of journalists affiliated with the major regional outlets. This suggests that in spite of the prominence of the lead agency accounts and their collaborators, traditional news organizations and those who work for them were significant contributors to this information space, both providing and shaping content, and diffusing it widely to interested audiences.

Often in social media research the default unit of analysis is a user, perhaps differentiated by the kind of activity they do online. For example, Reuter, Heger and Pipek (2013) differentiate social media users' roles in crisis information work as helpers, reporters, repeaters, and retweeters. While valuable, when we think of social media users in these terms, we obscure the fact that many social media users are organizations that put the weight of multiple individuals behind what is visible on social media. The evidence here suggests the importance of journalist organizations and those affiliated with them in terms of diffusing response information on Twitter. Of 78409 #530slide tweets, 31,448 were posted by either the organizational account of a journalism outlet or an individual journalist affiliated with one. Though , in theory, anyone with an internet connection can be a publisher, the most retweeted journalism accounts in this case are those with ties to broadcast (14699) and print (4864) compared to 223 tweets from digital first journalists or those not stating an affiliation.

Citizens: More Diffusers Than Sources. About half of the retweeted accounts were citizens (1004 of 2034). Represented in green on the graph, the vast majority of these were retweeted only once. In this case, citizens appeared to play a more significant role in diffusing information from response and journalists by retweeting them. The many green lines connecting clusters across the graph as well as the green in the center of the graph suggest that the citizens being retweeted are largely mediating content from official sources and journalists. However, in many cases, you can see that this work does appear to connect clusters that may not have otherwise been linked.

There are two interesting exceptions to this pattern. @nwfireblog (Figure 4, 7), a regionally focused blog by firefighters for firefighters retweeted 545 times with #530slide. @nwfireblog's proximity in the network graph to the lead agency accounts suggests that this informal communication channel reflecting the regional firefighter community was a valuable source of information for those either directly or indirectly involved in the response. @BreakingSkagit (Figure 4, 8) was retweeted 324 times with #530slide. This is the only scannerhead account seen in the first two hours that maintains a role as information source in the 530slide conversation. Both of these accounts illustrate that citizen-media makers can indeed be important information resources after a disaster. However, their efforts are situated among hundreds of journalist and dozens of official response accounts.

Peripheral and Missing. Sparsely represented here are the broader professional media accounts beyond journalism. Though, for example, the regional classical radio station, print lifestyle magazines and digital outlets such as BuzzFeed were retweeted a bit, they are not significantly part of the 530slide conversation. These 28 broader professional media accounts garnered only 266 retweets combined. In contrast to what has been found in other studies, where celebrities are influential in a crisis conversation, only one celebrity is significantly retweeted, actor @AlyssaMilano (15). Those who retweeted her single tweet did not seem to interact with the rest of those tweeting #530slide. Off the retweet map entirely are the many prolific news aggregating bots. None of these were retweeted in spite of contributing 1405 #530slide tweets. These findings underscore that journalists working in regional news organizations continue to make distinct contributions to crisis communication in spite of heterogenous participation that takes place in public crisis communication via social media.

The Universal Public Narrative on Wikipedia at Year 4

In the above examples we saw how important information about the landslide was produced and disseminated via Twitter through the interdependent efforts of citizens, journalists, and responders during the emergency phase of the disaster. In the emergency phase, Twitter was instrumental to raising early awareness and helping the public to stay appraised of the response status. To further understand the respective contributions of citizens, journalists, and responders via social media to public information about the landslide, we now turn to a different social media platform, Wikipedia, at a different point in time, the fourth anniversary. As we saw on Twitter in the emergency period, the Wikipedia page about the landslide can be viewed as resulting from the combined and respective

efforts of citizens, responders, and journalists. All three were instrumental to the production of a relatively high-quality overview of the event, one that continues to be read and edited as new information comes to light.

The '2014 Oso mudslide' Wikipedia page is arguably the most important user-generated, publicly-available social media artifact about the landslide. Because Wikipedia revisions are publicly accessible, it was possible to closely follow its evolution from the moment of its creation (April 26, two days after the slide) through to the five year anniversary. At each stage in the crisis it has offered a publicly accessible narrative account of the tragedy. Like other social media platforms that had content about the landslide (Twitter, Facebook, Reddit, YouTube, Pinterest, GoFundMe, etc.) the initial version of the page was the product of intensive activity during the emergency period that waned with time. In contrast to the other platforms, the Wikipedia page is a living document that has continued to evolve over time as new information resources became available. Around the 4th anniversary of the landslide, the page was still averaging two hundred page views a day. The Wikipedia page's importance as a comprehensive, publicly-available narrative account of the landslide arguably becomes more important with time as other resources about the landslide remain behind paywalls or have otherwise become inaccessible.

To better understand the interplay between journalists, responders, and citizens relative to Wikipedia activity, I look here at the contributions to the page as it existed on the year 4th anniversary, March 24, 2018. All cited references and all editors were considered in relation to the social roles of journalists, citizen, or response (government). Each original reference was reviewed, as were the editor profiles and related links as they existed at that point.

Legacy Media, the Predominant Reliable Sources. Instrumental to the production of high quality Wikipedia pages is the platform's requirement that information must come from "reliable sources[17]." Similar to what can be seen in the emergency period #530slide conversation on Twitter, journalists and government sources dominate the list of the citations and external links (hereafter referred to collectively as references) on the '2014 Oso mudslide' page. Of 72 references at the four-year anniversary, 63.8% (46) were from journalist sources, 23.6% (17) from government sources. The remaining 13% (9) were professional technical domain experts authoring technical reports (5) and professional blog posts 12.5 (4).

The page is informed in good part by content provided by journalists— and particularly those working in legacy news organizations. Of 45 journalist sources, all have a byline affiliated with a news organization. Whether because of the nature of the content produced by news organizations or the ability of news organizations to pass Wikipedia's standards for reliable sources, (or both), the content of the page at this point of analysis is largely woven from content that passed through hands working within a news organization.

Perhaps surprisingly, just as with early Twitter, we can see the echoes of traditional arrangements in news production in looking at the types of journalism relied upon to develop the page. The relationship between broadcast news and print news seen in the early Tweets is flipped here. Print news, long associated with giving narrative accounts of disasters meant to serve both the moment and posterity are over-represented: 34 references have roots in print journalism, while 10 have roots in broadcast. The region's largest newspaper, the Seattle Times, is particularly relied upon, cited 22

[17] https://en.wikipedia.org/wiki/Wikipedia:Verifiability#Responsibility_for_providing_citations

times. Only 1 journalist-produced reference is from a digital-first/digital-only outlet (Weather Underground).

The fact that regional broadcast news is more prominent in early Twitter but regional print news is more prominent in contributing to the Wikipedia narrative suggests that though technological convergence has for decades made it possible for different kinds of journalism to make similar contributions to public information, differences rooted in traditional arrangements persist.

