Networks and Resilience in the World Trade Center Disaster

by Kathleen Tierney and Joseph Trainor

Research Objectives

This paper focuses on one aspect of the organized response to the 9-11 attacks: the multi-organizational network that emerged in New York City to carry out emergency response-related tasks. After a discussion of the methods used in this research, the paper focuses on the characteristics of that response network, including its size, composition, and emergent properties, as well as the various tasks that were undertaken during the post-disaster response period. The paper concludes with a discussion of the distinctive strengths of the network as a form of organization and the manner in which networks contribute to resilience in the post-disaster environment.

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The September 11, 2001 attack on the World Trade Center was by any measure one of the most damaging and costly disasters in the nation's history. The death toll resulting from the attack has now been finalized at 2,749 (New York Times, 2004). An estimated 790 survivors were treated in area hospitals within 48 hours of the attack; of that number, 139 were hospitalized, the majority due to smoke inhalation (Centers for Disease Control, 2002). This injury total does not include victims who sought assistance from other health care providers and facilities, nor does it include longer-term health impacts resulting from the attacks. The events of September 11 caused significant short-term psychological distress among New York City residents as well as the population outside the areas that were attacked (Galea et al., 2002; Silver et al., 2002; Delisi et al., 2003). Longer-term psychological impacts have yet to be determined.

The economic impacts of 9-11 continue to be assessed nearly three years after the attacks. In 2002, on the basis of eight different studies on short-term economic impacts, the U. S. General Accounting office estimated that the attacks resulted in $83 billion in direct and indirect economic losses in the New York City area alone, $16 billion of which would likely not be compensated by insurance or other forms of assistance (General Accounting Office, 2002a). Recent reports indicate that 9-11 continues to have negative economic impacts on New York City in areas such as gross city product and jobs, and that the disaster is perhaps the single most important factor

accounting for the city's slow recovery from the last recession (Office of the Comptroller, 2003).

In the fifteen months following the September 11 attacks, the U.S. Small Business Administration approved more than $1 billion in economic injury disaster loans for businesses that experienced revenue losses that were related to the attacks (Small Business Administration, 2003). Assistance provided by the Federal Emergency Management Agency (FEMA) to individuals and households in New York totaled more than $314 million as of 2002, covering services ranging from mortgage and rental assistance for displaced households to the provision of mental health counseling (Federal Emergency Management Agency, 2002). Post-September 11 FEMA funding to public-sector entities has been estimated at $7.4 billion, which includes funding provided for transportation system reconstruction ($2.8 billion), activities associated with debris removal and the provision of insurance for those working on the debris removal operation ($1.7 billion), and other response and recovery-related programs (General Accounting Office, 2003).[1] A February 2004 report from the Insurance Information Institute indicates that insurers expect to pay out approximately $40.2 billion in World Trade Center losses, of which business interruption will constitute approximately 27 percent. About $19 billion in claims had been paid out as of October, 2003 (Insurance Information Institute, 2004). With respect to other impacts of the attacks, the airline industry reported a record loss of $7.7 billion and an increase of $14.4 billion in long-term debt and other liabilities in 2001 (Air Transport Association, 2002).

There has been only one U.S. disaster that resulted in a greater loss of life: the 1900 Galveston Hurricane, which killed 6,000 (see Noji, 1997 for a review of death tolls from 20th century disasters). Prior to 9-11, the most costly natural disasters, in terms of direct losses suffered, were the 1994 Northridge earthquake (with an estimated $44 billion in direct losses), Hurricane Andrew ($30 billion), and the 1993 Midwest floods ($19 billion). The largest insured losses were experienced in Hurricane Andrew—$15 billion—compared with more than $40 billion for the Trade Center disaster. (Estimates based on National Academy of Sciences, 1999).

Users of this research include emergency management agencies at the local, state, and federal level; other organizations charged with planning for and responding to disasters; and network analysts. By showing the complex and diverse networks that emerge and the wide range of tasks responders must address, this study on the World Trade Center provides a realistic perspective on planning and response requirements for large-scale community-wide disasters.

The 9-11 attacks in New York triggered a massive response not only on the part of governmental agencies, but also on the part of the private sector, voluntary and non-governmental organizations, and the general public. Focusing on charitable giving alone, a 2002 report by the General Accounting Office indicated that more than 300 charities requested and received donations for the victims of September 11 and that 34 large charities reported collecting approximately $2.4 billion in donations (General Accounting Office 2002b).

Particularly important for this discussion, the scale of the emergency response to the attacks was commensurate with the size and severity of the event. September 11 was a disaster that greatly exceeded the scope of prior disaster planning in New York City. Although the city had been involved in a range of activities aimed at enhancing preparedness for natural disasters such as hurricanes, as well as planning for terrorist attacks, planners had never envisioned a crisis like the one the city faced on September 11. The attacks occurred without warning, caused widespread death and injury, resulted in the collapse of two of the world's largest buildings, killed hundreds of emergency workers, and caused the collapse of 7 World Trade Center, the building that housed the city's emergency operations center. The city thus had to cope with the loss of its main disaster response coordination facility at the height of the emergency. Planning had similarly never envisioned the need to respond to an event whose impacts resembled those of a major disaster

and necessitated a full-scale disaster response, but that was also a crime scene, a national security emergency, and a potential environmental disaster.

