

Citizen Communications in Crisis: Anticipating a Future of ICT-Supported Public Participation

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ABSTRACT

Recent world-wide crisis events have drawn new attention to the role information communication technology (ICT) can play in warning and response activities. Drawing on disaster social science, we consider a critical aspect of post-impact disaster response that does not yet receive much information science research attention. Public participation is an emerging, large-scale arena for computer-mediated interaction that has implications for both informal and formal response. With a focus on persistent citizen communications as one form of interaction in this arena, we describe their spatial and temporal arrangements, and how the emerging information pathways that result serve different post-impact functions. However, command-and-control models do not easily adapt to the expanding data-generating and -seeking activities by the public. ICT in disaster contexts will give further rise to *improvised* activities and temporary organizations with which formal response organizations need to align.

Author Keywords: Disasters, crisis, crises, extreme events, NIMS, peer to peer, grassroots, policy, volunteerism

ACM Classification: H.5.3 Groups & Organization Interfaces—collaborative computing, computer-supported cooperative work, organizational design, K.4.1 Public Policy Issues, K.4.2 Social Issues, K.4.3 Organizational Impacts—computer-supported collaborative work

INTRODUCTION

Information and communication technologies (ICT) are bringing about remarkable changes in response to disasters. New ICT research and development efforts from HCI-related communities are being directed at formal response

activities in emergencies and crises. This includes work in the areas of emergency medical service [18, 26], structural and wildland firefighting [6, 22], urban search rescue [32], emergency evacuation simulation [23], emergency dispatch work [3, 34], and information systems modeling for formal response [5, 16, 43, 51].

However, in addition to the attention to formal response activities—those activities by emergency personnel to assess and manage crisis and perform search and rescue—uses of ICT that were not previously forecasted (*v.* [37]) are now emerging. Specifically, the role held by members of the public in disaster—a role that has always been characterized as one of high involvement by disaster sociologists throughout the nearly century-long history of disaster research—is becoming more visible, active, and in possession of greater reach than ever seen before.

Activities by members of the public in disaster situations are an emerging form of societal-scale computer supported cooperative activity that extends and challenges our knowledge of computer-mediated interaction. Not only is peer-to-peer interaction a phenomenon of sociological and technological design interest, but so too is how citizen-generated information affects the work practices within the organization of formal response. The latter provides an opportunity to extend the foundational HCI/CSCW research on work practices within command-and-control and safety critical environments [15, 17, 19, 20, 21] to the less stable and more socially distributed situations of disaster.

It is no surprise that members of the public used the internet and mobile phones to communicate in recent disasters, since these *citizen journalism* activities [13] were themselves reported widely by popular media. The December 26, 2004 Indian Ocean Tsunami and August 29, 2005 Hurricane Katrina crises each garnered tremendous public response in the form of blogs, photo and video sharing, and other online venues where people made offers of housing, jobs and emotional support [33].

This paper offers a new perspective on and framing of citizen-based activities that arise out of peer-to-peer communications in disaster contexts—activities that serve

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important tactical, community-building and emotional functions. We draw on disaster sociology research using an information science perspective to parse and analyze emergent behaviors, and to anticipate where the public's involvement in disaster response is heading in our expanding digital world. Our goals for this paper are to set the stage so that such issues can be further explored empirically, and to outline high-level concerns for ICT development and deployment. Our understanding of this new form of interaction is important for information scientists to pursue in terms of technology design and development: with much new attention to the crisis arena by technologists, it is critical that introduction of such technology be conducted with an appreciation for its unique social arrangements. We see the new attention to the disaster domain as an opportunity for our community to influence policy and bring our skills on ICT and organizational sciences to bear on shaping the emergent organizational forms that might account for, support, and adapt to ICT-enabled public participation activities.

Approach and Scope

Our paper is one of synthesis and analysis across domains of expertise, drawing from disaster sociology literature to newly frame from an information science perspective the basic features of what we call the *ecology of peer-to-peer communications*. We restrict our consideration to persistent forms of communications that emerge *during* or *after* disaster strikes. By *persistent* forms, we mean communications that are visible, recordable, and/or transferable to other people over time. In disaster settings, these include missing person fliers posted around an impact area, SMS messages inquiring about the safety of a friend, chalked messages or pictures on a sidewalk, spray-painted messages on buildings, MMS video, messages on web-based discussion sites, among others. Peer-to-peer communications can arise before a disaster strikes during the pre-impact warning stage: this is another large area for innovation and information science involvement that is beyond the scope of our discussion here.

