Journalists as Crowdsourcerers: Responding to Crisis by Reporting with a Crowd

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Abstract. Widespread adoption of new information communication technologies (ICTs) is disrupting traditional models of news production and distribution. In this rapidly changing media landscape, the role of the journalist is evolving. Our research examines how professional journalists within a rural community impacted by Hurricane Irene successfully negotiated a new role for themselves, transforming their journalistic practice to serve in a new capacity as leaders of an online volunteer community. We describe an emergent organization of media professionals, citizen journalists, online volunteers, and collaborating journalistic institutions that provided real-time event coverage. In this rural context, where communications infrastructure is relatively uneven, this ad hoc effort bridged gaps in ICT infrastructure to unite its audience. In this paper, we introduce a new perspective for characterizing these information-sharing activities: the "human powered mesh network" extends the concept of a mesh network to include human actors in the movement of information. Our analysis shows how journalists played a key role in this network, and facilitated the movement of information to those who needed it. These findings also note a contrast between how HCI researchers are designing crowdsourcing platforms for news production and how crowdsourcing efforts are forming during disaster events, suggesting an alternative approach to designing for emergent collaborations in this context.

Key words: Crisis informatics, crowdsourcing, crowd work, digital volunteerism, online communities, open journalism, participatory journalism, social computing, social media, infrastructure

1. Introduction

Information communication technology (ICT) is transforming the ecosystem of emergency response, changing not only *how* things are done, but also *what* kinds of tasks are necessary and *who* does them. Social media activity, in particular, is disrupting existing practices around emergency and humanitarian response (American Red Cross, 2011; Harvard Humanitarian Initiative, 2011; Hughes & Palen, 2012). In recent years, social media tools (e.g. Facebook and Twitter) have experienced rapid uptake by citizens all over the world. During large-scale emergencies, users turn to these platforms to share information with

others and to seek information for themselves (see e.g., Palen & Liu, 2007; Sutton et al., 2008; Shklovski et al., 2008; Qu et al., 2009). Armed in many cases with mobile devices, citizens are newly enabled to report information via social media platforms from the ground during disasters, contributing a potentially valuable new information source for other affected people as well as formal responders (Palen et al., 2010). Social media sites have also become places where a converging audience assembles to help make sense of this information (e.g. Vieweg et al., 2008; Qu et al., 2009; Heverin & Zach, 2012) and are consequently playing host to new forms of disaster volunteerism (Starbird & Palen, 2011). Responders are finding that these tools provide new opportunities for outgoing crisis communications as well (Hughes & Palen, 2012).

This rapid change to the information-communication landscape of disaster response is putting pressure on relationships between traditional stakeholders. Hughes and Palen (2012) discuss the evolving role of public information officers (PIOs)—and emergency managers more broadly—as these traditional response professionals adapt to the new information-sharing behaviors of a connected audience.

This disruption is not limited to emergency response. The field of journalism is also experiencing rapid change as it, too, adjusts to a new paradigm that includes citizens as producers as well as consumers of information. The citizen journalism phenomenon (Gillmor, 2006) and the emerging concept of open journalism (Lewis, 2011) are products of this transformation. This paper focuses on the evolving role of journalists during crisis events, examining how practitioners in this field are adopting new tools and adapting existing work practices in response to changed and changing conditions.

Here we examine this evolving role by describing the activities of journalists, as well as other community members and the remote audience, during the early response period of Hurricane Irene in the Catskill Mountains of New York, an area that experienced widespread and in some places catastrophic flooding in the storm's aftermath. Homes, bridges, and even an entire town washed away (Rosenberg & Applebome, 2011).

Our research reveals how a group of individuals came together to provide vital information resources and coordinate community-based relief efforts during this event. This emergent community helped to collate, filter, verify, and broadcast information during Irene, using a combination of available ICTs and a network of social connections to bridge gaps in both event coverage and information access. This research seeks to understand how this online community emerged and evolved during the course of the event, focusing both on the technical infrastructure (Star & Ruhleder, 1996) and human infrastructure (Lee et al., 2006) that shaped it. More specifically, we examine the role that a small number of journalists played in helping to catalyze, organize, maintain and promote this effort. This research points the way towards new roles and responsibilities for journalists in the changing information space of disaster response and offers design implications for those seeking to build systems to support crowdsourcing efforts and other online collaborations during disasters.

2. Background

2.1 Social Media Use during Crisis: Enabling New Forms of Participation

Social media are enabling new forms of public participation during disaster events. Studies show that in the wake of crisis events members of the public turn to social media to seek and share information (e.g. Palen & Liu, 2007; Sutton et al., 2008; Qu et al., 2009; Palen et al., 2010). An important aspect of these behaviors, related to the phenomenon of citizen reporting (Gillmor, 2006), is the newfound ability for those at the scene of disaster events to share information about conditions on the ground. These eyewitness reports, broadcast over social media, have the potential to improve situational awareness for responders and other affected individuals, helping them to make better decisions (Sutton et al., 2008; Palen et al., 2010). Additionally, just as spontaneous volunteers and others have responded physically to disaster events in past, remote individuals are now converging onto the digital scene of disasters—using

social media (Hughes et al., 2008). Hughes et al. (2008) explain that digital convergers arrive with a range of motivations, from watchers and supporters to helpers and exploiters.

These new forms of participation are transforming emergency response (Palen et al., 2010). Emergency responders face new expectations (Hughes & Palen, 2012)—e.g. that citizens will be heard through these channels and that responders will interact with them there (Latonero & Shklovski, 2011); and that response agencies will be able to keep pace with real-time information sharing (personal communication, Jim Aleski, emergency manager).

2.1.1 Disrupting Traditional Roles in Journalism

Journalists and news outlets have been under pressure to accommodate changing dynamics related to the information-seeking and information-sharing behaviors of a connected audience (Siapera & Veglis, 2012). These conditions have contributed to an institutional crisis in the field with many traditional news outlets closing or scaling back coverage, and this trend has been accompanied by an identity crisis for journalists (Dueze, 2005) with some viewing the rise of the "citizen journalist" (Gillmor, 2006) as a potential rival or even replacement for the professional (Rosen, 2008), culminating in a notion that journalism can take place without a journalist—"journalism as doing" as opposed to "journalism as being" (Lewis, 2011).

The challenge of meeting changing audience demands has led to much experimentation and innovation both within traditional news outlets (Paullsson & Ugille, 2008; Paullsson et al, 2007) and among "news innovators" (Lewis, 2011) who embrace a complementary role for the public within "participatory journalism" (Nip, 2006). One perspective positions journalists as gatekeepers for information contributed by the crowd (Shoemaker & Vos, 2009). Expanding from this, Bruns (2008) describes the journalists' role as shifting from "gatekeeping" to "gatewatching." Barzilai-Nahon (2008) theorizes several possible of arrangements of "networked gatekeeping" which might better describe the interactions within an online crowd (Meraz & Papacharissi, 2013)

2.1.2 Enabling New Online Forms of Emergent Organizing

Social media are also extending forms of *emergent organizing*, a common occurrence in the aftermath of crisis events, where people come together and begin to improvise in the gaps of formal emergency response efforts (Dynes, 1970; Kendra & Wachtendorf, 2003). Social media users can be seen appropriating these platforms to provide assistance, often coming together to help shape the information space through filtering, verifying, synthesizing, and other forms of information curation (Starbird & Palen, 2011). Vieweg et al. (2008) described collective action organized through Facebook in the aftermath of the Virginia Tech shootings. Qu et al. (2009) looked at the use of an online forum to share information and coordinate action after the 2008 Sichuan earthquake. Starbird & Palen (2011) studied an emergent organization of crisis volunteers who used Twitter to assist after the 2010 Haiti earthquake, framing this activity as a form of *digital volunteerism*.

This form of crowd work has also been characterized as *crowdsourcing* (Harvard Humanitarian Initiative, 2011), a term coined by Howe (2006) to describe a connected crowd using online tools and systems to solve problems. In crisis contexts, crowdsourcing can support real-time problem solving as a crisis unfolds, such as the crowdsourced Ushahidi map that was deployed after the Haiti earthquake (Meier, 2010; Zook et al., 2010) and similar efforts that have taken place during several subsequent events (Gao, 2011). Crowdsourcing, digital volunteerism and emergent online collaborations are rapidly becoming established features of crisis events.

2.2 Focus on the Role of Human Infrastructure in Emergent Collaborations

In this paper, we employ Star & Ruhleder's concept of *infrastructure* (1996) and the Lee et al. (2006) extension of that concept to *human infrastructure* to frame our examination of an emergent online collaboration that took shape in response to major crisis in a small, rural community. Lee et al. (2006) use

the term "human infrastructure" to characterize a research orientation that focuses on the human and social structures that constitute collaborations. Their view builds upon the work of Star & Ruhleder (1996), which critically examined the nature and function of infrastructure in an organization. Extending this concept to include the work that people do within these collaborations, Lee et al. (2006) describe how human infrastructure is integrated into what they call "artifactual" infrastructures, which include the systems and technologies that we typically associate with the term *infrastructure*. Noting its fluid and procedural nature, Star & Ruhleder (1996) suggest that we look at infrastructure not as a noun, but as a verb—as in *to infrastructure*. Following this view, Lee et al. (2006) describe human infrastructure as even more dynamic than artifactual infrastructure, constantly being reshaped through a recursive process of action and adaptation. The concept of human infrastructure and the procedural nature of *infrastructuring* (Star & Ruhleder, 1996) provide a productive frame for examining the emergent collaboration described in this paper and for highlighting the role that journalists played within it.

2.3 Event Background: Hurricane Irene's Impact in the Catskills

In late August 2011, Hurricane Irene impacted communities from the Caribbean to Canada causing 67 fatalities and 15.8 billion dollars in damage (Associated Press, 2012). Though downgraded to a tropical storm before reaching the northeast U.S., six states there reported 100-year flooding. Less than a week later, Tropical Storm Lee made its way to New York exacerbating flood impacts and spreading the official disaster area. Together, the two storms damaged 38 of New York's 62 counties causing wind damage, flooding, or both (New York Office of the Governor, 2012) Combined the storms are the state's largest natural disaster and second costliest after Sandy.