Methods and Data Sources

This analysis is based on data that were collected from three sources. First, data were gathered through quick-response field work, which was carried out in the immediate aftermath of the Trade Center attack. Field workers from the University of Delaware Disaster Research Center (DRC) went to New York City three days after the WTC disaster and received permission to observe disaster response operations at the city's reconstituted emergency operations center at Pier 92, at command posts near Ground Zero, and at other sites associated with the emergency response to the 9-11 attack. For two months following the attack, DRC staff remained in those settings, recorded extensive field notes, spoke informally with individuals who were responsible for coordinating various phases of the emergency response, and attended meetings at which decisions were made regarding response and recovery strategies. In all, more than 700 person-hours were spent in the field in direct observation of emergency activities.

Second, a variety of documentary materials containing information on emergency response activities were collected. These data sources included newspaper accounts that were collected systematically for six months following the terrorist attacks; situation reports generated

Links to Current Research

This research focuses on the analysis of emergent disaster response networks. It contributes to basic knowledge on the composition and characteristics of disaster response networks and on the ways in which networks contribute to community resilience following disaster impact. It also highlights the challenges associated with managing emergency response operations in large-scale disaster events.

by responding agencies; and a variety of other materials including maps, meeting rosters, statistical reports, after-action studies, research reports, and book-length journalistic accounts.

Third, just over one year after the WTC disaster, in-depth, face-to-face interviews were conducted with more than sixty individuals representing agencies and organizations that played a key role in emergency response activities. Interviewees were selected based on what had been learned from initial field work about the roles they had played in post-disaster decision making and response coordination. The interviews sought information on such topics as initial perceptions and situation assessments immediately following the attack, tasks undertaken by various organizations and how those tasks changed over time, the extent to which prior planning influenced organizational responses, how multiple organizations coordinated their activities, and key lessons learned.

To date, both qualitative and quantitative techniques have been employed in the analysis of the WTC data. Qualitative analyses have focused on such topics as convergence following the WTC attack (Kendra and Wachtendorf, 2003a); the creative element in crisis response operations (Kendra and Wachtendorf, 2003b), organizational improvisation in response to complex disaster-related demands (Wachtendorf, 2004); the timely restoration of New York City's emergency operations center as an example of organizational resilience (Kendra and Wachtendorf, 2003c); and

organizational adaptation under conditions where prior planning did not exist (Kendra, Wachtendorf, and Quarantelli, 2003). What these qualitative analyses have in common is their emphasis on the large-scale mobilization and collective sensemaking activities that accompanied the response to the 9-11 attacks—processes that are characteristic of major disasters. During such events, responding organizations must address unexpected and unplanned-for challenges, often under very severe time constraints, and they do so through their ability to incorporate new members; identify and utilize new resources; develop new organizational forms; compensate for lost personnel, facilities, and other resources; find alternative ways of accomplishing their aims if plans cannot be implemented and discard methods that do not work; and in general develop new action strategies under uncertain and urgent conditions.

Quantitative analyses, which are not yet complete, center on mathematically modeling the response network that emerged following the 9-11 attack. These analyses are based on coded data drawn from all three sources described above. Although all of the data have not been coded, and network modeling has just begun as of this writing, it is possible to draw some preliminary conclusions from currently available data and model outputs. The sections that follow highlight key features of the multi-organizational network that emerged in response to the 9-11 attack and discuss how such networks enhance resilience in the immediate aftermath of disasters.

Preliminary Findings: Characteristics of the WTC Emergency Response Network

It will never be possible to determine definitively how many organizations, groups, and individuals participated in the community response to the WTC disaster. It is clear, however, that in the hours, days, weeks, and months following the attack, emergency response, relief, and supportive activities were carried out by literally thousands of organized entities and many tens of thousands of individuals. This discussion centers on one subset of that response and relief activity: organizations that were directly involved in emergency response activities on September 11 and in the twelve-day period following the attack and whose participation in response activities was documented through DRC's data collection methods. The twelve-day period was focused on for purposes of this study because that time period encompassed the most intense phase of the emergency response. After that period, activities began to shift from emergency operations to post-disaster recovery. One indicator of this transition was the city's carefully-managed movement away from actively searching for victims at Ground Zero and toward demolition and debris removal at the site. The data that have been analyzed to date provide considerable insight into the characteristics of the WTC crisis response network. Chief among those characteristics are size, diversity, decentralization, and emergence.