We draw upon our own original on-site and remote research of the August 29, 2005 Hurricane Katrina aftermath; from secondary sources reporting empirical findings from other disasters; and from interviews with disaster social scientists present at specific crisis events.

We conceptually and analytically consider both digital and non-digital messages. There are multiple reasons for this. First, the more visible citizen role—as now enabled by ICT—is recent, but public participation is not, so there is much to be learned from events predating the recent years of high internet access and mobile telephony diffusion. Furthermore, the availability of such technology and rights to digital information access vary considerably around the globe. We can anticipate future ICT-enabled directions by learning from past and ongoing behavior of low-tech messaging interactions. Second, disasters can level

telecommunications infrastructures: low-tech messaging will remain a critical way for impact-area residents to share information. Third, conceptual consideration of low- and high-tech messaging together reveals attributes of existing and emerging information pathways that run between people and organizations—pathways that are subject to changing policies and socio-technical practices in a new political world of disaster response.

Our paper places peer-to-peer communications activity in an organizational context of formal agency response to anticipate the implications of this emergent behavior on and within the formal response effort itself. Cultural and political matters are inherently at work here; given this, we discuss implications for formal response in the US context within which we live and work, even though we have global society interests.

In the US, new federal policy mandates conformance to a personnel and procedural response system that relies on a command-and-control model, where a designated authority controls personnel and resources in a hierarchical reporting structure for the purposes of executing a mission. However US policy continues to develop, especially in light of Hurricane Katrina response failures [44, 45], it is clear that the role of the public must be addressed in formal response, something that this emerging *all-hazards* response model does not easily do. Our stance is that the old, linear model for information dissemination of authorities-to-public relations-to-media is outmoded [30], and will be replaced—at least in practice—by one that is much more complex. The peer communications described here are a critical piece of these emergent information pathways.

The remainder of our paper is organized as follows: We first review disaster sociology literature to establish the role of citizens-as-participants in disasters. We then look at two recent, contrasting disaster cases—the August 29, 2005 Hurricane Katrina disaster in the Gulf Coast region of the US and the September 11, 2001 World Trade Center attacks in New York City—to illustrate differences in the nature of peer-to-peer communications post-impact. We follow with a brief review of additional cases to illustrate other forms of peer-to-peer communications. We then discuss the implications of this kind of citizen-led activity for the command-and-control model of response, identifying areas of concern for organizational change in the presence of ICT and opportunities for ICT innovation and research.

PUBLIC PARTICIPATION IN DISASTER

High involvement by members of the public in disaster is not new, though ICT makes their role more visible and broadens the scope of their participation. Disaster social scientists have long documented the nature of post-disaster public participation as active and largely altruistic. “First responders” are not, in practice, the trained professionals who are deployed to a scene in spite of the common use of that term for them; they are instead people from the local and surrounding communities [9] who provide first-aid,

transport victims to hospitals in their own cars, and begin search and rescue [11, 40, 41]. Indeed, in cases of structural collapse, the majority of those saved are by local, emergent volunteer groups [1]. Individuals and local groups come together as emergent, temporary organizations that *improvise* rescue and relief efforts [29, 47]. For example, following 9/11, ferry captains and others self-organized to systematically evacuate people from Manhattan Island [25]. Members of the public in the immediate and surrounding area of a disaster provide relief in the form of shelter, clothing, blankets and food [40]. Victims of disasters—to the extent that they can—are themselves often among the volunteers. Faith-based organizations—church groups—provide both planned relief services including, for example, child day-care while parents complete insurance claims paperwork, as well as *emergent* services such as those provided by the St. Paul's Chapel in lower Manhattan in the wake of the September 11 disaster. The church became a respite center for recovery workers and was staffed by church volunteers for months following [38; Jeannette Sutton, personal communication]. It is also the local community that manages and shapes long-term recovery once the immediate response effort is complete. The public, in several ways, is central to disaster response.

In addition, people are natural information seekers, and will seek information from multiple sources, relying primarily on their own social networks—friends and family—to validate and interpret information coming from formal sources, and then to calculate their own response measures, such as when they will leave and under what conditions [30, 46, 48, 49]. Several studies (*e.g.*, [8]) found that people will often collectively decide with their extended family, friends and neighbors their evacuation behavior based on their interpretation of warning content, its mode of communication, and its source.

This brief survey of the public's participation in disaster illustrates that significant informal work is performed outside the formal response efforts. The sociology of disaster includes a public with its own impetus for participation that formal agency response has always needed to consider—though whether it has, or whether it has done so effectively, continues to be the question.