Flooding was particularly severe in the Catskill region where 500-year flood conditions were reported (Jonsson, 2011) causing record damage in four of the five Catskill counties. Located about 100 miles north west of New York City, the Catskills is a rural mountainous area. Its ICT infrastructure is variable. In August of 2011, the only communication or telecommunication infrastructure that reached all areas of the Catskills was landline phone service, while some areas lacked cell service and other lacked Internet service. Additionally, no single traditional news outlet reached or covered all areas of the Catskills, leaving many rural areas rarely covered.

A portion of the Catskills is by some metrics the wettest place in New York State, a title that has remained consistent as the state has become progressively wetter since the 1960s. Since the 1990s, the Catskills have experienced several severe flooding events with minor flooding occurring on a regular basis. While Hurricane Irene caused damage throughout, the meeting point of four counties was intensely impacted by major flooding. The 249-year-old town of Prattsville was described as "nearly wiped off the map" and a number of villages and hamlets were cut off by infrastructure damage (Quigley & Durante, 2011). Emergency and cellular communication towers were washed away, leaving several impacted areas without emergency communication for first 72 hours of the event.

Figure 1 is a map of the Catskills. The inset shows the region in relation to New York state. The shaded areas within the region represent locales that where noted on the crowdsourced crisis map (see section 4.3) as having transportation infrastructure damage due to Hurricane Irene. Data provided by Don Meltz.

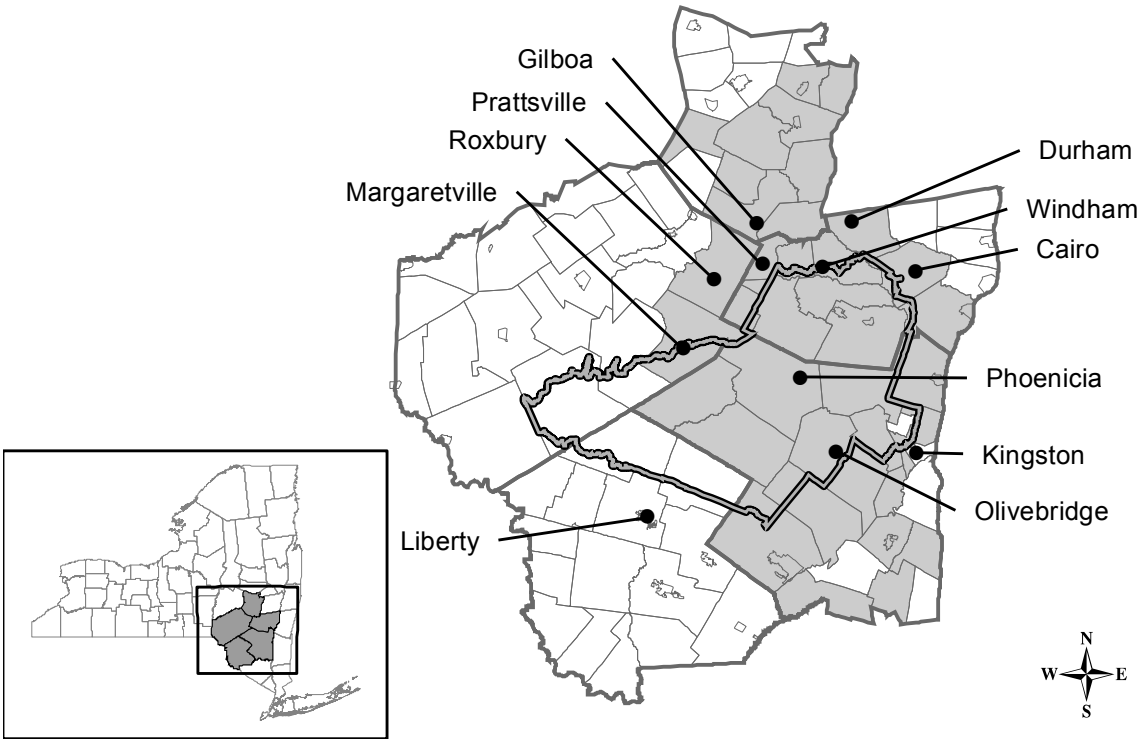


Figure 1. Map of the Catskills.. Inset map shows the region in relation to New York state. Shading on the larger map shows locales that were marked as having infrastructure damage on the crowdsourced map featured in section 4.3. The outlined area in the middle is the boundary of the Catskill Park from which the region takes its name. Data provided by Don Meltz.

In these conditions, many residents of the Catskills began to improvise efforts to fill gaps in the formal emergency response and to share information across technological divides. These efforts were distributed across many news organizations and online resources, but in this paper we focus on two specifically: the Watershed Post (WP) and the Watershed Post's Hurricane Irene Catskills Liveblog.

2.3.1 The Watershed Post

The Watershed Post (WP) is small news outlet that began operating in the Catskill region in 2010. They publish exclusively online, combining original reporting with stories from other news outlets in the region. Editors Lissa Harris and Julia Reischel are both former print journalists with experience in reporting and editorial roles within trade press, community news and science journalism. They created the WP to address a gap in media coverage for the five, predominately rural counties that comprise the Catskill region.

> ***Harris**: The role that we fill is a Catskills-wide place to go for news. … If you want to stay up on what's happening throughout the region you have to read about twenty different news outlets. So, when we started, the idea was to be an aggregator and a curator—to pick out the best of local news, and most interesting of local news for the region, and see if we can build a following that way.*

The WP works by aggregating and curating news from disparate sources. They also typically publish about one original story per day. They began as a single Twitter account (@watershedpost), then grew to include a website and Facebook page. Their readership is split about 50/50 between "upstate" and "downstate" viewers—i.e. between readers in and around the Catskills and readers in New York City.

Typically, the WP website sees about 1000 visitors per day. However, during the Irene crisis the website had 80,000 unique visitors (Reischel & Harris, 2011), peaking at 60,000 unique visitors in a single day (interview, Harris). These numbers suggest the WP played an important role in covering the event.

A major component of the WP's efforts to report Irene's impacts was a Liveblog that they deployed on 27 August. Over the course of the event, that tool served as an information-sharing and organizing hub for many local residents as well as the remote audience.

2.3.2 The Watershed Post's Hurricane Irene Catskills Liveblog

The Liveblog was launched within hours of Irene arriving and ran for thirteen days. During that time, it became an information source for those impacted and a site where various members of the connected crowd came together to assist in response and relief efforts.

Liveblogs are a form of social media, a subtype of weblogs designed for real-time, continuous updates during an event. They may be single-authored or have multiple collaborators, and in this case the Liveblog resembled a live public chat. During the Irene crisis, the WP used CoverItLive, a liveblogging service that integrates information from multiple sources, including posts from designated users and comments from guests. These may contain text and photos. CoverItLive also allows administrators to select Twitter feeds by account name or content keyword to appear in the Liveblog window.

An instance of a CoverItLive Liveblog can be embedded simultaneously into multiple websites. During this event, the Watershed Post published the key for their Liveblog, allowing a handful of other news outlets to make the Liveblog active on their own websites. The activity around this Liveblog was therefore distributed across different news outlets during the event, and its archive provides a record of an ecosystem of coverage that reaches beyond the Watershed Post (see Figures 2 & 3).

3. Methods

This research is based primarily on analysis of two data sources: contextual interviews conducted with people who publicly shared information related to the Catskills during the event; and the digital record of the Watershed Post's Hurricane Irene Catskills Liveblog.

3.1 Contextual Interviews

The first author conducted eleven interviews with individuals selected to represent a range of roles in the public information space that took shape in response to Irene's impacts in the region (Table 1). All took on the work of sharing information with the public, though each worked with a unique constellation of resources, collaborators and communication technologies. Several interviewees were pre-selected to represent specific perspectives in the event such as Harris and Loverro who respectively ran two important sources of real-time information for the region. These pre-selected interviewees collaborated with and relied on others for information in the course of their own work, and subsequent interviewees were selected because they were named as information resources or collaborators by pre-selected interviewees, a process called *chain sampling* (Patton, 2002). In this way, a spectrum of perspectives was attained and additional information resources (such as the crisis map discussed in this paper) uncovered. In addition, two interviewees were selected because of their role in formal emergency response.

Interviews were conducted nearly 12 months after the event. To aid detailed recall, ten interviews took place at the location where the interviewee conducted their information sharing work during the event. One interview was conducted over Skype. The contextual interview format enabled participants to demonstrate their workflow and tools employed during the event and to pull up other personal artifacts from the event such as web statistics and emails. Interviews ranged between one to two hours in length. Ten interviews were documented with audio, nine with photos.

The interview protocol employed semi-structured interviews based on the Critical Incident Technique (Flanagan, 1954). Proceeding in chronological fashion, interviewees were asked to describe their information seeking and sharing practices from when they first became aware of Irene to their self-defined conclusion of the event. After this, a survey of information sharing tools and platforms used during the event was administered verbally.

The initial intent of the interviews was to get a broad view of public information sharing during the event. Based on the account that each interviewee gave of their personal information seeking and sharing behaviors during the event, we mapped each individual's behaviors including information types sought, ICT tools and platforms employed, and individuals or organizations named as information resources and/or collaborators in information seeking/sharing work. We then generated a model of information flows representing the activities of all interviewees. We elaborated on and refined this model based on the analysis of the digital record.