Network Size and Diversity

The most obvious characteristic of the WTC crisis response network is its sheer size. Even though not all data have been coded and analyzed, it is clear that WTC was a disaster event that triggered organizational mobilization on a massive scale. Figure 1 shows preliminary output from a network analysis[2] that was performed on coded data derived primarily from documentary materials describing organizational activities and interactions
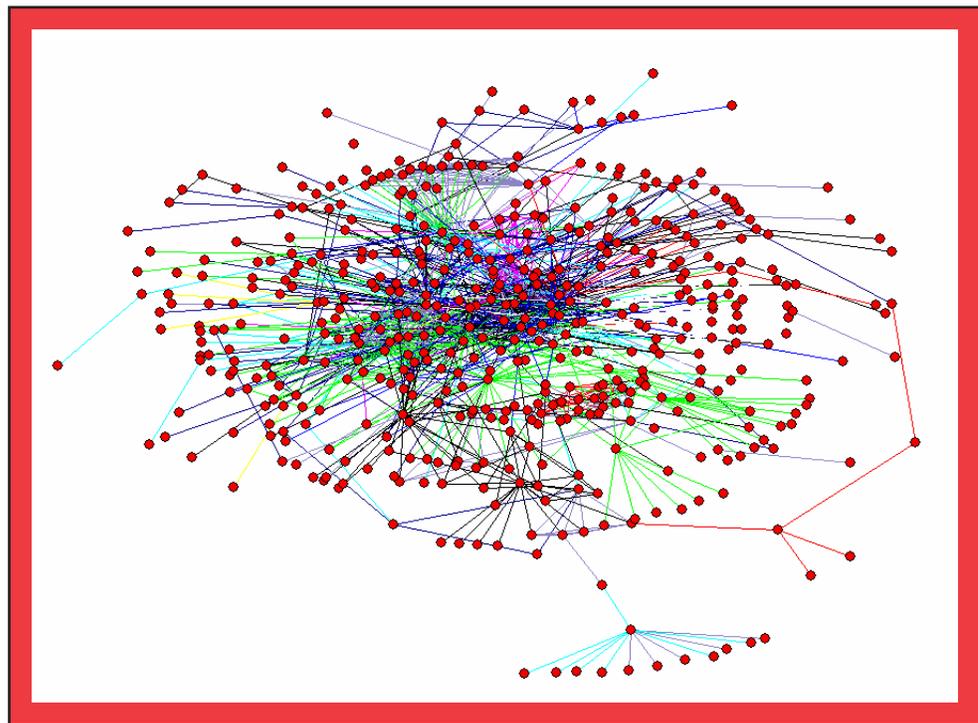
■ Figure 1. Structure of the World Trade Center Emergency Response Network

over the twelve-day emergency period.[3] This network includes 529 organizations and approximately 4,600 interorganizational interactions.[4] The size and scale of the response were related to the severity and complexity of the demands associated with the 9-11 crisis, the population size and rich organizational ecology of the New York City region, and the strong altruistic emotions the events of 9-11 engendered. Although the impact of the attacks was devastating in the Ground Zero Area, millions of people and hundreds of thousands of organizations in the impact region were largely unaffected and thus available to provide assistance. The attacks coincided with early morning news broadcasts and dominated news coverage throughout the entire country, resulting in rapid dissemination of information on the Trade Center disaster. All of these factors contributed to the massive convergence of aid and volunteers into New York City.

The network that developed to respond to the WTC attack was extremely diverse with respect to the tasks in which responders engaged, as well as the types of organizational entities that were involved. As shown in Table 1, DRC's analyses identified forty-two separate task areas around which emergency response activities were organized during the initial twelve-day period. Those tasks ranged from core emergency management functions such as fire-fighting, damage assessment, emergency coordination, and building inspection to less obvious support activities, such as the provision of legal services in the response context. The network included entities specializing in particular tasks

■ Table 1. World Trade Center Disaster Response Activities

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Building Inspection / Repair	Financial Assistance	Remains Recovery
Business Recovery	Fire Suppression	Responder Support Services
Cable Restoration	Food Provision	Response to New Threats
Counseling	Gas Restoration	Search and Rescue
Credentialing	Housing / Shelter Provision	Site and Facility Security
Forensic Investigation	Transportation Infrastructure Restoration	Site Stabilization
Damage and Situation Assessment	Injury Treatment	Space Provision
Debris Management	Law Enforcement	Support to Victims and Victims' Families
Debris Removal	Legal Issues	Technical Support Services
Donations	Logistics	Telecommunications Restoration
Electricity Restoration	Mapping	Victim Transport
Emergency Coordination	Occupational Safety	Volunteer Coordination
Environmental quality	Public Information / Relations	Water Restoration
Evacuation	Remains Identification	Wireless Telecommunications Restoration / Provisions

(e.g., search and rescue) as well as more "generalist" organizations, such as the Mayor's Office of Emergency Management. It consisted of many types of organizations: designated emergency response organizations such as fire, police, and emergency management agencies and the Red Cross; other local government agencies, such as the Department of Information Technology and Telecommunications and the Department of Design and Construction; a broad range of state and federal agencies; and numerous other organizations, including universities, health care organizations, technology firms, food service providers, contractors and construction companies, and organizations and groups providing crisis counseling to victims and first responders.