Changing Times for Public Participation

Broadly speaking, two forces—one socio-political and one socio-technical—require that the issue of public participation be addressed more fundamentally in formal agency response. First, the US national agenda calls for an all-hazards personnel and procedural system for disaster response. This system has been instituted federally, and is built on a command-and-control reporting model that does not include built-in considerations for the important roles that members of the public already play as participants—and not just victims—in disaster response.

Second, the possibilities for public participation are expanding with increased access to the Internet and the

wide diffusion of mobile technology—mobile phones, text and multimedia messaging, and global positioning devices. This technology in the hands of the people further pushes on boundaries between informal and formal rescue and response efforts, and has enabled new media forms that are broadly known as citizen journalism [13]. For example, wikis, which are websites that allow people to openly contribute by adding and/or editing content, enable broad participation in the creation and dissemination of information. Some visual wikis use mapping technology for linking textual or photographic information to representations of physical locations, thereby documenting, for example, the extent of damage to a specific neighborhood. Recent disasters show how people, whom we already know will seek information from multiple sources during uncertain conditions, have fueled the proliferation and utility of these sites. In this way, the public is able to take not only a more active part in *seeking* information, but also in *providing* information to each other, as well as to formal response efforts.

CITIZEN-TO-CITIZEN COMMUNICATION ECOLOGIES

2001 WTC Attacks & 2005 Hurricane Katrina

We now consider some of the peer-to-peer communications that arose in the aftermath of two recent disasters. These disasters, the September 11, 2001 World Trade Center attacks and the August 29, 2005 Hurricane Katrina, each occurred within the US American cultural context and resulted in catastrophic damage and loss.

The period during and immediately following the September 11, 2001 attacks on New York City were characterized by confusion and information seeking about what was happening and the whereabouts of people in the impacted region. Mobile telephony antennas located on top of towers were destroyed and other portions of telecommunication infrastructure were down. The internet provided VOIP, email and text messaging service for key city officials for managing the emergency and for providing information to the media and public [7].

Not long after these immediate phases of impact, inventory and initial rescue, an additional form of citizen-originated communication emerged: persistent peer-to-peer communications in the form of fliers and posters literally papered buildings, fences, cars and signposts around the region of impact, resulting in a remarkable landscape [31]. As soon as it was safe to be downtown, friends, family and co-workers posted missing person fliers that displayed photographs, social security numbers, company affiliation and other identification information. These messages were intended to reach a wide but local audience of people who might have knowledge of the missing people. The thousands of fliers tended to be clustered around areas of existing or new significance, such as at a checkpoint into the cordoned off impact area, near family assistance centers, and churches [Tricia Wachtendorf, personal communication].

As time went on, these fliers took on a different meaning when it became clear that missing people would unlikely be found alive. The messaging areas evolved into makeshift memorial sites [14] with candles, teddy bears and additional messages of support where both locals and out-of-towners converged. Other kinds of persistent communications appeared in the form of messages written in the dust on buildings and windows or in chalk on sidewalks, and included poems, stories and artwork with emotive, religious, and political content.

In contrast, in the immediate aftermath of Hurricane Katrina, which made its second and most destructive landfall on August 29, 2005 along the coasts of Louisiana and Mississippi, a very different kind of citizen communications ecology emerged.

Shelters and web sites emerged as the destinations—information hubs—for seeking and providing information. Our own *quick response research* [36] as well as others' [Brenda Phillips, personal communication] following Katrina showed that shelters—especially the large shelters—became information hubs for shelter residents as well as other people. Because post-crisis shelters are usually much shorter-lived, this kind of high volume information exchange was atypical. Our research showed that the large, American Red Cross-run shelters had to establish well-organized call centers for incoming calls to residents (who sometimes numbered in the thousands); they also had to establish processes for recording, transmitting, and assuring that messages were received. The call centers also fielded queries from evacuees who were staying in hotels or with area friends and relatives, answering questions about how to get relief assistance, contacting the Federal Emergency Management Agency (FEMA), and so on. Some people had cell phones, but coverage was limited, and finding places to charge them was difficult. Indeed, shelter landline phone banks still had lengthy waits nearly one month later. The shelters were also the information destinations for people who wanted to offer help of housing and jobs—many such offers were posted as paper fliers on makeshift bulletin areas.