Date	**Interviewee**	**Role During Event**	**Initial Rationale for Selection**
8/6/12	Sara Kendall, Station Manager WGXC, Hudson, NY	Produced content	Real-time coverage / radio perspective
8/6/12	Andrea Girolamo, editor of online trade publication, Hudson, NY	Very active volunteer moderator on the WP LB	Moderator of event-specific online forum perspective
8/7/12	Ivan Lajara, Social Engagement and Life Editor, Kingston Daily Freeman, Kingston, NY	Very active on social media, produced much content	Print daily perspective
8/10/12	Tom Roe, Program Director, WGXC, Acra, NY	Produced content	Real-time coverage / radio perspective
8/12/12	Paul Smart, long time print weekly editor in region, Catskill, NY	Contributed content to WGXC	Print weekly perspective
8/13/12	Caroline Boardman, Public Affairs Director, Northeast New York Red Cross, Albany, NY	Communications for several impacted regions in NY	Formal response / public affairs perspective
8/16/12	Donald Meltz, planning and GIS consultant, Columbiaville, NY	Initiated a publically available crisis map for region	Crisis map perspective
8/16/12	Joe Loverro, Operations Manager WRIP 97.9, Windham, NY	Co-produced local real-time coverage; WRIP served as emergency communication for a portion of the event	Prominent regional real-time information resource during event
8/17/12	Alex Tighe, Founder of Greene County Neighbors Helping Neighbors, Greene County, NY	Initiated community based charity promoted through social media; supported WRIP social media presence	Became regional information resource through Facebook presence
8/21/12	Lissa Harris, Editor of the WP, Margaretville, NY	Produced content and ran liveblog	Prominent regional real-time information resource during

			event
8/23/12	John Farrell, Director of Greene County Emergency Services, Cairo, NY	Emergency response	Local emergency response perspective

Table 1. Interviewees

3.2 Selection of the Watershed Post Catskills Irene Liveblog

Through analysis of interview data, we identified the Watershed Post's Hurricane Irene Catskills Liveblog as a common resource across several interviewees. Two participants had been pre-selected for interviews to represent the Watershed Post's work: Lissa Harris, the Editor of the WP, and Andrea Girolamo, a volunteer moderator of the Liveblog during the event. The interview with Harris revealed that the WP devoted considerable resources—including a large portion of Harris's time—to running the Liveblog during the event. Interviewees from two other news organizations (the Kingston Daily Freeman and WGXC) reported substantial interaction with the WP and use of the Liveblog in the course of producing their own content. Other interviewees lauded the coverage provided by the WP during the event, coverage that was in many ways dependent upon work being done within the Liveblog. Several interviewees also indicated that a crisis map produced by local planning consultant Don Meltz was a useful resource for many in the region, and that the effort to produce that map was also connected to the Liveblog. Thus, it was determined that the Liveblog was an important resource—either directly or indirectly—for several interview participants and for many people in the affected region.

3.3 Analysis of the Digital Record

After identifying the Liveblog as a hub of activity, and the editors of the Watershed Post as integral to deploying and running that resource, we qualitatively analyzed the digital record of the Liveblog. We were most interested in substantiating how collaborations that facilitated information sharing were established and maintained during this phase. How did the Liveblog come into being and develop? How did the work practices there evolve? What tasks were taken on? What roles filled? Who filled those roles? And finally, how was the Liveblog integrated into the larger information space? These questions were grounded in the first round of analysis of the interviews, and continued to be refined as we repeatedly returned to the recorded interviews and back again to the digital traces of the Liveblog.

We focused our attention on the first four days of the Liveblog, from its creation before flooding began through the acute response phase and into the initial stages of damage assessment. Many of the practices and collaborations that supported information work on the Liveblog became established during this time. Both authors examined all Liveblog messages in this period in chronological order (~10,000 messages). We then selected specific activities, information sharing events, and artifacts for more detailed analysis. For example, to establish how the crisis map was created and maintained during the event, we reviewed the Liveblog record and the contextual interview data. To better understand how this map fit into the larger information space of the event, we reviewed other digital traces beyond the WP and the Liveblog, including other geographical information for the region that was available at the time.

Our methods therefore included qualitative analysis of both the contextual interviews and the digital record of the Liveblog. Identification of themes was initially grounded in the data from the contextual interviews, but we later analyzed these two sources in tandem to support, verify, and augment the list of salient themes.

4. Findings

These findings describe the information-sharing activities that took place in and around the Watershed Post's Hurricane Irene Catskills Liveblog. Using excerpts from both the Liveblog record and the interviews, we describe the activities that took place there, including the roles that certain actors played in

its deployment and maintenance. By documenting the work practices and the evolution of those practices, we aim to illustrate how the Liveblog users, together with the affordances of the Liveblog itself, shaped the flow of information and the resulting informational resource.

4.1 Deploying, Maintaining and Sustaining a Live News Feed

As Irene arrived, the editors of the Watershed Post decided to create a "live news feed" to cover what they deemed to be an impending crisis. They deployed at 4:08 pm on 27 August.

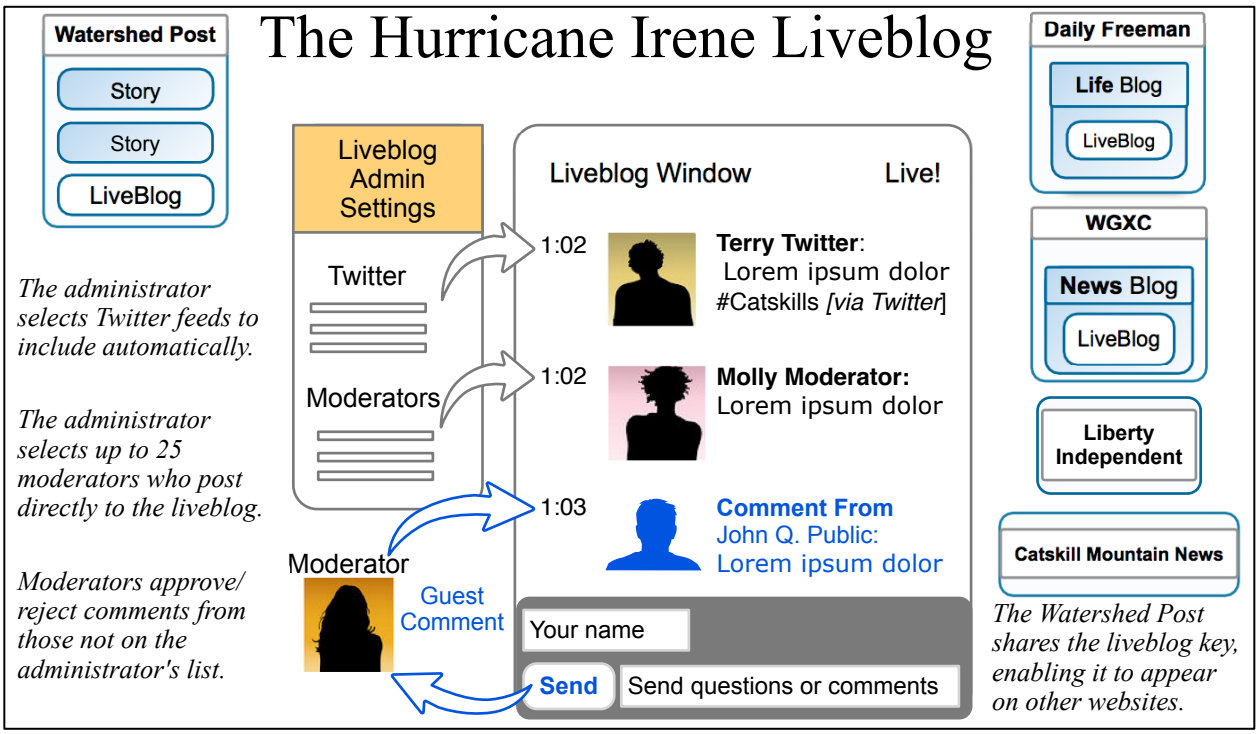


Figure 2. The Watershed Post Hurricane Irene Catskills Liveblog

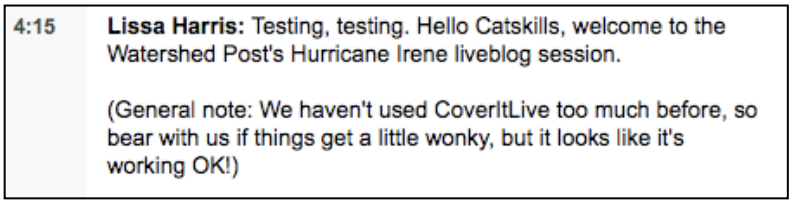
They opted to use the CoverItLive Liveblog service, which allows for the inclusion of several different information types, including unmoderated posts from pre-selected individuals and comments from guests that must be approved by moderators. Before launching, Harris created a list of local journalists and other trusted sources in the region with whom she was already familiar through her work at WP. She gave these individuals the status of "moderator," allowing them to post directly to the Liveblog without additional moderation. Harris continuously updated this list throughout the event.

CoverItLive also enables Liveblog administrators to choose Twitter accounts and topics to include—tweets sent by selected authors or with designated hashtags are automatically added to the Liveblog. For the Hurricane Irene Catskills Liveblog, Harris included several Twitter accounts from official sources, including FEMA, the American Red Cross, and NOAA, along with what she termed her "trusted" local sources. She also chose event-specific hashtags for tweet collection. These had to be manually adjusted as the crisis unfolded to focus on the most relevant information.

Using these CoverItLive affordances—the pre-approved commenter and moderation functionality, and the Twitter lists of topics and users—WP's editors consciously shaped the Liveblog's information feeds to be both inclusive and, in their view, trustworthy.

