

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

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crisis response, both formal and informal. Following observations and forecasts by early crisis informatics scholars [30,32], social media and other networked ICTs are now consistently appropriated by citizens, journalists and responders for sharing information [31], monitoring for situational awareness [48,51], organizing response efforts [43,48] 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 [37]. 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 [9,20,38]. 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 [37]. It turns our attention to a socio-technical system's value to users: They rely on it to perform work. Soden and Palen [41] 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 [41].

It is through the (often temporary) alignment of multiple infrastructures that information work gets done [47]. In this paper, we use the analytical language proposed by Vertesi [47] as a lens to explore multiple perspectives on social media use in a recent disaster. Social media have been described as "stitching" technologies [3,7] 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 [13, 14, 16, 21, 22] 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 [39]. Social media have influenced the way that government responders [18], journalists [7], and the public respond to crisis [39]. Further, they have enabled entirely new communities of practice including digital humanitarians [34], Virtual Operation Support Teams [10], and crisis mappers [42].

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 reforming, 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 [42] 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 [39]. As “stitching technologies” [3,8], 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 [40,52]. 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* [2,4,5,25,28] 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 Seamy 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 [36]. 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 [11]. Social media have been shown to stitch together the actions complementary sets of actors during crises including citizens and responders [10], remote and local citizens [50], and journalists and citizens [7,19].

Though we might expect that working in a multi-infrastructural context would multiply the issue of the “socio-technical gap” [1], Vertesi [47] 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 [6,49], 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” [47].

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 [17] with a trace ethnography [12] 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 [13,14,16, 21,22]. Therefore inferences about rural populations based exclusively on social media data may be subject to “urban bias” [16]. 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 [35]), 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 publically 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 [8] 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 [29]. 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 [44], 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 [39] propose, that access to heterogeneous sources of aid is a measure of community resilience, then the publically 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 [26]), we found several community members who were busy with response efforts intentionally restricted their communication channels and contacts [8].

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. [23] and [44]), 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 colleague’s, 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 [45], 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” [24,33] 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 [40] and Zhao et al [52], 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 seamless. 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 [18,27]. The strategy of integration described above at the State Emergency Operations Center is similar to that described by Tapia and Moore [46]. The TweetDeck in the alerts monitoring room represents one of the “pockets of use” [46] 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 [46].” 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 [11], 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 dammed 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 Friend 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 [52]. 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 [18] is still being pushed by social media usage patterns that are themselves still changing [52]. 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” [15] 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 [52], 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. Its 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-infrastructure 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 [24,33]. 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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