Decentralization

Although the management of crises is often described in "command-and-control" terms, suggesting that decision making and direction of response operations should be vested in a single individual or group of individuals who are "in charge" of the overall response, analyses of network relationships in the WTC disaster paint a very different picture. Referring again to Figure 1, the WTC response network is not highly centralized. As shown in Figure 2, even the task of coordinating key emergency operations was handled in a relatively decentralized manner, with the Office of Emergency Management, the Department of Design and Construction, and the Fire Department of New York serving as key nodes for overall emergency coordination, site management, stabilization, and debris removal at Ground Zero, and firefighting and search and rescue, respectively.

This decentralized pattern is common in post-disaster responses in the U.S. Disaster response operations are typically decentralized, rather than hierarchically organized, for several reasons. First, many disaster-related tasks, such as firefighting, building inspection, and emergency medical care, require specialized resources, facilitating the formation of semi-autonomous task-oriented subnetworks. Second, for many organizations involved in emergency operations, relationships
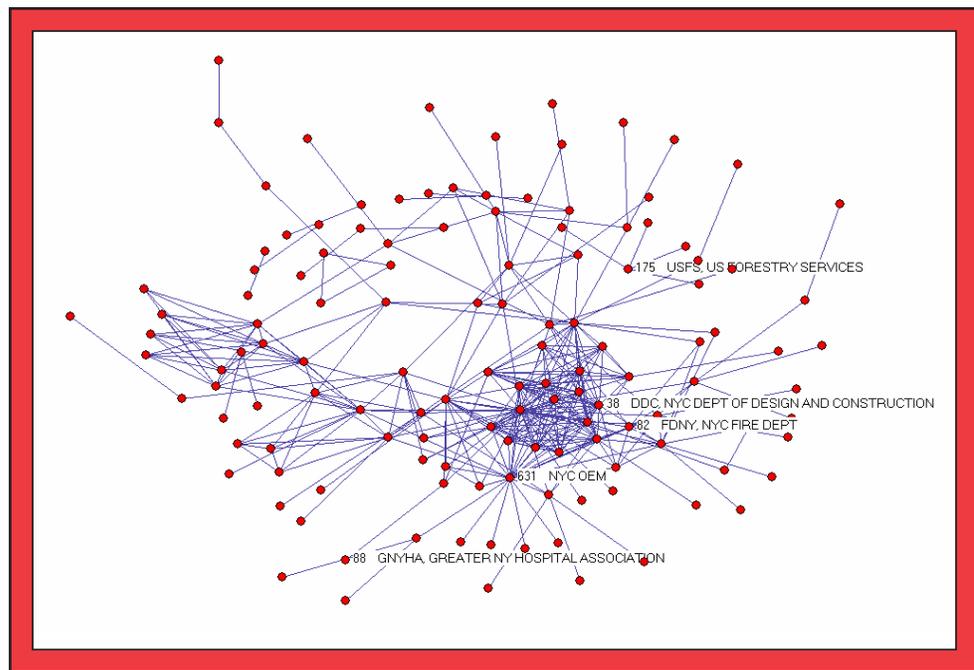
■ Figure 2. Emergency Coordination Subnetwork

with other responding entities involve coordination, rather than direct control over people and resources. Third, in the U.S. intergovernmental system, with its principle of "shared governance," different levels of government have different disaster-related authorities and responsibilities. Under the Federal Response Plan, for example, federal government agencies provide resources when they are tasked to do so, but they do not take control of the overall response.[5] Instead, local, state, and federal agency officials typically engage in collaborative decision-making. At the same time, both plans and day-to-day practice encourage more interaction within governmental levels than among them. As a consequence, while policy makers and high-level managers set general goals and objectives for response operations, those goals and objectives are pursued through decentralized decision making and collective action. Drabek (2003: 99) describes the process this way:

> Once network priorities are established…functional groups must proceed in a highly decentralized manner in relationship to the network…There is both decentralization of decision making at the tactical level and centralization at the strategic level for each subsystem within each sector of the overall network.

More generally, as will be discussed in more detail below, decentralized networks develop in response to the disaster environment itself. That environment, which is turbulent, ambiguous, and highly demanding, requires organizations to incorporate new information, organizations, and resources and alter their response repertoires on a rapid basis. Centralized decision-making structures are too cumbersome to function effectively in a crisis milieu.