Regional News Media as Key Reference Sources

In reviewing the locality of sources, proximity, again, largely explains the sources cited. A range of national "prestige" media outlets are represented: Associated Press, the New York Times, Washington Post, Reuters, and PBS News Hour. But most references are within the impacted region. A few are sub-regional/hyper-local, such as The Whidbey News Times, a newspaper serving a small island in the Puget Sound. Most references were only cited once. Even the newspaper described by interviewees as "most local" to the landslide, the Everett Herald, is only used once. The outlier, by far, in terms of references is the regional newspaper The Seattle Times, which is the largest circulation print outlet in the Pacific Northwest. It has won 11 Pulitzer Prizes for news coverage—an indication of the respect the outlet has among its national peers in the print news industry. The Seattle Times was used as a reference 22 times at this point in the "2014 Oso mudslide" page's development, constituting 31% of all references.

That the Wikipedia page relies so heavily on a single source deserves consideration. The fact it is a regional news outlet echoes the patterns seen on Twitter during the emergency. In the earliest minutes on Twitter, regional broadcast news was largely responsible for raising awareness about the event to both regional and beyond-regional publics. Here, perhaps, The Seattle Times is similarly, simultaneously serving regional and non-regional audiences. The landslide occurred 60 miles outside of the Pacific Northwest's most populous city. As an outlet with a regional focus, Seattle Times reporters and editors had to contextualize the disaster for a broader audience in the course of their reporting. Yet, as an event within the region, many aspects of the landslide were of concern and interest to its readers. The interpretive work done by those working at The Seattle Times to render a broader meaning of a hyper-local event would, therefore, readily set the stage for Wikipedia editors whose aim is to render an account of —in Wikipedia parlance— a "notable" event for a worldwide readership[18].

Likewise, the fact that the corpus of references on the Wikipedia pages is largely sourced from news outlets with regional scope or wider with ties to print and broadcast suggests there is something important about these particular kinds of sources in piecing together a disaster event narrative on Wikipedia. Perhaps, such sources provide a kind of content that lends itself to the editorial ethos of Wikipedia. Perhaps, the attributes of these kinds of outlets do the work of signaling that a source is reliable and/or that the content is of a notable nature. Whatever the case, these relations should be further explored.

Government Sources, Direct and Indirect

In the examples above of emergency phase activity on Twitter, we saw both official responders engaging the public directly and, more frequently, being mediated by journalists. This aligns with what is seen in terms of references on Wikipedia. At Year Four, 23.6% of references (17) were from

[18] https://en.wikipedia.org/wiki/Wikipedia:Notability

government sources. Most-cited is the lead response agency (Snohomish County) with 6 citations. The remaining government references represent a range of different ways that the government sector is an information resource around disasters. Sources include the Washington Departments of Transportation and Natural Resources, US Geological Service, and the Washington Division of Geology and Earth Resources. Of course, many of the news articles used include information from government sources. In a few cases, the journalist-produced references are simple distillations of government-issued press releases and other simple types of documentation that could have been directly cited. In such cases, there is little difference between what is reported by the news source and the original source. This raises an interesting question about why a news source would be chosen over a government source. As seen in the early Twitter activity, the overall trend among citizens curating the Wikipedia page was to choose news stories over otherwise available government content—though the minority content coming directly from government sources integrated into the page is substantive content. Such patterns both support and contradict the idea of social media platforms as a means for government response to directly engage citizens.

Citizens Curate the Narrative

The Year Four version of the '2014 Oso mudslide page' was the work of 77 Wikipedia editors. Viewing these editors in relation to the three social roles of interest here—citizens, journalists, and responders—is something of a challenge. In reviewing editors' User pages and related, 60 of 77 (78%) gave no hint of their offline positionality relative to these roles. With the possible exception of one who references working as a writer (so possibly a journalist), none associate government, professional response work, or journalism. Only 3 link themselves to a specific organization. Thus, whatever roles these editors have beyond Wikipedia, their contributions to the *2014 Oso mudslide* page can be considered to be performed from the role of citizen.

Though anonymous, what Wikipedians do disclose is informative, serving as a form of accountability. Most User pages disclose the kind of edits that a user typically engages in. One can also inspect each user's contributions across the platform as well as the conversations they have about specific articles and edits. Therefore, in contrast to other social media platforms where the curatorial hand of citizens (both individual curation and its collective results) can be obscured in important ways, on Wikipedia the curatorial hand of citizens is relatively straightforward to ascertain.

We saw in the earliest minutes on Twitter how the individuals who converged could be seen as collectively refining their understanding of the event, a pattern described as "collective sensemaking" (Heverin and Zach, 2012; Vieweg et al, 2008). Collective sensemaking is also apparent when examining the individual contributions of Wikipedians to the landslide page. As with other social media, we can understand each edit as a "micro-contribution" (Park and Johnston, 2017). Together, these complementary tiny contributions seem to add up to a "collective intelligence"— a term used to describe similar emergent crisis-related activity elsewhere (e.g. Starbird, 2013). Because editors with dozens of different types of expertise and interest elected to use their talents to improve the page, multiple aspects of the disaster were addressed, including scientific and technical dimensions[19]. In this manner, I would argue that the citizen editors performed even more like journalists than the digital volunteers working through other social media platforms who Norris (2017) argues constitute a new kind of journalism. Wikipedia is a platform that enables the kind of integration of content that

[19] For example, different from the content in #530slide Twitter conversation, the Wikipedia page shows a deeper engagement with the technical aspects of the slide. Several of the government documents cited on the page are obscure (for non-experts) technical reports such as a PDF of a 1968 Department of Natural Resources sizing up the history of slide activity in the vicinity of the Oso Landslide.

adds up to something greater than its parts—just as a news organization does—by enabling those with multiple kinds of insight and access to integrate their respective contributions. Yet, as we have seen, the relationship between journalism-by-analogy and journalism-as-traditionally practiced is greater here than it may at first appear. If professional journalistic sources were to disappear, how could Wikipedians provide value to public information about disasters?

The breadth of different types of editing performed by the Wikipedians who converged on the page evokes the breadth of roles within a large news organization with its many editorial "desks" and "beats." Among the host of editorial sub-specializations are those who edit only specific types of content (the Pacific Northwest, seismology, meteorology). Again evoking the work of the traditional newsroom, some specialize in copy-editing and grammar. Others disclose that they "patrol" new pages for vandalism. Five authors identify as bots. Unlike the ineffectual news aggregating Twitter bots described above, the Wikipedia bots perform useful tasks such as converting http links to https links or assuring regularity of style in reference formatting.

Just as citizens do on Twitter, Wikipedians self-select what contributions they make, if they care to do so. In the language of Crisis Informatics, we can view this as another example of social convergence and digital volunteerism. An important difference here is the ongoing nature of the work. Whereas other research has found attrition of digital volunteers shortly after an emergency (e.g. Park and Johnson, 2017), the Wikipedia page continues to be an object of attention for viewers and editors alike years after. This should remind us to avoid generalizations about "social media use" during crises. The persistence of citizen activity is specific to the phase of the crisis, the platform, and the nature of the information work.

The Response That Never Ends: The Everett Herald's Landslide Coverage at Year 5

In the previous instances, we saw that regional news organizations were important information sources at different points of time on two different social media platforms, Twitter and Wikipedia. We will now consider the information work of one news organization— the one that a PIO described as the "most local" news organization to the landslide, the Everett Herald . We will consider the post-emergency information work visible on the Herald's website at Year 5 using language and theories that Crisis Informatics researchers have applied to online information work visible on major social media platforms. Doing so adds another dimension to understanding the role of social media systems after a crisis and the respective contributions of citizens, responders, and journalists to the information work that takes place through them.