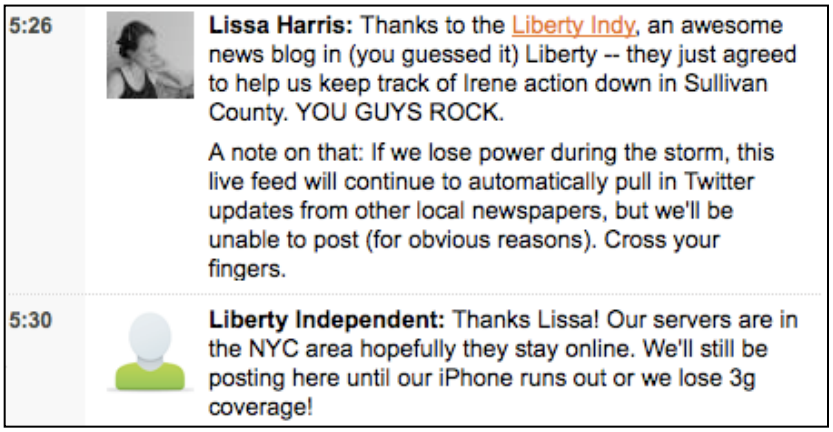
4.1.1 Sharing "the Keys" to the Live News Feed: Establishing a Collaboration with Other Journalists

Harris posted the first comment to the Liveblog at 4:15pm, initially establishing it as a product of the WP:



Soon after, Reischel tweeted out a link to the Liveblog instance on the WP website from the @watershedpost Twitter account. Because that account was on the designated list, this tweet was captured in the Liveblog (top tweet, below):

In the next few hours, Harris and Reischel began to reach out to other regional media outlets and journalists for assistance. Reischel put out a public call via the @watershedpost (at 4:24, above) to participate in the feed by tweeting the hashtag #catskills. Harris emailed a list of "other journalists we were friendly with" in the region. Harris explained that these actions had two motivations: first, to increase the number of contributors to the Liveblog; and second, to ensure that the Liveblog would remain active if the WP editors lost the ability to run it themselves due to the storm. Harris wanted to give other journalists "the keys" to the Liveblog—by assigning them moderator status and allowing them to embed the Liveblog in their own websites—so that they could collectively keep it going. In Harris's rationale, collaboration among outlets would increase the likelihood that coverage would continue even if individual outlets were disrupted.

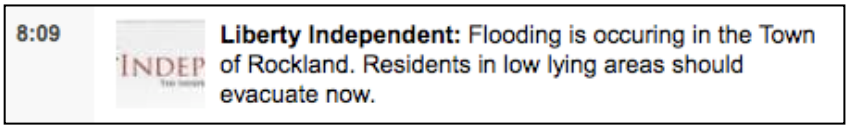


Journalists from other organizations committed to taking over the Liveblog should the WP editors be cut off. At least four news outlets posted the Liveblog window on their own websites: the Liberty Independent, another ad-based online-only news outlet; the Catskill Mountain News, an ad-based weekly which claims to be "the oldest continually operating business in the Town of Middletown, NY;" WGXC, a community radio station in Acra, NY; and the Kingston Daily Freeman, at the time the largest

circulation print daily covering a portion of the impacted area. The Liveblog became a shared product and a collaboration site for a rapidly assembled collection of journalists and media outlets.

4.1.2 Interconnected Media: Direct and Indirect Information Sharing through Multiple Channels

Through the early morning hours of 28 August, Liveblog content came primarily from the trusted sources that the WP designated. The participants contributed to the Liveblog either directly by commenting as did the Liberty Independent (below), or indirectly through their tweets like Ivan Lajara, the Life Editor of the Daily Freeman (below).

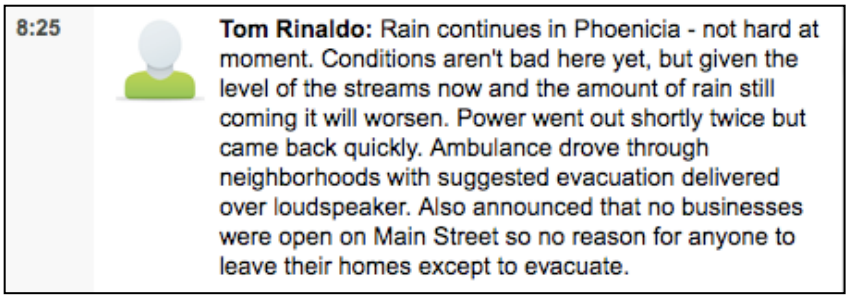


Though some contributors used a single method of sharing, others used a combination of channels, depending upon their connectivity and the type of message. Lajara typically shared information through his tweets (Figure 3, A), but when his message would not fit within Twitter's 140-character limit, he would add it directly into the Liveblog. Taking advantage of the inter-connectivity between the platforms, News Director Tom Roe and Station Manager Sara Kendall of WGXC, a community radio station, both kept the Liveblog window open to follow along, but participated mostly by tweeting:

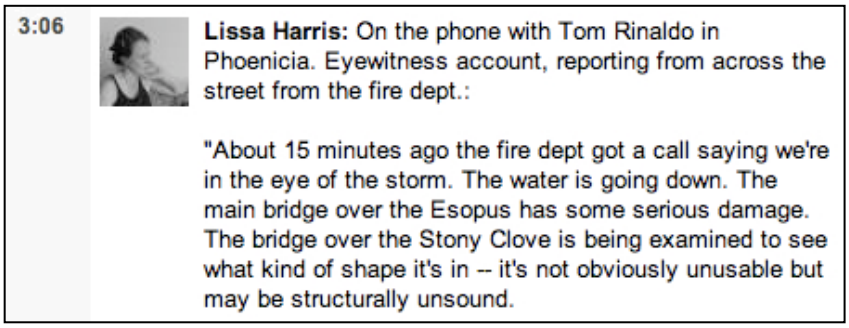
> ***Roe**: I was typing into the Liveblog, but mostly we were typing into our own Twitter feed so our listeners got that information, but we knew [the viewers of the Liveblog] were also getting that information.*

Contributing reporters used a mix of institutional and personal accounts. Doron Tyler Antrim of the Catskill Daily Mail tweeted news from his personal account. Lajara tweeted some newsworthy items from the Daily Freeman account—e.g. the death count from the storm—but shared his own observations, such as a tree falling behind his house, from his personal account. Like many of the participating journalists, when posting directly to the Liveblog, Lajara used only his name. Speaking to the distributed and democratic nature of the Liveblog collaboration, it is likely that readers of the Liveblog could not always differentiate between professional journalists and citizen reporters.

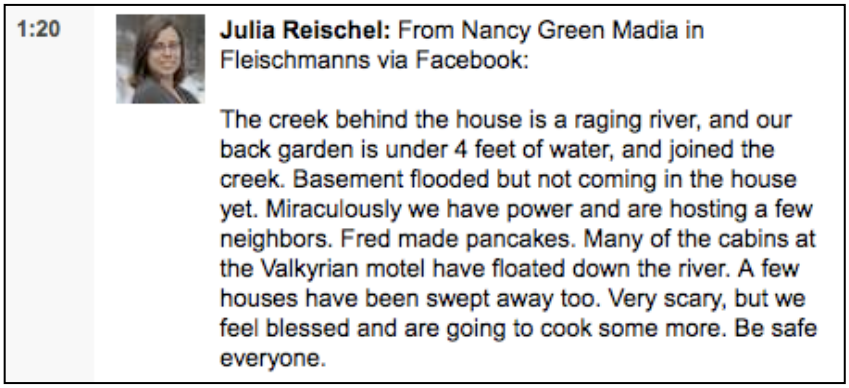
A few of the early participants, as well as many of those who contributed later in the event, were not affiliated with a particular news outlet. Tom Rinaldo, a resident of Phoenicia, NY, an area that suffered considerable flood damage, was not a trained journalist, but his activity during this event can be seen to blur the line between an eye-witness account and journalism. In her interview, Harris referred to Rinaldo as her "correspondent in Phoenicia." He was on the WP's initial list of trusted sources and began posting comments in the Liveblog within four hours of its launch (Figure 3, B):



As the event progressed, Rinaldo lost power and Internet, but he continued to share information using a landline phone to call Harris who typed his reports into the Liveblog (Figure 3, C):



This strategy of posting secondhand information was another method of indirect sharing. Reischel and Harris often passed along information from their "readers," gleaned from phone calls, Facebook posts, tweets, website comments outside the Liveblog, and other channels (Figure 3, D):



Other Liveblog contributors shared secondhand information as well—everything from conversations with neighbors to information from other news outlets and official sources. In this way, enabled by a diverse array of technologies in a rural community with varying modes of ICT access, and powered by human actors, the Liveblog participants worked to bring together information across technological platforms and communication channels.

4.1.3 Moderated Sharing through Guest Comments

Another method of information sharing occurred through moderated guest comments. People who were not on the designated list of contributors could submit comments to the Liveblog, but these comments required a moderator's acceptance before they would post. After the region began to flood in the morning of 28 August, participation shifted from primarily tweets and comments of trusted sources to include a much larger proportion of guest comments like the following:

On the CoverItLive platform, comments from guests appear in blue text and can easily be distinguished from comments posted by a Liveblog's administrators and moderators, which appear in black. Moderated comments are further distinguished by the text "Comment From" appearing on them. As the flooding worsened and many more people joined the Liveblog activity, the primary color of the Liveblog shifted from mostly black to mostly blue. Many of the guest comments were eyewitness reports like the one

above from Terry Doyle, host of a popular community radio show. Later, Doyle would report via the Liveblog that the radio station had lost power.

Though the Liveblog maintained its function as a newsfeed, its purpose became manifold as participation grew. Stranded people asked for help. Others asked for assistance finding loved ones. Many posted comments asking if specific areas had suffered damage:

8:43	**Comment From Erin** My fiance and a large group of our friends are celebrating his bachelor party at a cabin in Lennox, NY, just outside of Hunter in Greene county. Last I heard was earlier today and they had lost power and were stranded due to flooding. Any word on the area?

12:23	**Comment From erica** Anyone know anything about the Durham area?

Sometimes, these questions were answered by the moderators, but more often, people stepped out of the crowd to answer questions:

12:25	**Comment From ml** Erica - Durham got a lot of rain but nearby towns of Freehold and Greenville are largely fine with flooding and power outages but - from what I gather - nothing near the devastation in places like Windham.

There were also offers of support or other assistance. Later on, discussions emerged over issues such as who should be allowed into the official disaster area and where rebuilding should be allowed.

Due to the design of the CoverItLive platform, the Liveblog's "moderators" could control what content became visible, providing a mechanism for potentially reducing misinformation and for shaping the culture of the shared resource.

4.1.4 Moderators Step Out from the Crowd

As increasing numbers of participants joined the Liveblog, the work of moderating grew more demanding. Guests began sharing hundreds of comments per day, sometimes more than one hundred per hour, and each one had to be approved before it posted to the public view. Initially, Reischel and Harris handled that task by themselves, but soon it became too burdensome. By 6pm on 28 August, the WP editors felt they had reached capacity for running the Liveblog while also trying to confirm reports, write stories and answer calls from other journalists. In addition, they were within the disaster area where power and communications were still vulnerable. Harris posted a call for volunteer moderators:

6:02  **Lissa Harris:** CALL FOR VOLUNTEERS!