Emergence

Under everyday conditions, individual, group, and organizational behavior is consistent with existing cultural norms and organizational and societal rules and procedures; in other words, such institutionalized features of social life generally provide adequate guidance for organized action. However, under stressful and uncertain circumstances such as those that accompany major disasters, the activities of individuals, groups, and organizations begin increasingly to be characterized by emergence, rather than institutional routines. The concept of emergence refers to social relationships and activities that are new, novel, and non-institutionalized—in other words, different from routine or expected relationships and activities (Marx and McAdam, 1994). Disasters are occasions that stimulate the development of various forms of collective behavior, or behavior directed by emergent norms, as opposed to institutionalized ones. They also set the stage for the formation of emergent groups, or groupings that have no pre-disaster existence but that come together in order to address needs that their members consider vital. The larger the disaster event, the greater the tendency toward emergent activities and social relationships (for additional discussions, see Brouillette and Quarantelli, 1971; Stallings and Quarantelli, 1985).

At the group, organizational, and interorganizational levels, disasters are invariably accompanied by the rapid development of emergent multi-organizational networks (EMONS) (Drabek, 1985; 2003). Emergence occurs along several dimensions within these networks. With respect to network actors, or the nodes comprising the network, while the involvement of some actors is expected (e.g., specified in prior plans), many other actors, including emergent groups, become involved on an as-needed, unplanned basis. Similarly, many of the links or relationships that develop among actors in the network are non-routine and unplanned. The activities in which network actors engage may also be emergent—that is, different from their routine activities, and even different from those specified in disaster plans. Additionally, although EMONS generally stabilize over time, they are very dynamic, with actors entering and leaving the network and new relationships forming on a continuous basis (see, for example, Harrald, Cohn, and Wallace, 1992). It is thus very common in disasters for network actors to be unfamiliar with one another's roles and capabilities and uncertain about the nature of their relationships with one another, especially during the initial phases of the response. The numerous planning and strategy meetings that take place during disasters are needed in order to facilitate the negotiations that must take place among network actors as they attempt to manage emergence. Although such negotiations are often very time consuming, they are absolutely necessary since, as will be discussed in more detail below, emergence is a major source of resilience within disaster response networks.

The WTC EMON possessed the same emergent properties as other networks that develop in response to disasters, encompassing numerous new network actors, interorganizational relationships, and activities. The sheer size of the EMON, which vastly exceeded the scope of prior planning, is one indicator of the degree of emergence that characterized the response. Another is the extent to which numerous organizational actors participated voluntarily, rather than as a result of prior agreements.

Focusing on only one component of the response, the subnetwork that managed the debris removal and remains recovery operation at Ground Zero and the Staten Island Fresh Kills landfill site was almost entirely emergent, involving new network actors and new activities. While debris removal is necessary in all disasters, the WTC debris removal task was distinctive in many ways, necessitating very complex site stabilization operations, the sorting and hauling of enormous volumes of debris, and complex sifting and sorting operations capable of supporting both remains identification and retrieval and a forensic investigation. Responding to the demands associated with these activities, the subnetwork that carried them out developed and evolved "on the fly" as the disaster response progressed. New York City's Department of Design and Construction (DDC) acted rapidly on the day of the attacks to define for itself a key role in the management of site stabilization and debris removal at Ground Zero—a role for

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which the agency had no pre-disaster authority (Langewiesche, 2002; for more detailed discussions on the emergent and improvisational qualities of this phase of the emergency response, see Wachtendorf, 2004).

This same emergent quality characterized other response subnetworks. For example, as has been documented by Huyck and Adams in their MCEER report (2002), a range of remote sensing technologies were employed by organizations in the aftermath of the 9-11 attacks on an almost entirely emergent basis. Similarly, with respect to mapping for damage assessment and other purposes, while plans had been under way to coordinate mapping activities in the city prior to 9-11, and while some formal data-sharing arrangements did exist among agencies, maps and other GIS products were developed at the reconstituted emergency operations center at Pier 92 by an emergent subnetwork that included city agencies, GIS vendors, and groups from local universities (Thomas et al., 2003). Other key emergency response activities, such as the inspection of Lower Manhattan structures that were damaged by the 9-11 attacks, were also carried out by newly-formed subnetworks. In this case, volunteer engineers worked with city building officials to inspect damaged structures, using the ATC-20 rapid post-earthquake damage screening protocol (for other discussions, see Tierney, 2003). In similar ways, network actors engaged in other response-related tasks actively reached out to partner with organizations and groups they thought possessed needed resources and expertise,

even when mechanisms to formalize their participation were not in place.