Emphasizing its roots in print which stretch back to 1901, the Wikipedia page about the Everett Herald calls it a "newspaper" though its website, HeraldNet.com, has been online since 1997. During the time of the study, the journalists at the Herald were encouraged, indeed required, to use Twitter and Facebook in the course of their work. Social media shares of Herald stories and social media posts made by Herald journalists were among the earliest Tweets to be shared during the emergency. Responder and citizen controlled hyper-local and event-specific Facebook pages and groups posted Herald stories throughout the study.

Long Term Information Post Disaster: Hypotemporal and Hyperlocal

To better understand the digital record of the landslide, it is helpful to first consider the nature of long term information work that follows from a disaster. Though we commonly conceive of disasters as standalone events, (Soden and Palen, 2018; Tierney, 2007; Watts, 2017), according to disaster experts, many of the most effective avenues for reducing harm need to be taken before a disaster occurs (Knowles, 2012). For example, if a local planning board denies building permits within a slide-prone area, the chance that a neighborhood would be destroyed if a landslide occurred is eliminated. In practice, properly assessing risk and implementing best mitigation practices are persistent challenges. Disasters are often flexion points to reconsider how disaster risks can better be mitigated

(Knowles, 2012). For example, the Oso Landslide catalyzed state and federal inquiries on reducing slide risk. In turn, these inquiries stimulated new scientific and technical inquiries. Another challenging line of inquiry are questions of accountability. Was any person or entity responsible for the landslide? Did the planning board understand the level of risk when they permitted the neighborhood? Or did the level of risk change? Were money and other resources used responsibly during the emergency? Did the right people get aid?

These are not simple questions to answer. Rather, their answers are often the product of multiple venues and many different kinds of expertise. The process of inquiry can stretch into years, sometimes decades. If early sensemaking in an emergency can be considered "hypertemporal" (Palen and Hughes, 2018), we can consider post-emergency information to be "hypotemporal."

Another attribute that applies to these kinds of questions is that they are civic in nature. That is, the answers to such questions are instrumental to public decision making— impacting how well future disasters are mitigated, the effectiveness of future emergency responses, and the success of long term recovery for the impacted community. It is not enough for post-emergency *civic information* to be produced. To inform public decisions, civic information needs to be integrated into decision making venues and processes. In the U.S, a lot of public decision making about long term recovery and future mitigation happens at the local level. In many ways, communities are not only the first responders, but they are also the last responders. To resolve post-emergency work to best effect, they need relevant information.

A Continuous Integration of Post-Emergency Civic Information in Current Events

At the fifth anniversary the lead story was the dedication of a new memorial sculpture at the landslide site. Results for "Oso Slide" OR "Oso Landslide" OR "Oso Mudslide" OR "530slide" on the Everett Herald's website returned 8490 results. That is an average of more than four stories a day. Many of these stories occurred in the first months after the landslide when every news item was about the landslide or touched on it in some way. But the Herald's production of information about the landslide has been ongoing. Just as the paper had covered all aspects of the emergency, it continued to link the landslide to present civic concerns and cultural interests post-emergency.

Disasters are more than problems to be solved. They are social upheavals that cast long shadows on impacted individuals, communities, and responders. Because regional journalists reflect the community and are part of the community, much of the coverage by the Everett Herald mirrors the sentiment and expressions of citizens' and responders' social media posts. The lead story at Year 5 was the commemoration of the memorial at the landslide—also covered by international outlets. Stories leading up to the memorial included airing the desire of community members and responders for a memorial, the raising of funds for it, the call for an artist to design it, and naming the artists ultimately selected. In the immediate aftermath of the disaster, the Herald ran stories on individuals who were missing, victims, survivors, community volunteers and official responders. Post-emergency stories gave periodic updates on individual survivors and responders as well as organizations involved, such as a 2018 story on the "Fast-acting, life-saving local heroes" at the local Red Cross.

Reflecting the fact that disasters are local and responding to them is shouldered in some way by nearly every person and entity, the work individuals and organizations did during the disaster is continually brought into view by Herald reporting. A sampling of the broad range of government offices and officials considered (and reconsidered) in light of their landslide work including the coroner's office, the county ombudsman, elected officials and council candidates. Such features span the range of honoring good work done to airing critique of performance.

Stories tying the Oso slide to disaster mitigation appeared regularly. For example, the economic case for mitigation was discussed in "Landslides take a toll on state's economy" on June 19, 2015. There

was regular coverage on specific mitigation recommendations following the slide such as the January 2017 story "New maps, spurred by Oso slide, shed light on hazard areas. Washington's Department of Natural Resources is following through with a key safety recommendation that arose in the aftermath of the Oso mudslide." There was coverage on the work of elected representatives For example, a February 13, 2019 story focuses on state efforts: "State plugs away at mapping landslide-prone areas. The DNR wants to study the area around the Oso slide and similar terrain across the state." A February 14, 2019 story reports on federal deliberations: "Congress considers new program to pinpoint landslide risks." Many mitigation stories referencing the slide focused on current mitigation dilemmas such as a March 2018 story about erosion facing one rural area in the county: "It's Lochsloy vs. the river, and the neighborhood is losing. Landowners don't know where to turn to stop relentless erosion by the Pilchuck River."

In addition to many stories about mitigation, many stories concern questions of accountability. The civil trial that followed the landslide on behalf of victims and survivors was regularly reported on until "the last remaining defendant settled with people who were harmed by the disaster" in October 2016. The Oso slide was linked to other proceedings such as the September 2016 story about a suit in a neighboring county: "Island County settles landslide suit for $1.5 million. Island County commissioners recently settled two lawsuits brought by Central Whidbey homeowners." Other threads of accountability reported on allegations of how aid was used after the Oso slide: "Former Oso pastor accused of pocketing $40k in slide donations" (October 2018). And many evaluated performance and/or covered reforms to government offices such as the May 2017 story: "Mudslide case spurs reform at Attorney General's Office."

Civic Sensemaking

These are but a few examples of the breadth of ways the landslide experience was interpreted and reinterpreted by reporters at the Herald, connecting the landmark landslide to myriad aspects of cultural and civic life. They appraised performance of public figures and entities in light of their performance during the landslide, thus shedding light on places of community strength and places for community improvement. If we can consider the kind of meaning formation we saw in the earliest Tweets about the landslide as "collective sensemaking" than we may conceive of the Herald reporting as a form of sensemaking too—a sensemaking that was incremental, occurring over months and years. As the early sensemaking on Twitter aided mobilization to the Oso emergency, the sensemaking taken on by Herald reporting post-emergency is likely instrumental to collective sensemaking on the long term aftermath of the landslide. Herald journalists persistently followed-up on recovery work pertaining to the slide when it occurred. They also continuously connected the landslide to ongoing concerns that could impact preparedness and mitigation of future disasters. Thus this incremental coverage—which integrated the perspectives and actions of citizens and responders— might be considered to be as a form of *civic sensemaking* – a process that could lead to improved resilience for slide prone communities in the region.