Some shelters had a few networked computers for accessing websites and looking up information and satellite images of their neighborhoods and businesses. (One month after the hurricane, only 8 computers were available for approximately 1000 residents in the large River Center shelter in Baton Rouge). For very many shelter residents, this was the first time they used a computer, and they needed hands-on training to use a browser, set up an email account, and so on. Weblogs, wikis, and other web-based resources were created by the greater public to assist displaced citizens. These websites provided virtual gathering spaces where the public could share information, find missing people, as well as coordinate relief efforts, though it meant that people had to visit multiple—potentially hundreds of—sites for a truly comprehensive search. On visual wikis, people annotated maps with textual

and visual information about damage to neighborhoods, specific houses, and landmarks. Web sites were set up by grassroots and later official relief efforts to help coordinate the widespread national effort to provide housing for displaced victims of Katrina. Coordination was largely done peer-to-peer between those offering and those needing housing, though the numbers of successful transactions remains uncertain.

Disaster Characteristics & Communications Ecologies

The Katrina and WTC citizen communications ecologies were quite different. Contrasting them makes the reasons quite apparent: the physical characteristics of the disaster agents and their social consequences gave rise to differing spatial and temporal arrangements for community response.

Stage 0: PRE-DISASTER State of social system preceding point of impact
Stage 1: WARNING Precautionary activity includes consultation with members of own social network
Stage 2: THREAT Perception of change of conditions that prompts survival action
Stage 3: IMPACT Stage of "holding on" where recognition shifts from individual to community affect and involvement
Stage 4: INVENTORY Individual takes stock, and begins to move into a collective inventory of what happened
Stage 5: RESCUE Spontaneous, local, unorganized extrication and first aid; some preventive measures
Stage 6: REMEDY Organized and professional relief arrive; medical care, preventive and security measures present
Stage 7: RECOVERY Individual rehabilitation and readjustment; community restoration of property; organizational preventative measures against recurrence; community evaluation

Figure 1. Eight Socio-Temporal Stages of Disaster [9, 35]

The September 11 terrorist attacks resulted in a highly destructive disaster with a short impact duration and *no forewarning* (no Stage 1 and shortened Stages 2 and 3, see Fig. 1), but it had an *impact area* contained in geographic scope (Fig. 2)—what is known as a *localized* disaster. The region that included the World Trade Center was of a size that could be cordoned off with checkpoints that allowed limited access into the specific area that would come to be known as "Ground Zero." The cordoning of the *total impact and fringe impact* areas created new places for public gathering at its perimeter, an area known as the *filter* area where services, equipment, and information were staged for use in the fringe and total impact areas. This is how activity in the filter area is commonly characterized, with aid and resources provided by the *community aid* and eventually *regional aid zones* (Fig. 2). The location of public services, such as family assistance centers and faith-based relief help

centers in the filter area created additional places for exchange of information and later, for wider public gathering [Wachtendorf, personal communication]. Furthermore, the kind of information initially being sought—locating missing people—was thought to be found in this contained area surrounding the impact site.

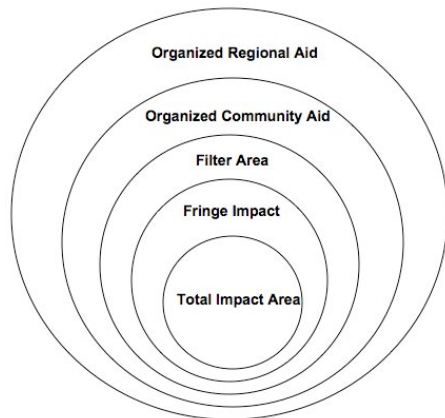


Figure 2. Spatial Disaster Zones (adapted from [9])

The transitions from the stages of Impact, to Inventory, to Rescue, to Remedy to Recovery (Stages 3-7, Fig. 1) were rapid. For only a matter of days were people hopeful that missing people might be found; it was during this time that information sharing by members of the public shifted from a rescue-related orientation to what Dynes calls *community evaluation* [9], a period that marks movement to recovery and sensemaking. Similarly, though web sites appeared following the disaster, they tended not to be for the purposes of locating people, but rather for this later-stage activity of memorializing and discussing the social and political implications of the event (Stage 7, Fig. 1).

Hurricane Katrina, in contrast, occurred over a vast region and over a lengthy amount of time. The widespread destruction by Katrina in the city of New Orleans was fueled by a hurricane that came with advanced forewarning when preparatory activities by authorities and households began (Stages 1 and 2, Fig. 1). However, it was not the hurricane that caused the most damage in the city, it was the secondary effect of Lake Pontchartrain levee breaches that led to the real disaster of city-wide flooding. Therefore, many people evacuated in anticipation of a serious hurricane, but did not plan to be gone for weeks and in many cases, indefinitely. Still others did not attempt to evacuate initially, some thinking they could weather the storm, but many others because they did not have means of transportation and resources to stay elsewhere. Not only was the city's population widely dispersed, the hurried late-stage, post-flooding evacuations meant that families were broken up, often without easy means of reuniting.