Folks, I have a feeling we're on borrowed time with our internet connection here. MTC has lost its backup generator, their main office is flooded.

Right now, comments are being moderated -- by us. If we go offline, I have no guarantee we'll be able to publish reader comments. I have given a few other people moderation powers, but they're in the same boat -- subject to power interruptions, busy with many other things, etc.

CoverItLive will allow me to select 25 readers to make comments directly, without waiting for the moderator. Do you want this power? COMMENT SAYING "I VOLUNTEER" AND I WILL GIVE IT TO YOU. Hoping for a mix of different areas around the Catskills, but if you're willing to keep in touch and be conscientious, you're in no matter where you are.

Within minutes several guest participants offered to assist:

6:04 **Comment From Amy Kleisner**
I volunteer.

6:05 **Comment From Angela**
I volunteer. I'm in Olivebridge and will be online thanks to my iPhone and car charger!

Eventually, more than 20 volunteers took shifts moderating, allowing for continuous coverage for thirteen days. Unlike eyewitness reporters, moderators did not need to be in the impacted area to contribute and several of the most active were from outside the disaster area. For example, two of what Harris describes as the "main" moderators for the Liveblog, Girolamo and Gibbons, live outside of the Catskills region. Like most of the other volunteer moderators, Girolamo and Gibbons were unknown to Harris and Reischel before the event, underscoring the emergent nature of this collaboration.

The transcript of the Liveblog records a complex and varied role for moderators, confirmed by Girolamo. In addition to approving comments, moderators answered questions and shared information about the unfolding event. Due to the synchronous nature of the platform, with readers and commenters coming and going rapidly, moderators worked to continually establish context for participants by, for example, regularly reposting the best known information on a specific topic. When participants posed questions, moderators actively sought answers, often going outside the Liveblog platform. Girolamo explained that she would often seek answers by reposting questions to Facebook and Twitter (see Figure 3, E). Within the Liveblog, she employed the term "crowdsourcing" to describe this activity:

5:58  **Andrea Girolamo:** Let us know what information you need and we'll definitely try to keep crowdsourcing the answer! Be well!

Moderators also helped vet information by, for example, publicly questioning hearsay information. They facilitated conversation among participants, many of whom sought not only information but also support. Moderators also worked to maintain an appropriate emotional tone, allowing people to vent their concerns, frustrations, and fears while remaining both calm and supportive. Finally, moderators supported WP reporting by summarizing developments that occurred during their shifts.

4.2 An Information Hub in a Larger Information Ecosystem

In total, the Liveblog recorded 27,768 total posts—6229 posts from trusted sources, 9728 moderated comments, and 11,811 tweets. The platform became both a site of collaboration for affected people and volunteers, with 1337 unique contributors over the course of the event, and a shared resource—an "information hub"—for both locals and the global audience. The effort received attention from the national press, including a news report from CNN describing "crowdsourced reports streaming in" of flooding impacts (Kinsman, 2011).

Shared content included everything from information about weather conditions, power outages, damage to homes, and washed out roads, to inquiries about missing and stranded people, instructions for where to get supplies, calls for volunteers, and fund-raising coordination efforts. The conversation evolved with the event, shifting from information-sharing related to impact to self-organized relief efforts.

The above account shows how the Liveblog brought together information from diverse information sources and channels, i.e. pulling in direct posts, messages shared on Twitter, and second hand reports carried over from Facebook, other websites, phone calls, and conversations with neighbors. The reverse was also true—information shared on the Liveblog was rebroadcast through diverse channels and remixed into a variety of different resources. Community radio station WGXC shared information they gleaned from the Liveblog on their News Blog and through their radio broadcasts (Figure 3, F). Commercial radio station WRIP also exchanged information with the WP, carrying information over to their Facebook page. The WP used information on the Liveblog to create a separate webpage with a town-by-town listing of current conditions in each area. The Liveblog was also used as raw material for another important resource, a live map. Figure 3 illustrates many of these cross-platform information-sharing activities. We return to the significance of this activity in the Discussion.

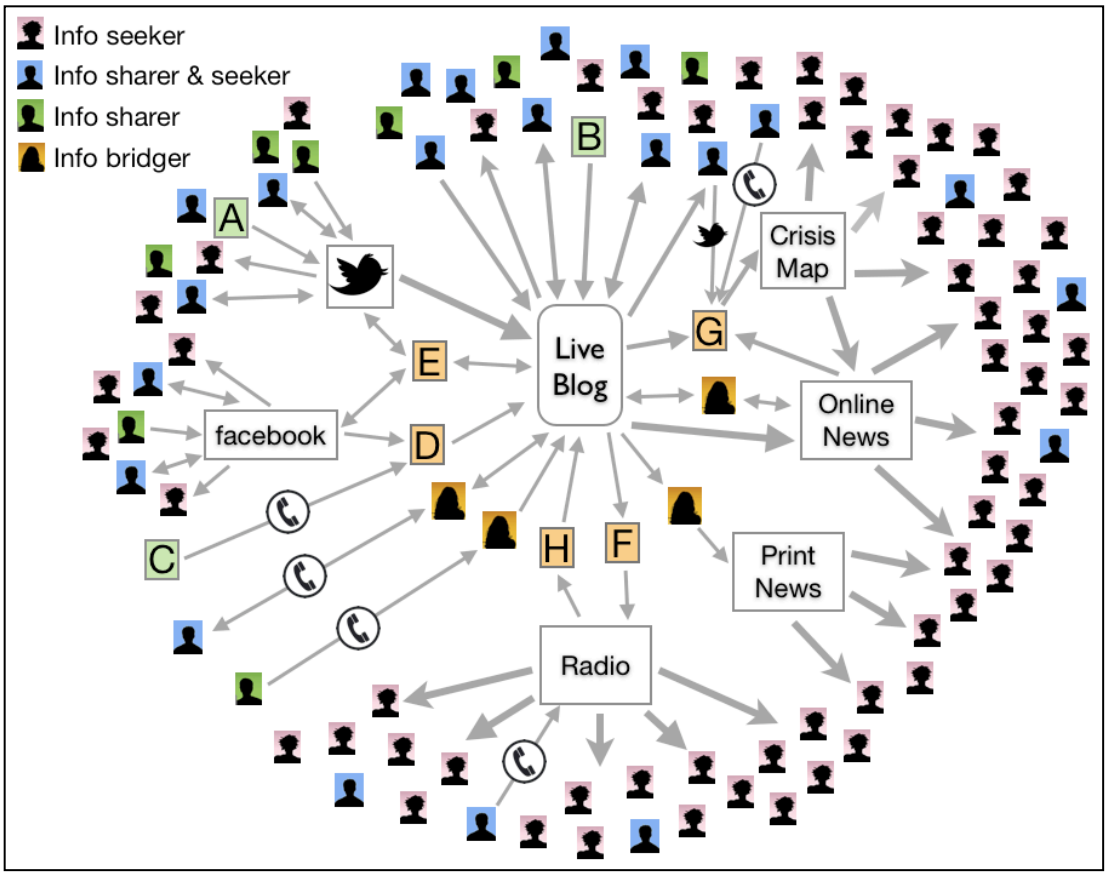


Figure 3. Information Ecosystem around Hurricane Irene Catskills Liveblog

4.3 A Crowdsourced Map, "The Most Helpful Thing": Enabling Micro-Collaborations

Irene wreaked havoc on the infrastructure of the Catskills, washing away roads and bridges in some places while leaving others intact but structurally unsafe. In some cases entire towns became cut off (interview, John Farrell). For first responders, relief workers, and everyone else, navigation was a major information challenge.

The area that sustained the most intense damage straddled the border of four counties, and no single official source made a complete list of road closures available. The state 511.com map published on the web only showed closures of state maintained roads, not locally maintained or county maintained roads. One affected county in the Catskills produced a map of road closures, but the PDF document was outdated soon after publishing.

Where official information was lacking, the crowd filled the gap. Don Meltz, a GIS specialist, started following the WP's coverage of Irene via Twitter on 27 August, as the storm hit. When reports started coming in of road obstructions and closures, Meltz noticed that the information was difficult to make sense of:

> ***Meltz**: Each county had their own separate set of road closures that only pertained to their specific county. One of the problems was the counties were only listing road names. You couldn't actually see the route through the area. The state had the 511 map, but again, one of the problems with that is it's a point on a map with a text description. Roads are not points. Roads are long stretches of line. The way that the information was distributed was not the best way for the consumer to read it. So I just thought, plot it on the map. Let people see it, it will make more sense.*

Inspired by volunteer-led crisis mapping efforts around the Haiti earthquake and the Colorado wildfires, Meltz contacted the WP to offer his services. Within hours, he published a map of information aggregated from the WP's website and the Liveblog (Figure 3, G).

> ***Harris:*** *With Don [Meltz], and we were just feeding him snippets of information, this road is down here, this bridge is out here, and he would put it on the map.*

When possible, Meltz used official sources to vet the information, but in many cases that was not possible. After Harris and Reischel put out a call for volunteers to help Meltz, a handful of individuals began to send him updates through Facebook, email and Twitter. Some even drove around to confirm where roads were closed or open.

The resulting map became, as Kendall of WGXC put it, "the most helpful thing" in the crisis—the most comprehensive and most frequently updated map available to the public for the region. It was a dynamic resource that evolved with the crisis. As the emergency moved into relief mode, Meltz added shelters, donation locations, and hazardous waste drop off points to the map, making updates for about two weeks.

Though production of this map was not originally a primary goal of the Liveblog's leaders, the structure of the environment, including the affordances of the platform and the practices established within this particular instance, facilitated this and other micro-collaborations that took place among subsets of participants.

