

# Managing Information Processes in Disaster Events: The Impact of Superstorm Sandy on Business Organizations

**Louise K. Comfort**

Center for Disaster Management  
University of Pittsburgh  
lkc@pitt.edu

**Brian A. Chalfant**

Center for Disaster Management  
University of Pittsburgh  
bac84@pitt.edu

**Jee Eun Song**

Center for Disaster Management  
University of Pittsburgh  
[jes199@pitt.edu](mailto:jes199@pitt.edu)

**Mengyao Chen**

Center for Disaster Management  
University of Pittsburgh  
mec147@pitt.edu

**Brian Colella**

Center for Disaster Management  
University of Pittsburgh  
[bac47@pitt.edu](mailto:bac47@pitt.edu)

## ABSTRACT

Building community resilience to natural disasters represents a major policy priority for the United States as hazards impact vulnerable urban regions with increasing frequency and severity. Applying network analysis techniques, we examine the dynamics of emergency response to Superstorm Sandy, which struck the United States east coast in late October 2012 and caused over \$72 billion in damages. Drawing on a variety of data sources and analytical techniques, we document the storm's impact on a system of interacting private, public, and nonprofit organizations. We find that the storm's response network exhibited clear patterns of information gaps and flows among different types of organizations. Our findings suggest a general lack of communication between government agencies and businesses, an area of potential improvement in future regional-scale emergency response systems.

## Keywords

community resilience, disaster response, organizational networks, information systems, intergovernmental communication and coordination

## INTRODUCTION

The process of change in public policy represents a perennial challenge to policy makers. As they seek to implement change in an actual context of operations, the very act of introducing change alters the social, technical, and organizational conditions in which they are operating, often in unanticipated ways. For policy makers operating in the urgent, dynamic environments that evolve following extreme events, this problem is even more critical when resources are scarce, time is urgent, and the consequences of error may escalate the damage further. Understanding the conditions that trigger change in perceptions and actions in communities exposed to hazards and that enable collaborative action to reduce risk is essential to achieving successful policy change. Change involves an interactive process of adaptation to dynamic conditions for the whole community to achieve the shared goal of resilience to hazards.

Mobilizing effective strategies for mitigating the steadily increasing costs of natural hazards represents a key priority for the United States (US). In 2011, there were 14 federally declared disasters with losses of over \$1 billion reported in the US, with an estimated total of \$55 billion in losses across all disasters documented in the US (National Academies, 2012, p. 1). This total was easily exceeded in 2012, with losses estimated at \$72 billion from Superstorm Sandy alone (Aon Benfield, 2013). To curb mounting losses from natural hazards, the National Academies (2013) issued a report calling for the development of disaster resilience as a ‘national imperative.’

Community resilience emerges from a complex system of individuals, organizations, and institutions – each with different degrees of authority, responsibility, access to resources, experience, exposure to risk, and capacity for action – interacting to achieve a shared goal (Glass, Ames, Brown, Maffitt, Beyeler, Finley, Moore, Linebarger, Brodsky, Verzi, Outkin, and Zagonel, 2011) within the constraints of available time and resources. Such complex systems in practice are interdisciplinary, interorganizational, increasingly international, and cannot be controlled by a single authority (Comfort and Okada, 2013). Moreover, the complexity of the evolving system’s operations increases with the size, scale, and severity of the event. An extreme event generates interactions not only among the system’s internal components, but also with other related policy systems in the external environment (Fligstein and McAdam, 2013). Consequently, we approach this inquiry into the Superstorm Sandy emergency response system from a systems and network perspective. Identifying threshold points where risk can be recognized enables the system of interacting organizations to adapt and redesign its performance in practice to build the skills and resources needed for community resilience.

To explore this process of building community resilience, we examined the system of organizations that responded to the impact of Superstorm Sandy on the east coast of the United States. In what ways, if any, did these communities function as an interacting, networked system to achieve the goal of disaster resilience for the ‘whole community’?

## THE CONCEPT OF RESILIENCE

Building resilience in practice involves creating sufficient structure to hold and exchange information, while allowing sufficient flexibility to adapt to rapidly changing conditions (Kauffman, 1993). This task presents a major problem for public agencies that have the primary legal responsibility for protecting the lives and property of the residents of their respective communities. In a multilevel, federal administrative system, the appropriate calibration of responsibility to authority to resources in managing extreme events is a continuing policy debate. The question of which jurisdiction or agency has what responsibility for managing emergency events with what resources has led to a national discussion regarding the limits of government at all levels, with little corresponding acknowledgment of the need to restructure organizational participation and coordination at the community level. Disaster resilience on a national scale can only function if the communication of risk and coordination of actions to reduce risk are enacted across county, state, and national levels of operation.