The viewpoints of citizens, responders, and government officials concerning the landslide showed up on the Herald's news site in multiple ways. In addition to what Herald staff reported, citizens and officials sometimes contributed commentary, such as a "Viewpoint" by the state Commissioner of Public Lands that ran near the anniversary: : "Five years in, we're still responding to Oso. Work following the Oso landslide has helped make communities safer and more resilient to disaster." At the time, readers could comment on stories on the Herald's site enabling citizens to reflect and elaborate on stories such as one on replacing Snohomish County's emergency radios that ran in 2018. Future response capability pertaining to radio communication was tied to radio communication performance after the landslide. Within the comments, citizens weighed in on upgrading the 911 system, elaborating on the information in the story. One endorsed the idea of a 911 upgrade. Thus the comment function within the Herald's website was a platform where citizens participated in civic sensemaking as they elaborated and reflected upon Herald stories together.

CONCLUSION

By closely examining several instances where the online work of journalists, responders, and citizens was inter-related, this builds upon and extends Crisis Informatics investigations into the role of traditional media as it relates to the online information work of citizens and responders. These social roles have long been associated with different behaviors and responsibilities after disasters. Crisis Informatics has largely focused on explicating the online activity of citizens and responders (Hughes and Palen, 2018; Reuter and Kaufhold, 2018).

By examining several cases of important information work that took place through social media over time, we have seen that citizens, responders— and journalists respectively contributed to public information about the landslide at different phases of the disaster and recovery. Even as information demands evolved, each group made important contributions. The instances highlighted here were selected for the quality of the resulting information and its potential benefit to the impacted community. In all of these examples, the contributions of citizens, journalists and responders were inter-dependent and inter-related in important ways. The ultimate value to the community can be attributed to their combined efforts.

Social Divergence within Social Convergence: The Distinct Contributions of Different Social Roles

The mass online convergence that directly followed the landslide aligns with long understood sociological patterns of human behavior in disasters where individuals spontaneously converge on the site of a disaster (Fritz and Mathewson, 1957; Kendra and Wachendorf, 2004). Observing that mass convergence extends to online spaces was an early contribution of Crisis Informatics (e.g. Hughes et al, 2008; Palen et al, 2010).

Colloquially, online mass convergence is sometimes been referred to as a "crowd" implying that those within a mass convergence are somewhat interchangeable. Disasters especially are occasions where individuals are inclined to take on tasks they see as important whether they have requisite experience or not. Thus both social roles and organizational roles are often blurred, blended, and extended during mass emergencies (Dynes, 1970; Kreps and Bosworth, 1994). If we looked at other types of social media enabled communication such as expressions of support and community solidarity, we may have found the online work of citizens, journalists, and responders to be largely interchangeable. Focusing instead on key types of information throughout the disaster, we find in these instances the information work done through social media by citizens, responders, and journalists was inter-related and inter-dependent. Yet, the contributions of each were distinct and role-specific. Scannerheads and an eyewitness (citizens) brought the landslide into public view through Twitter posts. When journalists in regional news organizations began to tweet about the landslide, an "information cascade" followed as large numbers of citizens and other media became aware of the event. Yet, they elected to do so in this case *after* response organizations publicly confirmed the event. Likewise, citizens elected to share #530slide posts authored by news organizations and to a lesser degree response organizations. Journalists followed by government sources made up a strong majority of references for the Year 4 version of the Wikipedia page. Yet, social media platforms are not the only venue for community information work following a disaster. The Everett Herald website shows another way that citizens, responders, and journalists collectively engage. From one story to the next, as time passed, new information became available and new events occurred, the landslide was interpreted and reinterpreted in a venue facilitated by the Herald journalists. From such regional news venues as the Herald much information of import made its way onto social media platforms.

Different from pre-internet arrangements, response organizations and other government agencies employed social media to reach the public and vice versa. Yet, in several cases citizens chose

information about the landslide that was mediated by journalists at regional news organizations over government sources. Reflecting pre-internet arrangements, posts by journalists followed by responders were shared more on Twitter than those of citizens and organizational accounts were shared more than those of individuals. There is a similar pattern of sources for the citizen-produced Wikipedia page about the landslide at Year 4. But differing from pre-internet arrangements, citizens actively curated the contributions of journalists and responders, changing the visibility and reach of particular items of information.

Emerging Social Media Influencers: Established Community Institutions

Employing the language of emergency management and disaster studies, Yang et al (2019) found that "emerging" influencers on Twitter after Hurricane Harvey included news media and government agencies. From a Network Studies' point of view the title of "emerging influencers" nicely fits an observable network feature: these users accumulated large number of followers at a very fast rate relative to other users. "Emerging" also relates to disaster management— where formalized communication plans made in advance need to accommodate the inevitably unplanned "emergence" of other actors.

This study finds the same complement of social media influencers through a different set of metrics as Yang et al's study. Journalists and responders show authentic signs of "influence" in network studies parlance, and can be as seen as "emergent". Yet news *organizations* and government *organizations* were more often influential and relied upon sources than individuals for the information work showcased here. Looking at the arrangement of response organizations in the retweet graph of #530slide tweets, one can infer the official communications plan for the Oso Slide.

News organizations associated with the legacy technologies of broadcast and print news were also particularly important. This suggests that established institutional arrangement tied to different kinds of news production that took shape around prior technologies remain important even when social media have overtaken legacy systems. Similarly news organizations within the region— those with longstanding histories of local coverage within the region— were more relied upon than news organizations outside of the region. This suggests that the emergent activity visible on social media would have suffered without institutionally rooted, community rooted contributions.

8

Discussion & Conclusion

Displaced but Not Replaced: Local Journalism, Social Media, & Supporting Crisis-affected Communities

In Chapter 1, I raised the question of the relationship between traditional media and social media in light of a particular crisis response (the Oso Landslide). Understanding how these systems relate to the information work carried out by the crisis-affected a question with many dimensions (Chapter 2). Instead of making a direct comparison between them (done ably by many others already), here, I aim to tie consideration of each to what we know about the information work of the crisis-affected community in this case, and more broadly, what is known among crisis response researchers and practitioners about supporting a crisis-affected community.

By privileging key concepts shared by crisis researchers and emergency management practitioners about how humans respond to disasters, we get a different vantage point by which to evaluate the performance of social media and traditional media. From this vantage point, both traditional media and social media have the potential to work in service to community response. To anchor our consideration of these systems to that vantage point, I will use the term "local crisis infrastructure." In the tradition of Infrastructure Studies— as articulated by scholars in Science and Technology Studies, Information Systems, and Computer Supported Cooperative Work— "infrastructure" points us to a relationship whereby one system "under some description supports another" (Lee and Schmidt, 2018). And most fundamentally, crisis response is about supporting a crisis-affected community.

Supporting Crisis-Affected Communities: Principles from Disaster Experts

First, I briefly review three anchoring concepts from crisis response research and practice that can ground our conception of local crisis infrastructure. Encapsulated in these concepts are several basic considerations for supporting a disaster-affected community.