4.4 A New Role for Journalists: Reporting with a Crowd

A major theme that emerged from our data was the role that the WP editors played in actively shaping the information-sharing behavior that they later praised, and in catalyzing and supporting the multi-faceted collaboration on the Liveblog. This shaping took several different forms, including recruiting and assembling the collaborators, establishing the norms and practices of the Liveblog, and actively teaching new volunteers how to "work" within the community.

4.4.1 Building a Collaboration with Trusted Peers

Dabbish et al (2012) find that early participation in an online forum can influence the communication patterns that unfold thereafter. For the WP Hurricane Irene Catskills Liveblog, initial participation—shaped by the WP and their list of trusted sources—was comprised of people who were already "acting like reporters" throughout the region.

WP editors selected specific accounts of media peers and other trusted sources to post directly to the Liveblog, assigned them to the preferential administrator status, and in many cases contacted them directly to establish an explicit collaboration. Though journalists from separate news organizations often aim to provide complementary coverage on stories, within the traditional news model it is unusual for direct collaboration to take place across organizational borders, something both Lajara and Roe mentioned in their interviews. However, evidence in both the social media record and the interviews shows that the WP editors were indeed actively collaborating with individuals from several other news organizations through social media platforms.

Reflecting who is "acting like reporters" in pockets of the Catskills on a day-to-day basis, several other members of the early collaboration who were designated as trusted sources were not paid journalists, but did have experience reporting. Harris often referred to Rinaldo as the WP's "correspondent" and he had both previously acted as such and currently writes articles that are posted on their website. Terry Doyle, another key participant in the collaboration, majored in broadcasting in college, but used his skills to co-found community radio station WIOX—unpaid, i.e. "non-professional," work.

In many cases, the distinction between professional and citizen reporter may not have been clear to viewers of the Liveblog. Within the complex collaboration supported by the Liveblog, even "volunteers"

who were not initially identified as trusted sources—like Girolamo, editor of an online trade publication—were in fact media professionals as well. A volunteer moderator during Irene, WP hired her as a part time editor afterward the event.

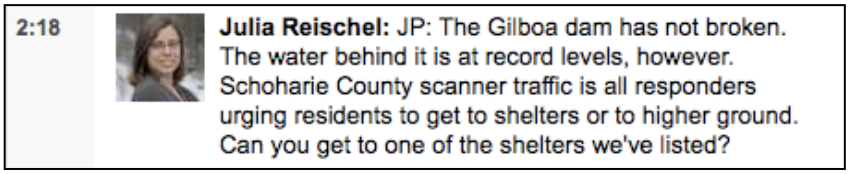
This research reveals that in its earliest stages, before its broader public transitioned from information seekers to information sharers to moderators, the community supporting the Liveblog was largely constituted by individuals with some knowledge of the work practices of journalism. This suggests that the culture of the Liveblog and the activities that took place around it were to some extent shaped by a shared understanding among their primary participants of journalistic practice. In other words, these individuals were not making up all the rules as they went, but were operating on top of a shared set of understandings about how a newsroom functions. And collaborators, especially the WP editors, were actively working to transfer these rules to volunteers coming in from the crowd.

4.4.2 Training the Crowd: Transferring Expertise

Just as the borders between separate news organizations became less restrictive and less perceptible during the event, the distinction between professional journalists and "citizen" reporters was blurred.

> ***Harris:*** *People were so, how do I say this, they were so well-behaved—they were such good information sharers while this was going on, while it was an emergency mode.* ***They were kind of acting like reporters.***

This comment from Harris, praising the quality of information sharing within the Liveblog, both reveals an important tension in the field of journalism and illuminates a potential new role for professional journalists. As the WP expanded contribution to include more public participation from the crowd, they worked to help train the new participants. A primary teaching method was modeling best practices, a task they often approached intentionally. One of these best practices was vetting, i.e. checking sources, identifying misinformation, and suppressing rumors. Harris and Reischel sought to teach the crowd first, *that* information needed to be vetted, and second, *how* to vet information. The following example demonstrates Reischel both vetting information and demonstrating the value and method of vetting:



The first comment in this example, a guest comment that contains a false rumor about the Gilboa dam, posted at 2:17pm on 28 August. At this time, only Harris and Reischel were moderating, which indicates that one of the two WP editors approved the comment. Shortly after it posted, Reischel addressed the rumor in the public forum. Harris and Reischel were intentionally light-handed in terms of accepting comments from the public into the Liveblog. Instead of strictly gatekeeping, these editors chose to allow some misinformation to bubble up so that it could be publicly addressed. Their approach served dual functions: contesting rumors and showing others how to contest rumors.

The following comment shows another contributor exhibiting the same good journalistic technique, addressing the Gilboa dam rumor again, 50 minutes later, and citing an official source to support the correction.

3:07	**Comment From Mark Warwick** Greene County Administrator live on Fox 5 - Dams did not fail but were breached by high water. All dams are intact.

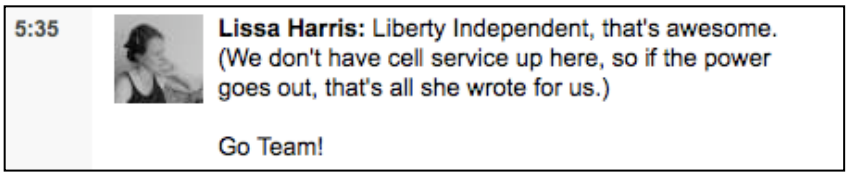
The Liveblog record shows the WP editors consistently working to educate and train the many participants there by intentionally passing along their journalistic practices to the crowd. Harris also spent considerable energy training the volunteer moderators, through demonstration, training sessions, and feedback. The following excerpt demonstrates several of those techniques. These posts occurred on 29 August during a training session for a new moderator:

5:22	 **Lissa Harris:** Jess, are you able to see/approve comments?
5:25	 **Jess Vecc:** Oh, I see to the right. Got it.
5:25	**Comment From JoeSchmoe** Julia: no I have not seen any coverage, I don\'t care to make a big fuss out of a little storm. Get used to it people, it happened in 2006 and it was worse, did you all think it would never happen again?
5:27	 **Lissa Harris:** Jess: The unapproved comments are to the bottom of the stack, in brown. Scroll to make sure you get to the bottom of it. Green button approves a comment. Can you try a few?
5:28	**Comment From RU** Really Joe Schmoe - if you can\'t bother with looking at coverage then don\'t bother commenting. People need this for info.
5:29	 **Lissa Harris:** Well, that was convenient: a troll just happened to stop by while we were training moderators. Dear moderators: That's an example of the sort of comment you shouldn't approve.

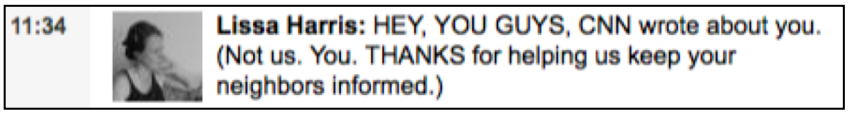
This excerpt shows Harris using the Liveblog to communicate with a new volunteer, Jess, while she teaches her how to moderate comments. Coincidentally, during this exchange, another volunteer moderator approved an inappropriate comment, which Harris incorporates into her instruction, educating both Jess and the current moderator on how to silence "trolls." The moderation functionality of the Liveblog allowed participants to purposefully shape the culture of the interaction space.

4.4.3 Coaching the Crowd: Instilling a Sense of Team to Motivate Participation

Harris also worked to instill a sense of team in the distributed participants. This was another important tactic, reflecting the reality of a multi-person and multi-organization collaboration. Harris's first reference to teamwork came within two hours of launching the Liveblog (at 5:35pm on 27 August), as she brought other journalists and media outlets onboard.

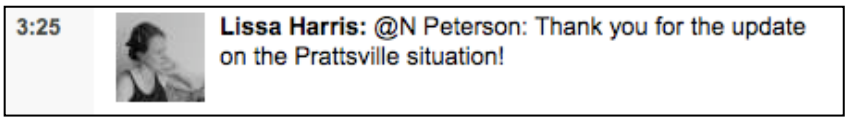


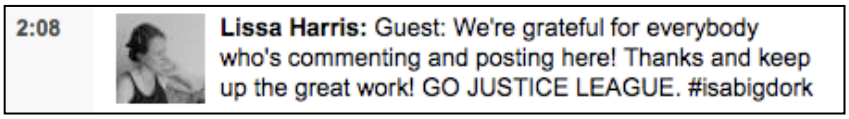
Harris would later extend this sense of team to include a broader range of participants, including citizen reporters and volunteer moderators. Much later in the event, as the WP was receiving widespread praise in the community and in the national press, she tried to make sure that other participants were getting their fair share of the credit.



These comments are a few examples among many posts that show Harris carefully fostering a sense of inclusion among the different participants. As she brought on collaborating partners and trained new moderators, she attempted to give them both responsibility and ownership of the work.

Another aspect of this work was rallying the group—thanking them for their work and encouraging them to keep going. Harris repeatedly left thank you messages in the Liveblog, sometimes calling out specific individuals for their contributions, and sometimes thanking the larger group for their collective work.





This last quote is not simply a message of thank you. The tone, including the exclamation points, and the content, especially "keep up the great work" and "GO JUSTICE LEAGUE," show Harris acting a bit like a little league coach—i.e. encouraging the group and cheering them on. Thanking and rallying may have helped to further foster a sense of camaraderie and inclusivity and to motivate volunteers.

For its part, the Liveblog audience also contributed to rallying. There are several guest comments in the Liveblog praising the WP editors as well as fellow crowd workers and encouraging them to "keep up the good work." This suggests that a shared culture of teamwork and thanking developed within the platform, likely shaped by Harris's actions. Though Harris did not explicitly describe it as such, this may have been part of an intentional strategy of motivating current contributors and recruiting future volunteers, key factors in sustaining such an effort over time (see Starbird & Palen, 2012).