To achieve a national level of capacity for rapid recognition of risk, timely response, and effective coordination, four basic requirements are needed. First, the science of hazards to which a region is exposed needs to be widely disseminated in the region through organizational training, building codes, professional standards for protection of community resources and residents to build public awareness of risk and professional response to hazards (Waugh and Tierney, 2007). Second, an advanced information infrastructure is essential to communicate risk information broadly to the public, but also to inform professional managers of risk with timely, valid updates (Comfort, 2007). Third, resilience is fundamentally a governance task, with public agencies interacting with private and nonprofit organizations to create a coherent strategy to reduce uncertainties in action (Koppenjan and Klijn, 2004). Finally, all actors in this complex process share the responsibility for maintaining current knowledge of their own status, as well as awareness of the changing status of others at risk (Weick, 1993; 1995).

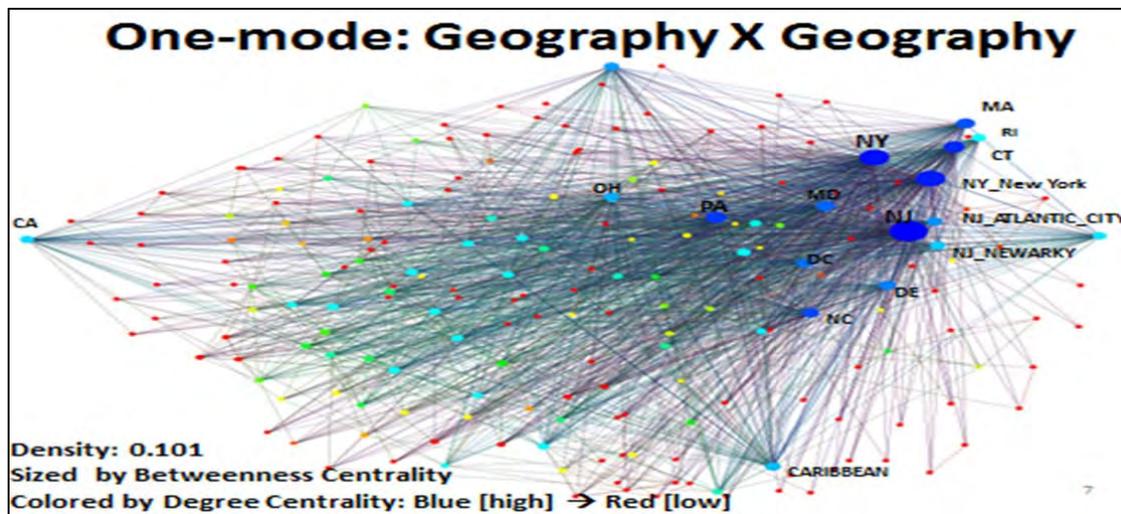
*Proceedings of the 11<sup>th</sup> International ISCRAM Conference – University Park, Pennsylvania, USA, May 2014*  
S.R. Hiltz, M.S. Pfaff, L. Plotnick, and P.C. Shih, eds.

**MEASUREMENT, DATA, ANALYSES**

Superstorm Sandy struck the east coast of the United States in late October 2012, offering – tragically – a case study for examining the actions taken by managers of public, private, and nonprofit organizations in coping with ensuing crises. We constructed mutually complementary datasets on the organizational response to Superstorm Sandy. We used these datasets to explore the interactions of public agencies – with designated emergency-response responsibilities – with private businesses and nonprofit organizations, and the extent to which those interactions offered protection and support to all groups in the affected communities.

Four types of data were collected, coded, and analyzed for this study. First, we reviewed the current emergency plans and procedures that allocated legal responsibility to public managers to protect their communities from harm, specifically the National Response Framework (FEMA, 2008a) the National Incident Management System (FEMA, 2008b), and the Workforce Investment Act (1998). This documentary analysis established public agencies as the primary actors in disaster preparedness activities, with private actors engaged in secondary instances of economic dislocation from changes in industry and market function.

Second, using rapid ethnographic assessment (REA) methods (Pfeffer and Carley, 2012), we searched, sorted, and summarized reports from the Lexis-Nexus Smart Indexing System, a digital database, using key words for Sandy or Hurricane Sandy to collect 1000 articles from newspapers, blogs, and professional reports regarding the storm’s impact on the coastal communities, and the actions taken in response. This initial data search covered the time period from 25 October 2012 to 11 February 2013. The REA methods allowed a rapid identification of key industries, organizations, persons, and areas of geographic impact from this large database of digital reports (Mayer-Schönberger and Cukier, 2013). Figure 1 below shows the geographic spread of organizations across the United States that engaged in response to Sandy, with nodes sized by betweenness centrality and colored by degree centrality.



**Figure 1. Geography x Geography Networks identified from Lexis-Nexus Smart Indexing System**

Third, the 1000 articles identified by the REA method were refined to 541 unique, non-duplicate articles that were closely examined for relevance to the study. Using this dataset, we identified particular, formal organizations involved in disaster operations. This analysis produced a set of 642 organizations from public, private, and nonprofit sectors that were involved in Sandy response and recovery operations.