The Disaster Phase Cycle. Commonly, we conceive of disasters as stand-alone events (Tierney, 2007). Treating them as such is reinforced by the fact that professional emergency management in the U.S. has an intentionally narrow mandate: Professional crisis responders are tasked by the U.S. National Incident Management System (FEMA, 2017) with saving human lives and reducing human causalities. Secondarily, their efforts may also aim to curb property damage during emergencies. The rationale for having emergency management mechanisms singly devoted to human safety is obvious and compelling. However, crisis practitioners and researchers also understand the limitations of this focus. Treating emergencies as stand-alone events can obscure the underlying causes of disasters as

well as the moderating conditions that either increase or decrease the severity of their impact (Tierney, 2007, Watts, 2017). A sole focus on the immediate circumstances of an emergency can, therefore, make us more vulnerable to future hazards. For this reason, crisis practitioners and researchers conceive of the emergency work after a disaster as one phase in an ongoing "Disaster Management Cycle" (e.g. Coetzee and Van Niekerk, 2012). Phases include *Mitigation* of hazards that can lead to disasters; *Preparedness* in light of an impending hazard; *Response* during an imminent emergency; and *Recovery* post-disaster.

Of these, steps taken in Mitigation and Preparedness phases can often have the largest impact on reducing potential harm to humans. For example, building codes designed to mitigate the spread of structural fires are responsible for the decrease in "conflagrations" that regularly engulfed cities prior to standardized building codes (Knowles, 2012). Decisions that can profoundly pivot a hazard from causing either more harm or less harm often occur long before a disaster occurs. If the Snohomish County Planning board had assessed the risk of a potential slide at the slope above the proposed Steelhead Haven development site differently, a landslide likely still would have occurred March 22, 2014, but it may not have been a mass-fatality disaster. Between a landslide with fatalities and one without stands work such as assessing risk, delineating land use zones, developing and enforcing building codes and materials standards, establishing insurance arrangements, among many mundane but ultimately life-saving deeds. It is through such unglamorous, incremental, and sometimes politically contested work that we achieve some of the most profound levers on how vulnerable (or not vulnerable) a particular community will be to a particular hazard (Knowles, 2012).

Unfortunately, in practice, humans don't tend to put much effort into avoiding disasters until *after* a tragedy has struck (Knowles, 2012). Inevitably, the disaster "event" is a flexion point motivating the assessment of past practices and a willingness to take new actions.[20] In this case, the Oso Landslide motivated a rethinking of landslide hazards in the Pacific Northwest and beyond. A partial list of the follow-up information work included many scientific, engineering and civic reviews of what occurred at the slide location. More broadly, it spurred wider interest and investment in the science and engineering behind landslide risk assessment and an uptake in interest in new paths for mitigation such as sensor-based alerting systems. These techno-scientific questions were enfolded within emotionally and politically sensitive questions, such as whether any individuals or entities were responsible for the landslide, whether the planning board should have allowed building at the site, and whether response resources were used properly. As is often the case, some long term recovery questions needed to be answered immediately such as how and where to rebuild State Highway 530. Answers to other questions are still unfolding years later.

Such information work is no less important to a crisis-affected community than the information needed with immediacy in an emergency. Thus, in considering how to support the information work of a crisis-affected community, we need to think well beyond the immediate emergency, broadening our scope to long before and long after the initial crisis (Soden and Palen, 2018; Tierney, 2007; Watts, 2017).

"Communities are the first responders." Among response practitioners, this workhorse phrase encapsulates several facts about disaster response. First, the bulk of response work is taken on by the impacted communities themselves (Dynes, 1970). Even in small-scale incidents such as car accidents,

[20] Though this process is regrettable in many ways, it is in this manner that places such as the U.S. mainland have seen increasingly frequent and more intense weather hazards (the most common cause of disaster), yet human casualties per event have gone down over time. See Knowles, 2012.

it is rare for professional responders to be first on scene. For large scale crises, the work of professional responders, though vitally important, is a relatively small part of the overall effort. Mass emergencies are typically characterized by "social convergence" (Fritz and Mathewson, 1957; Kendra and Wachendorf, 2004) whereby many social types engage in response related activity. During these times, individuals often take on novel (to them) response work and novel (to them) collaborations (Dynes, 1970; Kreps and Bosworth, 1994). Likewise, during emergencies, organizational missions are often extended and work boundaries blurred to meet the needs of the moment (Dynes, 1970; Kreps and Bosworth, 1994).

Formal crisis response takes its shape around these social facts of disaster. The U.S. National Incident Management System (NIMS) is designed (if imperfectly so) to empower affected communities to make decisions about the response. NIMS envisions formal disaster response as bottom-up. When a community's response systems become overwhelmed, they can request assistance from neighboring municipalities or counties. If those entities become overwhelmed, they can request state resources. The state may, as in this case, request federal support. In this way, formal response is aligned with and builds upon what is known of social behavior in emergencies.

After the emergency period, local decision makers are largely left with the ongoing work of preventing the next disaster and addressing long term recovery issues. In the case of the Oso Landslide, matters such as how to rebuild, how to mitigate future landslides, and determining causal factors of the landslide were integrally tied to local governance processes. In this sense, communities are also the last responders, addressing follow-on work from a disaster for years, even decades, afterwards.

"All disasters are local." A corollary to "Communities are the first responders." is that "All disasters are local", meaning the bulk of the response work will happen in the vicinity of the disaster. As with so much of human behavior, proximity strongly correlates with response work (Dynes, 1970). The further the distance, the less engagement there tends to be. This applies broadly to both formal and informal response efforts.

Social media seem to have softened this adage. Virtual assistance and expressions of support motivated by "emotional proximity" to a disaster are now common even when distance between actors is great (Huang et al, 2015). Social media have led to whole new forms of aid administered by new kinds of digitally-enabled actors such as digital humanitarians and crisis mappers (as in Chapter 4). Yet, the focus of remote efforts remains fixed on helping those in the affected area.

From these two adages ("Communities are the first responders" and "All disasters are local"), several key aspects of the nature of information work supporting a disaster-affected community follow. To sum, the affected community's information work in an emergency will be intensive. Even for small scale emergencies, citizens and emergency professionals alike are often both producers and consumers of key crisis information. From the point of view of those participating, important information work will result from working in atypical and sometimes novel social arrangements. As crises grow in scale, so too does the scale and range of information work as external supporters (both formal and informal) work to support the affected community. After a crisis, community information work will continue long afterwards. Effective long term recovery and mitigation requires the successful integration of techno-scientific information (e.g. assessing future risk) along with politically contentious information (e.g. re-zoning) into local decision-making processes.

Supporting Community In the Immediate Aftermath

Social Media Systems: Flexible Support during Crises. As described in Chapter 5, social media performed remarkably well as local crisis infrastructure in the immediate aftermath of the landslide. Surviving family members, community volunteers, government officials, responders, and journalists,

among others, made use of social media, integrating them into many vital and varied forms of information work addressing the crisis. In some cases, such as communication between journalists and responders, social media systems were the primary means for information to flow. In others, such as the semi-private communication among community members in Darrington via Facebook, they served as an important complement to other modes of communication—extending discussion and reflection that took place in face-to-face community meetings.