5. Discussion

This study examines an emergent collaboration that took shape after a major disaster event, incorporating a multitude of participants who were distributed both geographically and across technological tools and platforms. Emergent organizations are a common feature of disaster events, as individuals and organizations work to fill gaps in formal response efforts (Dynes, 1970; Kendra & Wachtendorf, 2003). Recent research in the developing field of *crisis informatics* demonstrates that disaster-affected communities and members of the remote crowd are coming together and self-organizing after events using social media and other ICT (Shklovski et al., 2008; Sutton et al., 2008; Qu et al., 2009, Starbird & Palen, 2011).

This description of a collaboration that took shape during a major flooding event in a rural area has several remarkable features with potential implications for design and practice. Specifically, this research demonstrates a potentially advantageous adaptation for journalists in a changing information ecosystem—towards leadership within crowdsourcing efforts—and offers insight into the design of crowdsourcing applications for the crisis context by highlighting a disconnect between how emergent collaborations are manifesting and how researchers are designing formalized crowdsourcing solutions.

5.1 Bridging Gaps in ICT Infrastructure: A Human Powered Mesh Network

The communications infrastructure of the Catskills is irregular—lacking in many places the connectivity that we have come to expect in most of the United States, e.g. for cell phones, the Internet, and even terrestrial broadcast (Dailey et al., 2010). Further, rural populations like that of the Catskills are older, less educated, and of lower income than their urban and suburban counterparts—all factors which are linked to variability in ICT use (Yardi, 2012). During crisis situations, when access to information is extremely important, gaps in communications infrastructure become a critical problem. This is especially true in low-resource areas where existing infrastructure is irregular, but it is also an issue in connected areas when infrastructure suffers outages due to the crisis itself.

In the information space surrounding this event, gaps were not limited to telecommunications infrastructure, but included varying diffusion of different ICTs—i.e. different audiences use different platforms. For example, though Harris used Twitter to reach out to fellow reporters, she understood that her local audience was elsewhere.

> ***Harris:*** *"Media people are on Twitter. Most of our readers are not. Definitely most of our rural readers are not. But New York City media is very much on Twitter."*

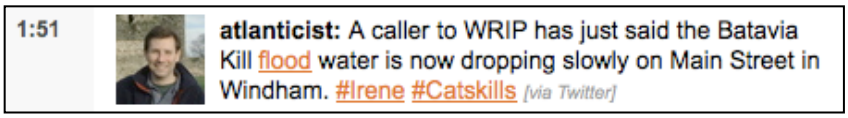
And Alex Tighe, a public relations specialist who created a Facebook charity during the event, found that when she expanded to Twitter she reached a different group of people:

> ***Tighe:*** *"I can't put it into a demographic but I noticed when I went onto Twitter I was reaching a different group of people. There seems to be more business-oriented people on Twitter."*

These gaps, both in the telecommunications infrastructure and ICT use, represented an important challenge for those seeking information during Irene, as well as those looking to provide that information, and they were bridged through the collaborative work of news outlets, journalists and the crowd. Repeatedly in the Liveblog we see evidence of participants bridging media outlets, communications platforms, and localities. Kendall, the manager of a local radio station providing real-time coverage during the event, described how she acted as a bridge between callers to her station and those with information on the Liveblog.

> ***Kendall****: Stepping out of the digital and into the analog felt like, "How do we bridge these?" There's this crazy communication ecosystem happening on this Liveblog which is aggregating all of these Twitter feeds. What are some more ways that we can get that information to people who are not [connected]? A perfect example is when we would get a phone call from someone saying, "Hey do you know when the road in Preston Hollow is going to open again?" I could post that question to the Liveblog and say, "A caller wants to know..." and I would get six responses and then I'd be able to tell them over the phone.*

Other efforts moved information in the other direction, from phone lines to the Liveblog. For example, this Twitter user shared information he attained by listening to a terrestrial broadcast of WRIP, a station in an area without cell coverage, from a caller who was in turn mediated through a landline phone.



Though affordances of the Liveblog platform contributed to its utility in bridging audiences—e.g. it blended two distinct online social media, microblogging and chat, providing an accessible public venue for participants with different communication tools, habits or needs—it is important to understand that the *work of piecing together fragmented audiences was not done passively by technology, but actively through the collective work of a connected crowd*. The digital record and interviews indicate that many "participants" in this complex information ecosystem were actively seeking, capturing, routing, and disseminating information from platform to platform, audience to audience. In study of online volunteers helping with pet reunification after Hurricane Sandy, White et al. (2013) use the term "cross-posting" to characterize this behavior at the local or individual level. Taken collectively, this activity has global, system-level effects that function to make a more usable information space by moving vital information to people who need it. This is analogous to the way that a "mesh network" can route information between nodes with the intent of reaching specific points within the network (Kay, 2009). In this instance, selecting how to route information to reach a chosen destination was more than a purely computational solution, but one that is at least partially human-powered. We offer the term "*human-powered mesh network*" to conceptualize this system, using this term to emphasize the distributed nature of the work to shape and route information, as well as the fact that the overall configuration supported intelligent decisions at the lowest level—i.e. this is a crowd made up of individual decision-makers choosing how to route information, who to collaborate with and how.

5.2 The Vital Work of Infrastructuring: Journalists as Crowdsourcerers

To piece together fragmented audiences, it helps to understand their contours. Professional journalists and news outlets played important roles in facilitating this *human-powered mesh network* and supporting other aspects of the collaboration as well. Their ability to do this well was likely related to their position in the affected community. The journalists at the center of this collaboration possessed a knowledge of and were embedded in and connected to other key infrastructures, e.g. emergency response, other regional journalists, and had preexisting relationships with actual audiences—not just a theoretical market share, but actual people, names, faces, etc. For example, Reischel and Harris understood that their audience was divided, and knew that reaching them required different means. They were able to leverage this experience to help link nodes in the network. This included anticipating where the contours of one audience dropped off and where another began. The WP editors encouraged Liveblog participants to listen to WRIP, a radio station which was providing critical communications in their area, and then report its coverage in the Liveblog (Figure 3, H), utilizing the power of the crowd to bridge information modalities.

5.2.1 The Human Infrastructure of an Emergent Collaboration

The Liveblog and the information-collaboration space surrounding it—including but not limited to its function as a human-powered mesh network—can be viewed as *emergent* infrastructure. Similar online volunteer efforts have *emerged* repeatedly after crisis events in recent years (e.g. Qu et al., 2009; Starbird & Palen, 2011). However, emergence is not a property of technology, but one of human activity. In this case, the activity of journalists played a critical role in catalyzing this emergence through their infrastructuring work (Star & Ruhleder, 1996). The Liveblog record shows the WP editors, with the help of their "trusted collaborators" in the area, laying the foundations for these collaborations, and rapidly orchestrating the resources and talent that "emerged" during this event. This infrastructuring work included more than just assembling the necessary tools and platforms, but also connecting the people and establishing the work practices that helped the collaboration*s* develop.

This research shows the infrastructure that emerged after Hurricane Irene being built upon human infrastructure (Lee et al., 2006) supplied initially by the journalists. In the Lee et al. study (2006), scientists were shown to build their collaboration upon existing human infrastructures, including expertise of individual collaborators and relationships between them. Similarly, the community response in this effort expanded upon personal networks, including existing relationships between journalists that helped to structure the initial collaboration. Human infrastructuring in this case also included developing, adapting and communicating shared practices, and establishing a shared sense of ownership within the collaboration. As time went on, additional collaborators including volunteer moderators also participated in infrastructuring activities, and that work was itself differentiated based on the participants' expertise, location, and access to ICT.

Infrastructuring work does not always fall within traditional organizational arrangements. For example, Lee et al. (2006) found infrastructuring activities did not map to what were identifiable teams in a scientific collaboration. Likewise, although in this emergent collaboration the term "team" was employed by participants as a motivational construct, the boundaries of that team were not rigid. The collaboration was not a monolithic entity, but consisted of many overlapping groups. Interviewees all referred to their own work as a collective activity conducted by a "we," but each had their own set of collaborators. Even interviews who worked with the Liveblog, no two shared the exact same set of collaborators. Micro-collaborations—like the effort between Don Meltz (the GIS specialist) and other participants in the Liveblog to build a crisis map—took shape, often extending beyond the Liveblog to other tools and groups. Subgroups were distinct but often had overlapping goals which were not typically redundant, but synergistic. Yet, even micro-collaborations that did not directly involve the WP editors or other journalists still benefited from their activities to establish and maintain this infrastructure.

5.2.2 Journalism and Crisis: Disasters as a Catalyst for Change

This case demonstrates journalists adapting to changing conditions in information production and establishing a new role for themselves during a major crisis event. Improvisation is a common feature of crises—individuals and organizations appropriate available tools and creatively apply them to emerging challenges (e.g. Dynes, 1970; Kendra & Wachtendorf, 2003; Palen & Liu, 2007). Crisis events can also serve as catalysts for adopting new technology, and previous research has demonstrated that affected populations will adopt social media tools to meet communication needs during events (Palen & Liu, 2007; Sutton et al., 2008). Hurricane Irene was not just a catalyst for new behaviors among individuals, it also accelerated institutional shifts within participating journalistic institutions, as Lajara explains:

> *And news organizations, we finally put down our walls and said, "All right. We're totally going to be part of this." So you could say it was a shifting moment—though before we had this philosophy of doing it—it was an opportunity to finally say, "All right, you know. Time to do it."*

Paulussen and Ugille (2008) point out that participatory journalism requires supportive organizational structures. The Watershed Post is among a new crop of journalistic institutions that see the role between professional and participatory journalism as complementary rather than competitive (Lewis, 2011). Aligned with Paulussen et al. (2007) findings, this research shows the WP and other collaborating journalists taking on the work of moderating, coordinating, and training their citizen counterparts to facilitate news production as a collective effort. Within the Liveblog, Rosen's conception of journalism happening without journalists (2008) is visible in the way the crowd self-organized around geographic locales, not only reporting what they saw, but also confirming information about their vicinity and acting as "rumor patrol." Such peer-production demonstrates a higher level of coordination than simply sharing eyewitness reports and photos. These self-organized, ad hoc efforts embody many activities that fall within the domain of journalism, though some of the actors may not view themselves as journalists. Yet, to the extent that these self-organized efforts relied on a platform maintained and shaped by journalists, the role of the professional is not diminished but *extended* (Dynes, 1970).