The *filter area* where resources are staged was also distant and vast. In our own investigations, we saw how the greater Baton Rouge area, located an hour away from New Orleans, was the staging area for the closest shelters and

both the enormous FEMA and American Red Cross headquarters, though the city itself was still too small to house all workers and volunteers in addition to displaced residents. Several shelters were located in Baton Rouge, however, hundreds more were established across Louisiana, Texas, and Mississippi, with each state requiring a FEMA headquarters. Eventually, shelters were opened in all 48 contiguous states to accommodate the massive evacuation.

With the population dispersed across the United States, the community *zone of effect* [9, 12] was therefore extended into other US states, where resources like housing and school education were heavily taxed. The *regions of community and regional aid* (Fig. 2) were blurred and extended effectively across the entire reach of the US. Because the temporary and permanent sheltering of people, cleanup, and infrastructure rebuilding was (and continues to be) of such massive scale, the socio-temporal stages of Inventory, Rescue, Remedy and Recovery were extended, and experienced differently across sub-populations.

The rise, then, of web sites as virtual information hubs as well as large shelters as physical information hubs dotted across the region served in place of what often takes place in the filter and community aid areas of localized disasters like 9/11, areas that are more typically constrained by geographical place and a time interval of shorter duration.

Additional Brief Crisis Cases

Other crises highlight additional characteristics of citizen communications under different conditions.

2003 China SARS Epidemic

In early 2003, the SARS epidemic emerged in China and became a prolonged and emerging crisis with uncertain and changing spatial extent, and with little information provided by official sources. The crisis was not spatially distinct from non-crisis areas—people were living and working within the space of the ensuing problem. These conditions gave rise to peer-to-peer communications that sought and provided information about the physical locations of apparent SARS victims. This largely came in the form of SMS text messaging, which could be discretely sent between citizens without repercussion [28]. Over the long span of the crisis, a reported 120 million text messages were sent. Peer-to-peer information dissemination led to rumor and then humorous content [28], a reflection of the crisis moving from individual to collective action and eventually community evaluation.

July 7, 2005 London Tube Bombings

The London underground bombings suggest how another kind of citizen communications will be enabled in the future. In the UK, camera phones with multimedia MMS messaging were already common in Summer 2005. The sudden, unexpected impact of the bombings created structural damage in specific places that left people trapped underground. Victims were able to take photos and video of their surroundings. Though the lack of mobile phone

coverage in the subway and a general failure of the telecommunication infrastructure to support emergency services meant that this information could not be immediately provided to authorities, they were eventually forwarded to police and became helpful in the investigation, as well as broadcasted through the media around the world.

Earthquakes World-Wide

Earthquake social scientist Louise Comfort's research of 15 earthquakes worldwide shows that the post-strike, peer-to-peer communications behavior is similar to that following 9/11, where localized, in-place communications in and around the region of affect arose. Fliers and posters collected outside "municipal buildings, local stores, churches, mosques, nailed to trees, fences, and hung from banners across public streets." After the September 21, 1999 ChiChi, Taiwan earthquake, information was posted at Buddhist shrines, "which had long served as communication centers for the damaged communities." In Banda Aceh on the island of Sumatra following the December 24, 2004 Indian Ocean earthquake and tsunami, the UN Humanitarian Information Center became the kind of information hub that the shelters served in Katrina. Already a place to receive information, the Center became a clear location for public gathering in a city that experienced heavy destruction [quotes and accounts, Louise Comfort, personal communication]. These examples illustrate the saliency of cultural symbols and local geography in disaster, which is present in all situations of disaster.

Wildfire Incidents

As with Hurricane Katrina and the December 26, 2004 Indian Ocean Tsunami (the Sumatra-Andaman earthquake), the large spatial extent of wildfire means that there are few obvious gathering places. Residents are evacuated outside a large area denoted by the "trap line"—the miles-long cordoning of the fire region. People are dispersed in hotels, shelters, and friends' homes while they wait for days for fire to subside. However, wildfire hazards differ because they are seasonally predictable and their paths—unlike the more erratic hurricanes—can usually be projected to allow forewarning. People who live in wildfire hazardous regions are encouraged to develop evacuation contingency plans that include places to stay, means of transportation, and ongoing contact with friends and family. Information seeking tends to be directed at learning about the safety of their own homes and livestock, and anticipating their return.