Emergent Multi-Organizational Networks and Resilience

Part of MCEER's mission consists of conducting fundamental research that can shed light on the conditions that enhance organizational and community resilience following earthquakes and other disasters. This analysis of the WTC crisis response suggests ways in which EMONS contribute to resilience. More specifically, interpreted in light of sociological research on networks, this analysis highlights the characteristics and strengths of emergent networks as *a form of organization that is distinct from other types of organizational arrangements*, such as bureaucracies, markets, and hierarchies. The network as a form of organization can be defined as a set of entities that "pursue repeated, enduring exchange relations with one another and, at the same time, lack a legitimate organizational authority to arbitrate and resolve disputes that may arise during the exchange" (Podolny and Page, 1998).[6] Response networks like the one that developed in the aftermath of 9-11 have many features in common and thus many of the advantages of the "ideal type" network form. One such advantage is enhanced organizational learning (Podolny and Page, 1998; Carley, 1999). Another is the transfer of legitimacy from higher-status actors to other actors in the network, enabling the latter to more

readily gain support for their activities (Podolny and Page, 1998). Emergent networks enhance resilience because they raise the probability that needed information and resources will become available through network ties and because they empower even network newcomers within the context of the overall response. Networks are also thought to foster the development and diffusion of innovations (Powell et al., 1996)—a key requirement in the crisis environment.

Networks are better-suited than other organizational forms to detect and respond in appropriate ways to the challenges posed by excessive demands and environmental turbulence, because of their capacity to gather information and identify and mobilize resources. This responsiveness stems in part from their ability to capitalize on diverse information sources and resource pools. In their analysis of the response of financial services organizations following the Trade Center disaster, for example, Beunza and Stark (2003) point to the need for both *replicative and generative* redundancy in crisis response operations. While replicative redundancy refers to the ability to reassemble or reproduce what has been lost in a disaster—for example, by having back-up systems and alternative operational sites or, as happened in the 9-11 disaster, by literally reconstituting a key site—generative redundancy consists of the ability to access new information, resources, and perspectives. This form of redundancy is enhanced through diverse network ties, because (Beunza and Stark, 2003: 153)

[i]n situations of radical uncertainty, diversity of ties and diversity of means increase the likelihood that interaction will yield unpredictable solutions through 'creative abrasions' and 'generative friction.'

In their view, a key strength of networks is that they give rise to the kind of "laterally distributed intelligence" organizations require in unfamiliar and rapidly changing environments. Along these same lines, networks are capable of transmitting information and responding more rapidly than more highly-structured organizational forms. For network organizations (in this case, strategic interorganizational alliances) in competitive market situations, for example, it has been argued that (Knoke and Guilarte, 1994)

[a]lthough interfirm alliances may actually increase transaction costs above those of markets and bureaucracies, they offer superior benefits such as swifter response to shifting market conditions, better access to technical know-how and economic information, greater trustworthiness among partners, and reduced uncertainty.

While network organizations may or may not have all these advantages under all circumstances (see, for example, La Porte, 1996, on public organizational networks and the issue of trust), owing to their structural features, they are inherently more capable of rapid adaptation than highly formalized and hierarchical organizations.

Similarly, Comfort (1999) concludes in her multi-national study on system responses to earthquake disasters that the most effective system responses are those that are "auto-adaptive" or "self

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organizing"—that is, (1999: 73) "high on technical structure, high on organizational flexibility and high on cultural openness to new information and new methods of action." EMONS are a key source of this openness and creativity. Networks form the locus for the collective sensemaking (Weick, 1995) and organizational learning that must take place under conditions of ambiguity and uncertainty. To make sense of crisis situations as they unfold, responding organizations need rapid access to information, which is rendered more likely when organizational boundaries are permeable, barriers to information flow are weakened, and many and diverse actors communicate and coordinate with one another. EMONS facilitate this process. To deal with emerging problems as they are identified, responders also require the ability to act without having to adhere to pre-established institutionalized constraints, and EMONs provide this flexibility.

Conclusions

As the preceding discussions indicate, EMONS and the network form of organization contribute to organizational and community resilience in a variety of ways. Focusing first on the redundancy dimension, they help increase redundancies with respect to personnel, facilities and other resources, compensating for resources that are lost in disasters (replicative redundancy). At the same time, they provide the infrastructure for information transfer and the diffusion of novel problem-solving strategies (generative redundancy). Relatedly, they are capable of mobiliz-

ing resources of all kinds, which contributes to the resourcefulness dimension of resilience. Because of their diversity, decentralization, and relative lack of formal restrictions on network actors, they are also able to respond rapidly to disaster-generated demands. The advantages of networks over hierarchies can be seen by comparing the response to the 9-11 attacks and other large disasters in the U.S. with the manner in which such events are handled in other political systems that are more highly centralized and less able to accommodate emergence, such as the Japanese system. The slow and initially ineffective response to the 1995 Kobe earthquake can be attributed not only to the size and severity of that disaster but also to the relative inflexibility of the emergency response system, in terms of its ability to allow for emergence and enact structural adaptations that could have enabled the system to perform critical emergency tasks more rapidly and effectively (Comfort, 1999).