Several attributes of social media systems afforded the support of local information work apparent directly after the Oso Landslide. Vertesi poses that we get work done in "heterogeneous multi-infrastructural environments" in which we, ourselves, stitch together temporary alignments between heterogeneous infrastructures (2014). As "stitching technologies" social media readily enabled what Vertesi describes and in doing so performed particularly well at supporting the information work of the affected community. Many dynamic and temporary alignments of information resources were forged through these systems. Individuals were able bring a wide range of resources to bear upon their information. They initiated novel collaborations. Through social media, they selectively engaged in information work privately, semi-privately, and publicly. As needed, they readily engaged within their own social roles (e.g. private Facebook messages between affected community members) and across social roles (journalists and responders via Twitter). To sum, social media systems were well aligned with the information work people needed to do during the emergency and how they chose to go about that work. The ability to support emergency-phase crisis work in this way makes the uptake of social media systems during emergencies seems almost inevitable.

Bringing Value in an Emergency: Citizens, Responders— and Journalists

Yet the flexibility of these arrangements is not without form. By distinguishing the respective contributions of citizens, responders and journalists, it becomes clear that each group made distinctive contributions in important cases. Echoing many early Crisis Informatics studies that established social media platforms as important sites of emergency information work (e.g. Vieweg et al, 2008), in the first hours after the landslide, we saw citizens, responders, and journalists collectively piecing together an understanding of the event, raising awareness across the community, and amplifying particular kinds of information they saw of value. Contemporaneously, publicly visible posts from regional responders and "scannerhead" citizens confirmed and elaborated eyewitness citizen accounts from on scene, quickly leading to the impression that the landslide was a major emergency. Apprised of these posts, in short succession, regional journalists alerted their large follower bases, thus rapidly raising awareness of the emergency within the local community and, for better and worse, worldwide. As news spread in the days that followed, digital humanitarians working from afar amplified information they deemed beneficial to the community. It was in this way social media systems strongly supported raising awareness of the event in the early emergency period and aided response. In such cases, the respective contributions between citizens, responders, and journalists appear to be at least partly interdependent and not fully interchangeable.

Overall, the information work performed through social media during the emergency and response phases of this case align well with the Crisis Informatics uber-narratives pertaining to pro-social social media activity post-crises. Both citizens and responders made ample use of social media after the Oso Landslide, in many cases, to good effect. Therefore, this study supports the assertion made many times by Crisis Informatics scholars (e.g. Palen and Hughes, 2018; Reuter and Kaufhold, 2018) that social media are important venues for citizen-responder interaction. At the same time, this study shows that, at least in some cases, what may appear to be "direct" and "unmediated" citizen-responder interaction may, in fact, be mediated by journalists. The clearest example of this is the use of the event-specific Twitter hashtag #530slide. Proposed by the formal response and used by them through the response as a matter of protocol, content associated with the hashtag was largely timely and informative. #530slide tweets were shared by nearly twenty thousand unique users in the first three weeks after the landslide—most of those shares were by citizens. Yet, a closer look revealed

that journalists working in regional news organizations were very instrumental mediators in these citizen-responder interactions. It is true that many tweets by the response were directly retweeted by citizens. We might view those shares as examples of "unmediated" and "direct" interaction between citizens and responders[21]. But when all of the activity around the hashtag is examined, unmediated citizen-responder tweets are a smaller portion of the overall activity. More than 10% of those using the hashtag were journalists. The organizational accounts of regional TV news organizations were retweeted more than any of the official response accounts because more citizens elected to share #530slide tweets that came through news organizations than those of the response.

Likewise, when we look at information activity beyond social media, through interviews with affected community members and those who supported them, we learned that no two interviewees relied on exactly the same set of information sources or information channels. Yet the common resources across them were regional news organizations with ties to broadcast and print. Together these different lines of evidence suggest that journalists working within traditional regional news organizations continued to play an important role in mediating citizen-responder interactions during the emergency.

Supporting Long term Recovery and Future Mitigation: Local Journalists as Civic Watchdogs

Harkening calls to extend Crisis Informatics research beyond the response phase (e.g. Soden and Palen, 2018; Tierney, 2007), this study examined five years of social media activity following a single event. Post-emergency, information about the landslide continued to proliferate, and citizens, journalists and responders continued to be implicated in the information that circulated.

Citizen editors curated what is arguably the most important digital artifact about the landslide, Wikipedia's *2014 Oso mudslide* page. Yet, to do so, per Wikipedia standards,[22] they relied up on "verifiable reliable sources". Wikipedia's guidelines point specifically to journalists and news organizations as examples of verifiable reliable sources. At year four, most of the page was curated from stories produced by traditional journalistic news organizations with ties to print and broadcast, predominantly the largest circulation newspaper in the region, The Seattle Times.

Bruns (2003) argues that in the digital age news media are no longer information "gatekeepers" but rather they are "gatewatchers." Regional news organizations such as the Everett Herald were vigilant watchers from moments after the disaster well into long term recovery. But watching is too passive a word for the contributions of regional journalists. Regional news organizations continuously published information of potential value to the affected public from directly after the landslide through long term recovery. Major regional news outlets, and particularly, the "most local" newspaper, The Everett Herald, brought forth thousands of unique stories about the disaster. These were revisited, elaborated upon, and connected to other relevant community issues. This important intellectual work of integrating the landside experience into current public concerns was sited within traditional regional news organizations. Their ongoing efforts were arguably instrumental to long term *civic sensemaking* within the impacted community and their slide-prone neighbors.

[21] Of course these interactions are mediated by social media platform providers, network service providers, et al.

[22] https://en.wikipedia.org/wiki/Wikipedia:Verifiability#What_counts_as_a_reliable_source

Post-emergency information work is understood to be important to long term community resilience (Soden and Palen, 2018) and interventions upon information systems should take into consideration how post-emergency information is produced and made public (ibid). In this case, we find that regional news organizations were instrumental to post-emergency information. Some of that information makes its way onto social media. Therefore, when we consider how social media systems may be improved to better serve crisis-affected communities, we should consider improvements in relation to the contributions of regional news organizations both during an emergency and afterward.

Traditional Media: Displaced But Not Replaced

Both traditional media and social media have changed over the course of this study and will continue to do so. Since this study began in 2015, public concern over the role social media systems are playing in our lives has grown, and they are increasingly eyed as objects for intervention. At the same time, traditional media remains the focus of a string of interventions, largely unsuccessful so far, meant to prop up an industry that has been in financial freefall for the last two decades.

Inductive investigations such as this one can help to identify the elements of these systems that support prosocial information work and therefore help inform potential interventions. Those identifiably valuable elements are candidate constituents for future infrastructure (Soden and Palen, 2016). That is, when we deliberate what should be changed about these systems (what should they enable and support?), we will do best if we understand how they have worked (what have they enabled and supported?). Informed by core commitments of disaster response— which views the affected community at the center of a disaster as the central object for support— we now consider a few ways that these findings speak to the future of "local crisis infrastructure."

Even as concerns about their influence grow, social media are shaping our understanding of contemporary crises. As illustrated many times over (e.g. Palen and Hughes, 2018; Reuter and Kaufhold, 2018), this case study found social media supported the crisis-affected community in a number of important ways. Yet, the capacity of social media systems to support the affected community in this study appeared, in several important instances, to be attributable in some part to the contributions of journalists.

The fact that regional journalists may be continuing to shoulder certain kinds of information work of value to an impacted community deserves to be highlighted. "The crisis in journalism" wherein traditional news organizations continue a decades-long trend of slimming back and closing up, impacts the ability of news organizations to do journalism in crises. The devolution of local newsrooms may, in turn, impact the success of long term recovery.