In wildfire, traditional methods of information dissemination come from the public relations arm of the formal fire response, with information distributed to news stations to reach the dispersed audience. Recent wildfires in the western United States illustrate notable changes in information dissemination. The first illustration comes from the case of "Ranger" Al in the massive 2003 San Bernardino, California fires, who declined to evacuate and instead served as a point of contact to neighbors who left. Al came to field calls from many residents who wanted

specific information about the status of their homes, and eventually, someone on the outside of the trap line developed a web site with the information he provided that eventually received more than a million hits [39]. A second illustration is the formal public relations effort that uses ICT to disseminate information quickly in the form of one of the first web-based *Joint Information Center* sites designed with the general public as its audience. A similar information dissemination effort was seen in the 2003 Glacier National Park fires where web sites by the formal response effort and those developed by citizens were linked together in an effort to show cooperation, and to make sure that inaccurate rumors about safe return, for example, were not passed on to the public [Theron Miller, personal communication]. These changes highlight how ICT enables citizen-led information dissemination to exist outside formal information dissemination channels, and how formal channels can adapt to accommodate these new sources.

Summary

Citizen-to-citizen communications—with our particular focus on persistent forms—during and following a disaster arise out of needs to help and be helped. Its forms depend on how the physical characteristics of the disaster agent affect the built and social environment, which in turn results in different spatial and temporal arrangements for communications. People not only seek *response- and rescue-relevant data*, but opportunistically and actively provide it as well (eg., information about structural damage, flooding, places where people need to be rescued, missing person searches, and so on). They also seek and provide *relief assistance* (eg., information about housing, food, jobs, transportation help). Peer-to-peer communication can also be *emotive and evaluative* (including expressions of anger, grief, humor, wishes of support, political statements, and religious content). The communicative role of a message can also, of course, evolve over time as more information about an event emerges.

The forms that citizen communications take of course depend on what media is available at a given time, but it does not account in total for what we see. Even in the presence of ICT, physical places, for instance, will continue to have a role in citizen communications because of the meaning inherent in those particular places; because they target the right audience for a particular message; or because they more readily afford the presentation of artwork, objects and other components of emotional or evaluative expression. However, we also see that ICT affords new forms of peer-to-peer communication not previously seen, though still motivated by the same impetus that generates all public participation in disaster.

CITIZEN COMMUNICATIONS IN THE LARGER CONTEXT OF FORMAL RESPONSE

Data Intelligence & Coordination of Relief Work

Emerging ICT-supported communications in crisis will result in at least three changing conditions that need to be

addressed by the formal response. ICT-supported citizen communications can spawn, often opportunistically, information useful to the formal response effort. This includes the kind of information produced by MMS communications in the 2005 London Bombings, information that can contribute to the tactical or intelligence activities in crises (and serve other functions as well).

The availability of this data means that people can further seek and access information from each other. The recent availability of high-resolution aerial and satellite images on the web (eg., <http://earth.google.com/katrina.html>) provided a valuable resource to people in the 2005-2006 Gulf Coast hurricane season. Such capability can help the formal response effort in collecting and providing information useful to the public (as it now depends, in practice, on the media help to do) but can also place additional demands on the formal response effort to do additional verification.

Citizen communications can also create new opportunities for the creation of new, temporary organizations that help with the informal response effort. The idea of emergent or ephemeral organizations that arise following disaster is not at all new; in fact, it is one of the hallmarks of disaster sociology, and supports the need for communities to be able to *improvise* [27, 29, 46, 47] response under uncertain and dynamic conditions. ICT-supported communications, however, add another powerful means by which this kind of organization can occur. No longer do people need the benefit of physical proximity to coordinate and serendipitously discover each other. Rather, as we saw in Hurricane Katrina, the involvement of people well outside the impact, filter and surrounding community areas was made possible by nation-wide grassroots coordination on web sites where offers of housing and other assistance were made to those dispersed far and wide [33].

These forms of public participation map to functions of the formal response effort: the strategic or intelligence functions, public relations, and the coordination of relief work. How to account for the role of public participation in formal response efforts, however, is not an easy question to answer, especially in light of recent US national policy.

The Challenges of Command-and-Control Structures

In the US, a 2002 Congressional statute mandated the federal-level implementation of the National Incident Management System (NIMS). NIMS is a quasi-military organizational structure built upon the 36 year old Incident Command System (ICS) used in wildfire suppression. NIMS/ICS is built on a chain-of-command model that is meant to unambiguously divide responsibility of labor and support inter-jurisdictional coordination. NIMS/ICS uses a formal set of organizational roles that are filled as the need arises. The Incident Commander (IC) is the single person in charge of the entire effort who is given the authority of unified command, which puts command control in one person to which all agencies report. Officers are appointed to lead five organizational branches: Command, Operations,

Logistics, Planning and Finance. The Information Officer (who manages public relations) also reports directly to the IC, although, notably, this is not a chief-level position.