Rosen's definition of citizen journalism, "when the people formerly known as the audience employ the press tools they have in their possession to inform one another" (2008) only holds here if we acknowledge that the journalists are in a certain sense "the press tools" in this event, for they are an essential element of the infrastructure that supported the self-organized work the public conducted via the Liveblog. And it was the journalists as infrastructures, as infrastructurers, who enabled the crowd to act like reporters for the duration of the event. Similar to Le Dantec and DiSalvo's findings (2013), the infrastructuring work the journalists took on in this event supported differentiated crowd work as well as—in Le Dantec and DiSalvo's terms—"multiple publics" who made use of the Liveblog and its downstream information artifacts.

5.2.3 Journalists as Crowdsourcerers

The information collation efforts around the Liveblog can be considered as a form of *crowdsourcing*. A few of the participating journalists and other volunteers used this term to describe their work. When the national media picked up on the story, some employed the crowdsourcing term as well (Kinsman, 2011).

At a high level, crowdsourcing implies a group of people, connected through ICT, who work together to solve problem that would be difficult or impossible to solve alone. However, the term has diverse meanings. Some, like Girolamo in her comment in Section 4.1.4, invoke it as a term for aggregating citizen reported information or more actively soliciting input from a distributed crowd. Another popular understanding conflates the term with the kind of microwork that takes place on Amazon's Mechanical Turk platform (Starbird, 2012). Howe, who coined the term (2006), offers two slightly different definitions on his website (www.crowdsourcing.com), one which compares crowdsourcing to outsourcing—a definition that aligns somewhat with a microwork interpretation—and another with roots in a different kind of *source*: "the application of Open Source principles to fields outside of software."

The collaborative work described in this paper is both journalism and crowdsourcing of the Open Source variety—a crowd of people, connected through technology, working together in a self-organizing fashion on the problem of collating, filtering, synthesizing and routing information. Lajara used the term "open journalism" to describe this effort, suggesting alignment with the latter definition. Journalists made this effort "open" in multiple ways: one, by sharing their work and their work products across institutional borders; and two, by doing that work out in public—e.g. teaching new volunteers within the public forum, so their lessons could extend to others following the conversation.

The WP editors, with help from collaborating journalists, set the Liveblog platform in motion, then worked continuously over the next thirteen days to support and sustain it. Early on, they carefully crafted and maintained participant and hashtag lists, moderated content from citizen reporters, and established norms of behavior around information sharing. Later, to increase capacity, they shifted to recruiting, training and coordinating volunteer moderators. Throughout, Harris and Reischel relied on and worked to pass on their expertise as journalists and editors. They also worked to instill in the participating crowd a sense of shared responsibility and ownership, and consistently thanked and encouraged volunteers to, as others put it, "keep up the good work." This research shows them extending their institutions and practices to build a collaboration that supported information-sharing during this event, and suggests an alternative to existing perspectives on the evolving role of journalists. The journalists working to support information needs in the Catskills after Hurricane Irene were clearly not obsolete, nor were they merely gatekeepers (Shoemaker & Vos, 2009) or gate-watchers (Bruns, 2008). Instead, they were actively working to shape the information-collaboration space for effective information-sharing. In this case, journalists laid the infrastructure for a collaboration that helped to get critical information to those who needed it, and through this activity established a vital role for themselves *crowdsourcerers*, or the leaders and—in some ways—the designers of crowdsourcing efforts.

5.3 Crowdsourcing during Crisis: Designing for Emergent Infrastructure

The collaboration described in this work is also quite distinct from current approaches for designing explicit solutions for crowdsourcing. In human-computer interaction (HCI) and related fields, considerable research focusing on the Mechanical Turk platform (e.g. Kittur et al., 2008; Bernstein et al., 2010; Heer & Bostock, 2010; Ross et al., 2010) has pushed the crowdsourcing concept towards its outsourcing roots (Starbird, 2012). That line of research often uses models of distributed computing to inform the design of workflows:

> "Crowdsourced labor markets can be viewed as large distributed systems in which each person, such as a worker on Mechanical Turk, is analogous to a computer processor that can solve a task requiring human intelligence. In this way a crowdsourcing market could be seen as a loosely coupled distributed computing system." (Kittur et al., 2011)

Research attempting to design crowdsourcing solutions for news production has often approached the problem from this engineering perspective. In their research, Kittur et al. (2011) present a framework for crowdsourcing complex tasks and used the creation of scientific news articles as an example, demonstrating some success at using a crowd to generate news. Their system breaks the work of news production down using a computer science technique of partitioning, mapping, and reducing subtasks. Agapie and Monroy-Hernandez are developing and evaluating a platform designed to crowdsource local news production (2014). Their application, targeted at locally-relevant events that would not normally receive media attention, breaks down local news production into three types of tasks: reporting, curating, and writing. Though the system incorporates real-time feedback for workers, in its current version it handles all of the coordination work between workers—i.e. workers do not coordinate directly with each other. In a slightly different application within the crisis response domain, researchers are building and evaluating a crowdsourcing system that utilizes the crowd to help categorize and map social media data, using a microwork model (Imran et al., 2014). Though clearly useful for certain types of information-filtering and production, these formalized and rigidly structured solutions for crowdsourcing news production make a sharp contrast with the kinds of work that took place through and around the Hurricane Irene Liveblog.

Examining how this emergent crowdsourcing effort "worked" offers insights for designing future crowdsourcing platforms. This group was seeded by a group of journalists who appropriated available tools; recruited, trained and worked directly with online volunteers; and extended their existing work practices to improvise in the gaps of emergency response. Successful improvisation, though it may look random, requires participants to perform on top of a shared set of rules, norms, and understandings. In the case of the Hurricane Irene Catskills Liveblog, the collaboration was structured around shared norms and practices within journalism, and a common understanding across several key participants of what a newsroom is and does. This crowdsourcing effort can be seen as emerging from the work practices of journalism, rather than being derived from computer science and engineering principles, and it positions the participants within this collaboration, especially the journalists, as not merely users of ICT, but *designers* of that ICT (Pipek & Wulf, 2009).

To design information systems that can perform as infrastructure, Pipek & Wulf (2009) encourage the consideration of users as designers in situ performing infrastructuring work as needed. They focus on the *who* and the *when* of infrastructuring, as well as the concept of *embeddedness*. We employ this lens to further highlight the incompatibility of existing crowdsourcing design techniques and the organic crowdsourcing efforts we see emerge again and again during crisis events.

- *When did infrastructuring occur?* For the Hurricane Irene Liveblog, the infrastructuring work took place dynamically and adaptively as the event unfolded.

- *Who did the infrastructuring?* This work was largely conducted by journalists and other knowledge workers within the impacted region who had expertise with various tools and platforms, as well as local knowledge.
- Many of the participants in this collaboration were *embedded* in a particular knowledge work culture (journalism) and within the affected community (or just outside of it).

This arrangement was particularly effective in this crisis, and is likely to have value in other crisis contexts as well—when needs are unpredictable and changing, systems have to be adapted in the moment; when local knowledge is critical, the design team needs to include people with knowledge, expertise, and resources that are situated in the affected area.

This case suggests a different approach towards designing "crowdsourcing" systems for emergent collaborations, one that acknowledges design in-situ on the part of participants. In terms of technology, this research suggests that these designers look towards platforms that are easily appropriated and configured, and ones that are robust—i.e. can handle the massive convergence of participants occurs after a crisis event. Looking at how the Liveblog platform was utilized in this case, one feature that was important was its ability to integrate multiple information types—e.g. Twitter, comments from moderators, comments from the crowd. Related to that, functionality that allowed leaders to connect to others, recruit volunteers, and coordinate was extremely useful in this case. A collaboration is not just technical infrastructure, however, it is also *human infrastructure* (Lee et al., 2006). Human infrastructuring includes assembling the necessary expertise, including those we found important here: local knowledge, skills with recruiting and leading volunteers from the crowd, and knowledge of work practices around information vetting.

6. Conclusion

This research examines the activities of an emergent group of media professionals, citizen reporters and online volunteers who came together after Hurricane Irene to share and curate information related to event impacts in the Catskill Mountains of New York.

Within this multi-sited collaboration, individuals worked to get information to those who needed it, often moving information from one platform to another and one medium to another. In this case of an impacted community with uneven access to telecommunications infrastructure, this activity included moving information between digital channels and analog ones—e.g. from the Liveblog to the local radio. Collectively, this work served to bridge gaps in telecommunication infrastructure and ICT access and use, and functioned, in our view, as a *human-powered mesh network*.

In this arrangement, the work of creating, shaping and sharing information was differentiated and divided based on the situated-knowledge and available resources of individuals within the crowd. That differentiation unfolded rapidly in response to the crisis. Those in the impacted area could report and vet information about their locality with their neighbors. Those outside the region could moderate the Liveblog to support the quality of information and maintain the social norms of the forum while other information specialists created important information artifacts like the crisis map. And a few local journalists intentionally blended the ethic and practices of open source with their own journalistic practice to scale their ability to cover the event.

This case highlights a changing role of journalists, specifically during crisis events, as they adapt to a new information space increasingly influenced by peer-to-peer sharing technologies. The activity documented here was not merely focused around gathering information from the crowd, but was instead one that incorporated the crowd as co-collaborators in a multi-faceted activity that collected, curated, synthesized, and re-broadcast information across technological divides.

In this paper, we describe how these journalists leveraged their existing expertise while helping to organize, support and motivate a distributed group of crowd workers. These efforts, which we describe

through the lens of infrastructuring (Star & Bowker, 2006), included appropriating, configuring, deploying and maintaining the technical infrastructure, and providing the human infrastructure (Lee et al., 2006) by pulling together collaborators, establishing effective work practices, and leveraging their local knowledge and expertise as journalists. This activity suggests a potentially critical new role for journalists as leaders of crowdsourcing efforts during crisis events. These findings also illuminate a disparity between how HCI researchers are designing crowdsourcing platforms for news production and how organic crowdsourcing efforts are serving to inform publics during disaster events.

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