Just as it is possible to compare crisis response systems across societies, it is also possible to assess how well EMONs have been managed in different U. S. disasters (see, for example, Drabek, 2003) and, in the pre-event context, how well prepared communities are to manage emergence. Indicators of such capability could include the diversity of organizations and community sectors included in pre-crisis planning; strategies that may exist to incorporate volunteers and emergent groups into the response, including plans for providing space in emergency operations centers for such groups; information-sharing protocols

that allow for the expansion of communications networks on an as-needed basis; and mechanisms for establishing interorganizational linkages and enabling new network actors to join response networks rapidly in the event of a disaster (e.g., mutual aid agreements, special contracting provisions, plans for suspending regulations and legal requirements that could slow down response operations). All disasters are accompanied by emergence at the network level, but some communities are likely much more able than others to capitalize on emergence, and hence are more resilient in the face of disasters.

Acknowledgements

Endnotes

[1] These funds were expended not only in New York City but also in the greater metropolitan area. An additional $2.4 billion for transportation reconstruction and recovery is being provided through an interagency agreement with the U.S. Department of Transportation. A total of $3.5 billion is also being provided by the Department of Housing and Urban Development for assistance to businesses and individuals and for other recovery-related projects.

[2] UCINET and Pajek were used to analyze and visualize the network.

[3] It should be noted that, because it is based only on a subset—albeit a large one— of the data that were collected, this network model understates the number of organizations involved. Additionally, because more documentary data were available in these data sources on federal agencies than on local groups and agencies, this particular model tends to under-emphasize the participation of those entities.

[4] The different colors denoting network relationships correspond to different tasks around which activities were organized.

[5] The FRP itself provides a framework for response decentralization. The plan structures agency activities around twelve different "emergency support functions" (ESFs) which, while under the general umbrella of FEMA, operate in a more or less autonomous fashion during disasters.

[6] This is not to say that network relationships retain this form over time, or that all participants lack such arrangements, only that network organizations are not as constrained by contracts or other formal agreements than other types of organizations.

References

Air Transport Association, (2002), Airline Industry Review: Air Transport Association Annual Report, *www.airlines.org/econ/files/2002AnnualReport.pdf*.

Beunza, D. and Stark, D., (2003), "The Organization of Responsiveness: Innovation and Recovery in the Trading Rooms of Lower Manhattan," *Socio-Economic Review,* Vol. 1, pp. 135-164.

Brouillette, J.R. and Quarantelli, E.L., (1971), "Types of Patterned Variation in Bureaucratic Adaptations to Organizational Stress," *Sociological Quarterly,* Vol. 441, pp. 39-46.

Carley, K.M., (1999), "On the Evolution of Social and Organizational Networks," *Research in the Sociology of Organizations*, Vol. 16, pp. 3-30.

Centers for Disease Control, (2002), "Rapid Assessment of Injuries Among Survivors of the Terrorist Attack on the World Trade Center—New York City, September 2001, *Mortality and Morbidity Weekly Report,* Vol. 51, pp. 1-5.

Comfort, L., (1999), *Shared Risk: Complex Systems in Seismic Response*, Pergamon Press/Elsevier Science, Amsterdam and New York.

Delisi, L.E., Maurizio, A., Yost, M., Papparozzi, C.F., Fulchino, C., Katz, G., Altesman, J., Beil, M., Lee, J. and Stevens, P., (2003), "A Survey of New Yorkers after the September 11, 2001, Terrorist Attacks," *American Journal of Psychiatry,* Vol. 160, No. 4, pp. 780-783.

Drabek, T.E., (1985), "Managing the Emergency Response," *Public Administration Review,* Vol. 45, pp. 85-92.

Drabek, T.E., (2003), *Strategies for Coordinating Disaster Responses*, Institute of Behavioral Science, Natural Hazards Research and Applications Information Center, University of Colorado, Monograph #61.

Federal Emergency Management Agency, (2002), *FEMA's Delivery of Individual Assistance Programs: New York—Sept. 11, 2001,* Federal Emergency Management Agency, Washington, DC.

Galea, S., Resnick, H., Ahern, J., Gold, J., Bucuvalas, M., Kilpatrick, D., Stuber, J. and Vlahov, D., (2002), "Posttraumatic Stress Disorder in Manhattan, New York City, After the September 11 Terrorist Attacks," *Journal of Urban Health: Bulletin of the New York Academy of Medicine,* Vol. 79, No. 3, pp. 340-353.

General Accounting Office, (2002a), *Review of Studies of the Economic Impact of the September 11, 2001, Terrorist Attacks on the World Trade Center,* U.S. General Accounting Office, Washington, DC.

General Accounting Office, (2002b)*, September 11*: *Interim Report on the Response of Charities,* U.S. General Accounting Office, Washington, DC.

General Accounting Office, (2003), *Disaster Assistance: Information on FEMA's Post 9/11 Public Assistance to the New York City Area,* U.S. General Accounting Office, Washington, DC.

Harrald, J.R., Cohn, R. and Wallace, W.A., (1992), "'We Were Always Re-organizing… 'Some Crisis Management Implications of the Exxon Valdez," *Industrial Crisis Quarterly,* Vol. 6, pp. 197-217.