As a command-and-control structure, NIMS/ICS works well for dealing with disaster agents like fire. ICS arises from the practice of *fighting* fire, which is a kind of disaster that is protracted over long periods of time: *the personnel fight the disaster agent itself*. Also, we note that in fire, ICS is not used for post-disaster community and ecological recovery. ICS in fire is not directly responsible for relief and recovery efforts.

Therefore, in other kinds of disasters, the comprehensive applicability of this kind of command-and-control structure is far less clear [42, 50]. As we have explained, many disasters have single, short impact but with long post-impact phases of rescue and recovery where most of the formal work is directed. A quasi-military response to disaster frames disaster as a problem of restoring law and order, not one where the public welfare, health and community ties need to be restored and maintained, which in large part happens through the *very involvement* of the public itself [2]. Wenger et al. [50] note that ICS as an all-hazards response organization is “particularly weak in integrating the activities of relief and welfare agencies as well as not being receptive to the use of volunteers” (p. 12). Although the roll-out of this federally mandated system has always posed these particular problems, some issues have become all the more potent given the increasing ICT-enabled reach that the public now has. We now turn to these and other implications for ICT development and incorporation into the institutions of disaster response.

DISCUSSION & IMPLICATIONS

Our presentation has considered aspects of citizens’ communicative activity during and following disaster events. Different kinds of communication—both low- and high- tech—emerged depending on what was available when and to whom, and what needed to be communicated. The use of ICT in the more recent disasters is further heightening public participation, and suggests the new information pathways that will emerge in the future. We summarize these pathways, and discuss implications for the formal response and opportunities for design.

New Information Pathways

We draw attention to three information pathways that are either open to new ICT design or are originating from increasing ICT-enabled citizen participation. The first, *communications within the public affected by a crisis*, are not entirely new as we have explained, but they certainly are taking new shape. Especially for those hazards agents that result in a protracted impact phase (Fig. 1), like wildfire or public health crises where telecommunications infrastructure is not seriously affected, how information about the event is shared will quantitatively and qualitatively change. The post-impact phase will give rise

to more tactical- or rescue-related information depending on what infrastructure is in place and the spatial extent of the crisis. Emotive and evaluative expression characterizes peer-to-peer interaction in physical, public settings during the later stages of disaster recovery—an area that offers opportunity for ICT development.

A second information pathway runs *between members of the public who are affected by the crisis and those outside it*. This communicative pathway noticeably materialized following Hurricane Katrina when people across the US offered shelter and employment to displaced people. The potential for this pathway is enormous, and raises major questions for the organization of formal response.

The third information pathway *between the official public information officer function and members of the public* will shift from a mostly one-way depiction to two-way depiction of information exchange. This pathway will arise out of the need for an organizational destination for the data that citizens collect at the scene of the disaster.

Implications for Formal Response to New Pathways

Implications for the Information Officer Function and Intelligence Functions. How should data intelligence that arises out of citizen communication—the photos at the scene, GPS data points of destruction or of the stranded person in the flooded attic—be incorporated into the organizational structure of formal response? We anticipate that changes resulting from the tension between the mismatch of the public's role in disaster and command-and-control models of crisis response will first appear organizationally at the point of the public relations arm (the Public Information Officer or PIO function in the NIMS model). People employed in this function already have experience not only with providing information to the public, but also in receiving information, in part to understand what correct and incorrect information is circulating. Since the PIO is likely to first encounter information generated by members of the public, and therefore to appreciate the active role members of the public play in response, it could be the most able to act on such information and instigate organizational change from, in essence, the bottom-up.

Furthermore, new demands will be placed on this arm of the organization as members of the public obtain information from multiple sources. The public relations arm of crisis response exists exactly for this purpose, but will have to increasingly address its role vis-à-vis these other sources. The case of the wildfire *joint information center* activity described earlier in this paper, where the official web site and a citizen-led web site mutually pointed to each other is an early instance of how these sources could align.

Information collection and verification means that the whole organizational arm could be promoted to a more complex function of information management. Though the public relations role is in theory informationally

downstream from command, increased data intelligence coming in means that it could grow in importance to come to organizationally reflect the more visible role of the public. As such, we see this place in the organization—and not just the more visible and exciting command center and “first responder” roles—as a fruitful focus for further CSCW-and HCI-driven research and development.