Already in 2012 Hughes and Palen's study of the changing role of Public Information Officers in Colorado, interviewees reported that journalists in their region could no longer be counted on as reliable partners for getting information to the public. In contrast to days past, when PIOs and "beat" reporters cultivated personal relationships that facilitated smooth collaboration during emergencies, PIOs in Hughes and Palen's study bemoaned that newsrooms in their area no longer maintained staff levels that enabled those kind of relationships. The remaining staff were over-taxed and therefore unreliable partners. Those PIOs felt compelled to take a larger role in communicating with the public. They felt pressure to fill the gaps left by shrinking newsrooms, and viewed social media as a means of doing so. But the question remains open: who or what can take on the work formerly done by journalists?

Can citizens replace journalists? Shown here and elsewhere, citizens do important work through social media. Individually (e.g Andén-Papadopoulos and Pantti, 2013) and collectively in coordinated volunteer efforts they perform valuable information tasks that overlap with the work of professional journalists (e.g Norris, 2017). Yet, the early prediction of social media becoming a tool for "the

people formerly known as the audience" to replace traditional journalism has not been fully borne out (Bruns, 2016). Though volunteer-based *citizen journalists* and community media were important contributors to the information space around the Oso Landslide these efforts took place against a backdrop of ongoing sustained production of *civic information* produced in regional news organizations. All of these efforts can be seen as supporting informed civic decision-making in the affected community. Yet, according to the findings of this study, it seems unlikely that the work of citizens could replace that of journalists in regional news organizations.

Stepping back from this case study, it is hard to quantify how different communities may be differentially impacted by the shifts taking place in how we get information (Napoli et al, 2019). Muse Abernathy (2018) claims hundreds of U.S. communities are now "news deserts" while thousands more have "ghost newspapers" so resource-constrained they are incapable of functionally serving their community. Perhaps contradicting the theory that citizens can replace traditional journalists, several studies have found an uneven geographic distribution of user-generated content across several social media sites (Gilbert et al, 2010; Gilbert et al, 2008; Hecht and Stephens, 2014; Johnson et al, 2016a; Johnson et al, 2016b). Likewise, the capacity for local emergency management to engage the public varies according to locality (Plotnick et al, 2015). More work needs to be done to knit these lines of evidence together. The findings of this case study suggest that effective community information work is more likely to be the product of synergistic and complementary information work by citizens, responders, and journalists than it is to result from the work of one of these groups alone. It follows then, that it is at least as plausible that the same places that are news deserts may also suffer from a lack of quality user-generated content and/or effective public emergency management communication as it is plausible that citizens or responders can take on information functions formerly taken on by journalists.

On the outskirts of one of the wealthier US metropolitan areas, the Oso Landslide demonstrated a more robust showing by regional news organizations, national media, and every other type of media than may have occurred in other places in the United States, to say nothing of outside of it. Compared to other regional media ecosystems, the region around the landslide was (and is) in better shape. Even so, the devolution of local newsrooms is happening even in this relatively affluent region. The two newsrooms that produced the most civic information stories about the Oso Landslide over the long term, the Everett Herald and the Seattle Times, have both shed jobs since the landslide. Attrition of regional newsroom jobs is certainly a contributing factor to the devolution of regional news organizations' ability to support crisis-affected communities (as described by Hughes and Palen, 2012). With each newsroom layoff, the question looms larger: Will regional news organizations be less prepared and capable to cover the next slide? Will they be able to do the kind of continuous reporting that aids civic sensemaking between disasters— integrating lessons learned into opportunities for improving disaster mitigation and preparedness? Will they have the resources to continually hold accountable elected officials, government and aid agencies, and others in relation to their performance when the next disaster hits?

This dissertation upholds the importance of contemporary response organizations having the capability to proactively engage citizens through social media. At the same time, it shows that in several important cases, regional journalists were instrumental information intermediaries between citizens and responders. Their role doing so was visible in some cases, less so in others. In a few cases during field work that brought me in touch with responders and social media company representatives, I was surprised to occasionally hear the assertion that social media is a way for crisis responders to circumvent traditional media. In a narrow sense, this is true. In a broader sense, it is problematic. The findings of this study concur with many others suggesting that a proactive ability to communicate with the public via social media is beneficial to the affected community. This study also raises questions about whether regional traditional media may have an indirect influence on what appear to be unmediated citizen-responder interactions during the emergency and response phases.

Social media companies have an incentive to downplay the role that professional content producers such as news organizations play in their ecosystems because raising the visibility of their contributions may lead to pressure to share revenue or calls for other structural changes to the industry. The metadata that social media companies most readily provide to emergency managers, independent researchers, and others do not make it easy to get a definitive determination of where valuable content is being produced in these systems or who might be doing important intermediation work. We need a better accounting of what kind of intermediation work is occurring around citizen-responder interactions on social media before we can understand the (potentially negative) impact of having response organizations fill gaps left by news organizations.

Short of funding civic journalism, it is difficult to imagine how government functionaries could take on the role of civic watchdog for long term recovery and future mitigation information. How could a government functionary also be a civic watchdog? Certainly, other countries arrange things this way, but that would be a big change for our U.S. system of governance where "the press" is constitutionally recognized as independent of government. As local newsrooms continue to decline, gaps in the availability of civic information are likely to grow.

The evidence from the public digital record after the Oso Landslide suggests that filling the role occupied by better resourced regional journalists is a bigger task than expanding the role of Public Information Officer, citizen, or some new category of information worker. For in that record, the entire journalism industry is represented: press agencies, professional associations, trauma services for journalists, digital-only and digital-first news outlets, and high-school and college student-journalists and their professors, to name a few. Present are long-established print and broadcast networks from several countries, the shows they produce, their on-air talent, their camera operators, producers, even the journalists driving the news vans. The fact that we see outsize contributions from regional news organizations with ties to print and broadcast suggests that there is something about these legacy arrangements that is difficult to offload onto other actors or alternative arrangements.

One path being explored to improve emergency response is to create computational and analytic tools that can handle the "data deluge" (Cobb et al, 2014) of social media. Where such big social data analytic tools are integrated and who gets to use them are important considerations that should inform the future of local crisis infrastructure. Social media companies are under increasing pressure to better respond to crises, which they hope to do with as much automation and context-independent, scalable solutions as possible. There is much ongoing academic research in pursuit of creating automated tools to detect and understand crisis-affected communities. And there is a growing industry of social media analytics companies selling their services to all levels of government. Though some of these tools can be beneficial, it is probably imprudent to think of them as replacing information intermediaries that have strong ties to local communities and those embedded within them. As shown in Chapter 6, social media are an imperfect lens into the information work of crisis-affected communities. Aspects of local culture important to the community discussed by interviewees were often not directly visible in the digital record. For practical reasons in some cases and out of a desire for privacy in others, some community resources, response work, and discussion of sensitive topics were largely absent from the social media record.

Local information intermediaries such as regional journalists, who are in regular contact with a community on an ongoing basis are at an advantage in terms of understanding how social media activity may not reflect the whole community. There are many legitimate reasons why community members may not need, want, or be capable of disclosing information publicly on social media after a crisis. Being part of the community, local journalists may also be sensitive to, for example, when the absence of visible online activity is due to a desire (or need) among the community for privacy.