Huyck, C.K. and Adams, B.J., (2002), *Emergency Response in the Wake of the World Trade Center Attack: The Remote Sensing Perspective,* MCEER Special Report Series: Engineering and Organizational Issues Related to the World Trade Center Terrorist Attack, Vol. 3, Multidisciplinary Center for Earthquake Engineering Research, University at Buffalo.

References (Cont'd)

Insurance Information Institute, (2004), *Catastrophes: Insurance Issues*, Insurance Information Institute, New York, *http://www.iii.org/media/hottopics/insurance/xxx.*

Kendra, J. and Wachtendorf, T., (2003a), "Reconsidering Convergence and Converger Legitimacy in Response to the World Trade Center Disaster," pp. 97-122 in L. Clarke (Ed.) *Terrorism and Disaster: New Threats, New Ideas. Research in Social Problems and Public Policy, Vol. 11*, Elsevier Science Ltd.

Kendra, J. and Wachtendorf, T., (2003b), "Creativity in Emergency Response to the World Trade Center Disaster." pp. 121-146 in *Beyond September 11: An Account of Post Disaster Research,* Institute of Behavioral Science, Natural Hazards Research and Applications Information Center, University of Colorado, Special Publication #39.

Kendra, J. and Wachtendorf, T., (2003c), "Elements of Resilience after the World Trade Center Disaster: Reconstituting New York City's Emergency Operations Centre," *Disasters,* Vol. 27, No. 1, pp. 37-53.

Kendra, J., Wachtendorf, T. and Quarantelli, E.L., (2003), "The Evacuation of Lower Manhattan by Water Transport on September 11: An Unplanned 'Success,'" *Joint Commission Journal on Quality and Safety,* Vol. 29, No. 6, pp. 316-318.

Knoke, D. and Guilarte, M., (1994), "Networks in Organizational Structures and Strategies," *Current Perspectives in Social Theory*, Supplement 1, pp. 77-115, JAI Press.

Langewiesche, W., (2002), *American Ground: Unbuilding the World Trade Center,* North Point Press, New York.

LaPorte, T.R., (1996), "Shifting Vantage and Conceptual Puzzles in Understanding Public Organization Networks," *Journal of Public Administration Research and Theory,* Vol. 6, No. 1, pp. 49-74.

Marx, G.T. and McAdam, D., (1994), *Collective Behavior and Social Movements*, Prentice Hall, Englewood Cliffs, NJ.

National Academy of Sciences, (1999), *The Impacts of Natural Disasters: A Framework for Loss Estimation,* National Academies/National Research Council, Washington, DC.

New York Times, (2004), "Final WTC Death Toll Said Down to 2,749," January 23.

Noji, E., (1997), *The Public Health Consequences of Disasters*, Oxford University Press, New York.

Office of the Comptroller, (2003), Economic Notes: As Nation Recovers, City Recession Continues for 10th Quarter, New York City Office of the Comptroller, *www.comptroller.nyc.gov/budget*.

Podolny, M.M. and Page, K.L., (1998), "Network Forms of Organization," *Annual Review of Sociology,* Vol. 24, pp. 57-76.

Powell, W.W., Kout, KW. and Smith-Doerr, L., (1996), "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology," *Administrative Science Quarterly,* Vol. 41, No. 1, pp. 116-145.

Silver, R.C., Holman, E.A., McIntosh, D.N., Poulin, M. and Gil-Rivas, V., (2002), "Nationwide Longitudinal Study of Psychological Responses to September 11," *Journal of the American Medical Association,* Vol. 288, No. 10, pp. 1235-1244.

Small Business Administration, (2003), "SBA Approves over $1Billion in Disaster Loans to Victims of 9-11 Attacks," SBA Press Office Release No. 03-03, January 15.

References (Cont'd)

Stallings, R.A. and Quarantelli, E.L., (1985), "Emergent Citizen Groups and Emergency Management," *Public Administration Review,* Vol. 45, pp. 93-100.

Thomas, D.S.K., Cutter, S.L., Hodgson, M., Gutekunst, M. and Jones, S., (2003), "Use of Spatial Data and Geographic Technologies in Response to the September 11th Terrorist Attack on the World Trade Center," pp. 147-162 in *Beyond September 11th: An Account of Post Disaster Research,* Institute of Behavioral Science, Natural Hazards Research and Applications Information Center, University of Colorado, Special Publication #39.

Tierney, K., (2003), "Conceptualizing and Measuring Organizational and Community Resilience: Lessons from the Emergency Response following the September 11, 2001 Attack on the World Trade Center," paper presented at the *Third Comparative Workshop on Urban Earthquake Disaster Management*, Kobe, Japan, January 30-31.

Wachtendorf, T., (2004), *Improvising 9/11: Organizational Improvisation Following the World Trade Center Disaster*, Doctoral dissertation, Department of Sociology and Criminal Justice, Disaster Research Center, University of Delaware.

Weick, K., (1995), *Sensemaking in Organizations*, Sage Publications, Thousand Oaks, CA.