Implications for Relief Efforts. As the reach of response extends to a broader audience with ICT, how will the formal response effort align with, support and leverage wider community response? Relief work—the provision of food, shelter and basic necessities—already largely arises out of volunteerism through either grassroots efforts or managed through official channels. In the US, the Red Cross is federally mandated to provide domestic relief (unlike its role in the rest of the countries of the world). In addition to its own direct relief work, it helps coordinate relief assistance offered by other organizations, often with coordination plans established in advance. In addition, the National Voluntary Organizations in Disaster (NVOAD) is a body that helps coordinate efforts from many organizations that have missions to serve in disaster.

Beyond these planned volunteer efforts are those many efforts that emerge out of a latent need when disaster occurs [38], as we reviewed earlier. Many of these efforts band and disband fluidly, precisely because they arise to fill obvious needs. However, with the opportunity for more ICT-enabled participation, where web sites offering help can easily spring up and messages be easily posted, we foresee that a means for organizing, pruning, promoting, and coordinating these new volunteer activities will emerge to make them more effective and coordinate with the formal effort, much like the Red Cross and the NVOAD before.

ICT Design Implications

The opportunity and need for ICT development to support the kind of peer-to-peer communications we discuss here is wide. Our first objective of this paper is to show that work in crisis events extends beyond the narrow window of post-impact response by emergency workers—the window that tends to get the most research attention. The next objective is to show how the widening activities of the public are an important area to direct this attention, because the formal organizations of crisis response will be subject to change from the outside-in as much as from the inside-out.

We have shown how different forms of and content in peer-to-peer communications arise depending on the spatial extent and temporal pace of crises. Development and research attention, then, can focus itself by understanding the particular needs and social and technical infrastructural capabilities of the different spatial zones (Fig. 2) and temporal phases (Fig. 1), and the activity of the information pathways that occur there. For instance, mobile applications that use geographical-, social-, and community-awareness and social recommender services [e.g., 10, 24] might not be usable in the immediate aftermath of disaster strike, but can

serve an important sociological function at a later phase once infrastructural repairs are made. Coordinated ICT support can help volunteers outside the disaster region begin to immediately self-organize to offer relief to the affected region. Volunteers seeking information in the filter region—outside the impact area—might benefit from specialized mapping and location-aware support to navigate through an unfamiliar region and make queries about sharing rental cars and finding places to stay, for example.

Transitions between temporal phases and spatial zones are also critical places to focus in on development. At these transition points will be the challenge of moving from paper-based to digital media (and vice versa) because of different capabilities over time and/or in different spatial zones, different access by different populations, and appeals to different and unknown audiences.

For example, though offers of housing were made by people on web forums from across the US following Hurricane Katrina, it is not clear how shelter residents—many of whom had never used a computer before and only had very limited computer access after having learned—were meant to receive those offers. Neither was it easy for people from miles away who sent job announcement fliers to big shelters to convey that all jobs were filled after a time. Digital media and paper media afford different functions. Physical locations of messages can imbue additional meaning to message content. A message-in-place might pinpoint critical information about something that happened there or be in place for a particular audience. So, though digital messages can be easily transmitted elsewhere, this can mean loss of context with loss of the original author-audience relationship. Digital messages are often timestamped; paper-based messages are often not, based on our own observations in Katrina shelters. There is a need to marry physical and digital information hubs so that information can co-exist with the benefits of each.

As a final point, we make this closing observation and appeal: Not only can crisis situations benefit from informed ICT development, ICT development can benefit by working within crisis settings. Though disaster situations are special sociological conditions, they affect sometimes all aspects of a society—all social strata (though the disadvantaged are disproportionately affected) and activity—sometimes exposing features hidden to us under normal conditions that might be able to benefit from ICT support. Individuals and communities during the recovery stage engage in sensemaking and evaluation, and are especially open to rebuilding their communities. Our research community is tackling how to build software to convey emotion [eg., 4]; by attending to new forms of ICT-supported communication that allow for emotive expression and evaluation that takes place following disaster, we might ourselves be more innovative and understanding of such social phenomena. Crisis settings, therefore, are not only important situations *for* which to design; they are also important situations *from* which to design.

SUMMARY

With a focus on the dissemination of persistent forms of peer-to-peer citizen communications, we considered how the characteristics of hazard agents and the spatial and temporal features of ensuing disaster affect communicative needs and capabilities. ICT-abetted communications mean that people's already participatory role is increasing their ability to provide information and demand more in return. In the US, formal response organizational structures are moving toward a command-and-control model for all hazards, which does not account for the active role the public plays, particularly in an ICT-supported world. Opportunities for the information science community to work in this arena include not only innovation, but also shaping the organizations of formal response to support the new information pathways that will arise.

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