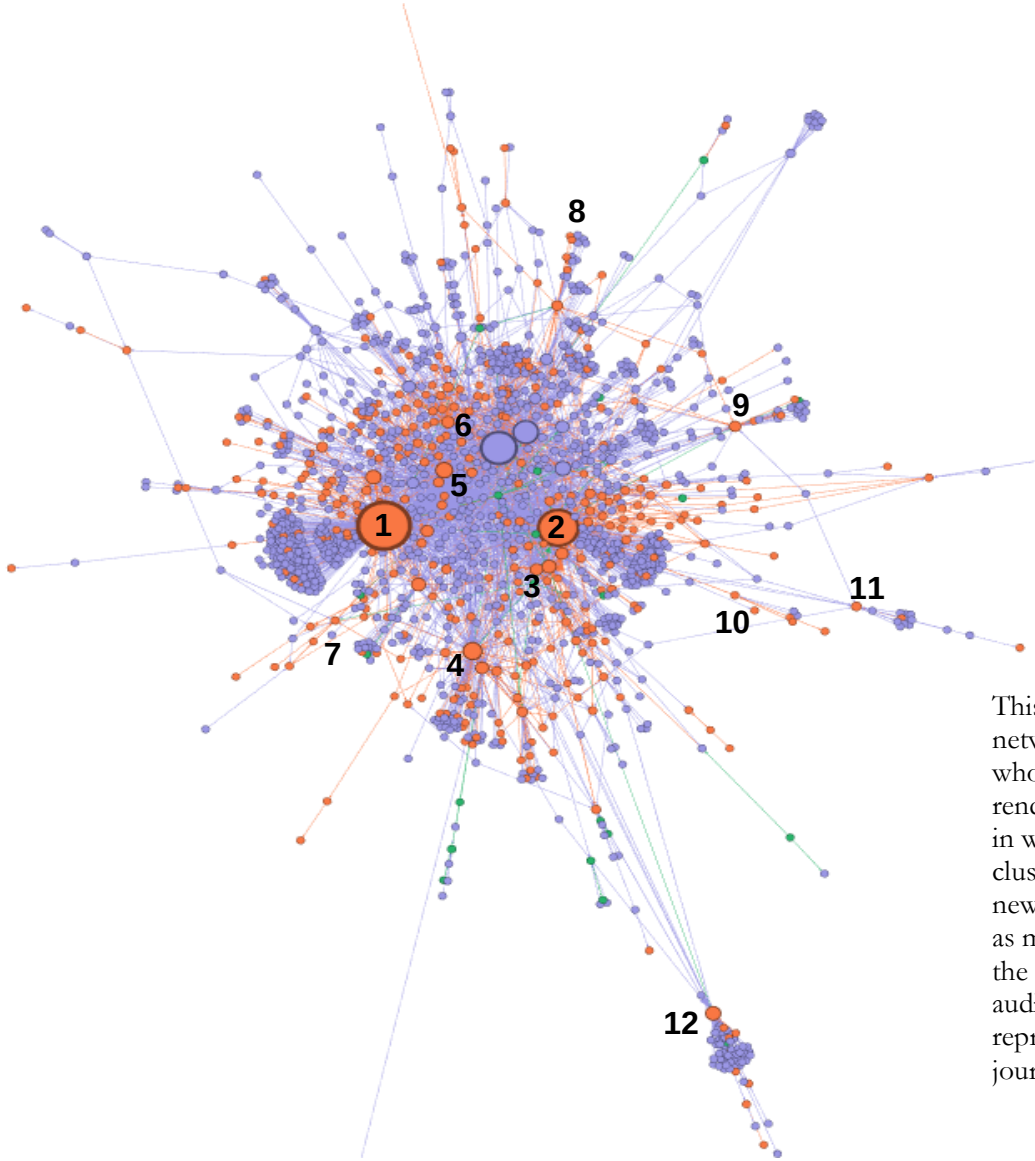
Any large-scale social media solutions being designed independently from community-situated information intermediaries are, as we have seen in this case study, probably relying upon them indirectly by virtue of the fact that news and response organizations are disproportionately influential in social media after crises. There are questions of equity for social media companies and others who capitalize on the work of regional organizations without contributing to resourcing the local journalism they are relying upon. But if such systems exclude the work of local journalists in their systems, they risk making decisions about crisis-affected communities in absence of awareness of the civic sensemaking process happening in the community.

In short, my conclusion from this study is that though social media are incredibly powerful platforms for public crisis information, they are not a substitute for local civic journalism. Local journalists are skilled information intermediaries who have a long term commitment to a particular community. Off-loading an understanding of crisis-affected communities to external actors such as the remote content moderators that work behind the scenes at Facebook and elsewhere likely has limited value to crisis-affected communities and may, in fact, create new vulnerabilities. Even well intentioned efforts to automate or otherwise scale up local news about crises in absentia of information intermediaries working within those communities could shift power and agency for civic sensemaking, and therefore civic decision making, out of crisis-affected communities

The kinds of civic information that follow from a disaster have never been cheap or easy to produce. The intermediation work is hard to do well. It takes considerable commitment and resources over an extended period of time. Part of that work is having an empathic sensitivity to community sensibilities, needs, and culture. Of all the social and technical arrangements possible in today's digitally networked world, a much smaller subset of arrangements lead to a combination of attributes that support long term information work of crisis-affected communities.

Appendix

Journalist Networks in the #530slide Conversation



Twitter Handle	Affiliation
1. @KING5Seattle	NBC affiliate, Seattle, WA
2. @komonews	ABC affiliate, Seattle, WA
3. @EverettHerald	County newspaper ("most local")
4. @seattletimes	Regional newspaper
5. @KIRO7Seattle	CBS affiliate, Seattle, WA
6. @Q13FOX	Fox subsidiary, Seattle, WA
7. Various	Regional radio stations
8. @KATUNews	ABC affiliate, Portland, OR
9. @realtimwilliams	Content mgr. CBS Pittsburgh, PA
10. @CTVNorma	Canadian TV, Vancouver, BC
11. @EdJoyce	Public Radio KPCC Pasadena, CA
12. @AC360	CNN TV show based in New York

This a different rendering of the same set of #530slide tweets shown in the network graph in Chapter 7. This in-degree graph, likewise, shows users who were retweeted two or more times during the first week. In this rendering, we can see several networks of journalists (orange) were involved in widely diffusing #530slide information. The rectangles approximate clusters of journalists affiliated with particular news organizations. Regional news organizations and journalists associated with them (1 – 7) can be seen as more integral to the #530slide conversation. Whereas, media outside of the region (e.g. 8 - 12) were at the periphery, informing more external audiences. "Non-journalists" are represented in purple. Nodes in green represent users that required additional analytic steps to designate as either journalist or non-journalist.

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IMAGE

Reid, Mark. (2014). *2014 Landslide in Washington State*. Aerial photo showing the full extent of the 2014 landslide area taken from the east. The damned river and flooded houses are visible in the foreground. The debris in the center covers the former Steelhead Haven neighborhood. *USGS Website*.