Table 1 below presents the frequency distribution of organizations identified from the news reports as participating in response operations for Sandy by jurisdiction and sector in 2012 and compares this distribution with a similar analysis for Hurricane Katrina in 2005. The distribution of organizations participating in Sandy response operations shows that the majority of organizations operating across all levels of jurisdiction (55.1%) were privately funded, with 35.2% of the private organizations operating at the national level. Overall, the majority of organizations operating across all sectors (55.9%) in the Sandy response system were operating in a national arena. These findings contrast sharply with the distribution of organizations by jurisdiction and sector in the Katrina response system in 2005. In the Katrina response, documented from news reports from the *Times-Picayune* newspaper published in New Orleans for the period, August 27 – September 19, 2005, the

pattern of organizational participation showed that only 15.6% of all organizations participating in response operations were privately funded, and that only 4.3% of organizations operating at the national level were privately funded. In contrast, a higher proportion of organizations operating at the municipal/local level in the Katrina response system in 2005 were public organizations, 12.6% in contrast to 5.1% for Sandy in 2012. While the proportion of public organizations participating in response operations was approximately the same for both response systems, 27.4% for Sandy in 2012 and 27.1% for Katrina in 2005, the most significant difference was the contrast in participation by nonprofit organizations, 17.4% for Sandy in 2012 to 57.3% for Katrina in 2005. These figures virtually reversed the pattern of participation by nonprofit organizations and private organizations in disaster response operations for the two events. This reversal, documented from comparative analysis of news reports, indicated a significant impact of Sandy on the business sector in affected communities that warranted further inquiry on the resilience of business organizations in disaster contexts.

Jurisdiction / Sector	Katrina, 2005				Sandy, 2012			
	Non-profit	Private	Public	Total	Non-profit	Private	Public	Total
International	11 2.0%	3 0.6%	6 1.1%	20 3.7%	3 0.5%	42 6.5%	15 2.3%	60 9.3%
National	69 12.8%	23 4.3%	76 14.1%	168 31.2%	57 8.9%	226 35.2%	76 11.8%	359 55.9%
Regional	1 0.2%	6 1.1%	25 4.6%	32 5.9%	8 1.2%	31 4.8%	3 0.5%	42 6.5%
State	81 15.0%	7 1.3%	6 1.1%	94 17.4%	6 0.9%	12 1.9%	45 7.0%	63 9.8%
Sub-regional	9 1.7%	13 2.4%	10 1.9%	32 5.9%	4 0.6%	7 1.1%	3 0.5%	14 2.2%
County	70 13.0%	3 0.6%	1 0.2%	74 13.7%	1 0.2%	0 0.0%	7 1.1%	8 1.2%
Municipal/ Local	68 12.6%	29 5.4%	22 4.1%	119 22.1%	33 5.1%	36 5.6%	27 4.2%	96 15.0%
Total	309 57.3%	84 15.6%	146 27.1%	539 100.0%	112 17.4%	354 55.1%	176 27.4%	642 100.0%

**Table 1. Comparison of Frequency Distributions in Response Operations by Jurisdiction and Sector, Hurricane Katrina, 2005 and Superstorm Sandy, 2012**

Fourth, we conducted a series of nine qualitative interviews with experienced managers of Workforce Investment Board programs at regional, state, and local levels to identify what major factors prepared business organizations for managing risk of natural hazards and what gaps in practice reduced resilience in actual events. Parameters identified in these interviews were then entered into a Bayesian influence diagram to show the likely direction and strength of interactions and interdependencies among the actors identified in the response system. The interview protocol and the list of managers interviewed are included in the Appendix, although for reasons of confidentiality, no attributions are made to specific managers in this analysis.

This approach represents a mixed methods strategy, taking advantage of ‘big data’ (Mayer-Shönberger and Cukier, 2013) to provide an overview of the response operations for the disaster region that included 24 states, and using the profile of organizations identified by the REA analysis as the basis for selecting the set of news reports for a more detailed content analysis of transactions performed by these organizations and the interactions among them. The documentary analysis reviewed the existing policies that allocate legal responsibilities for protecting communities from hazards. The content analysis of news reports documented the actions in preparedness and response operations that were reported for the communities at risk. The discrepancy between policies and practice by the comparison of these two data sources revealed significant asymmetry in information processes among different segments of the community, affecting significantly their capacity for action and the distribution of losses in communities affected by the storm. This discrepancy was then verified through a series of qualitative interviews with managers from organizations that had experienced extreme events, and had adapted their organizations in constructive ways. This multi-method approach to inquiry regarding the decision processes used in this actual event reveal insights into the impact of the storm, but also the processes of managing information flow prior to, during, and after extreme events in terms of enabling communities to achieve resilience to shared hazards.

**THE CONTEXT**

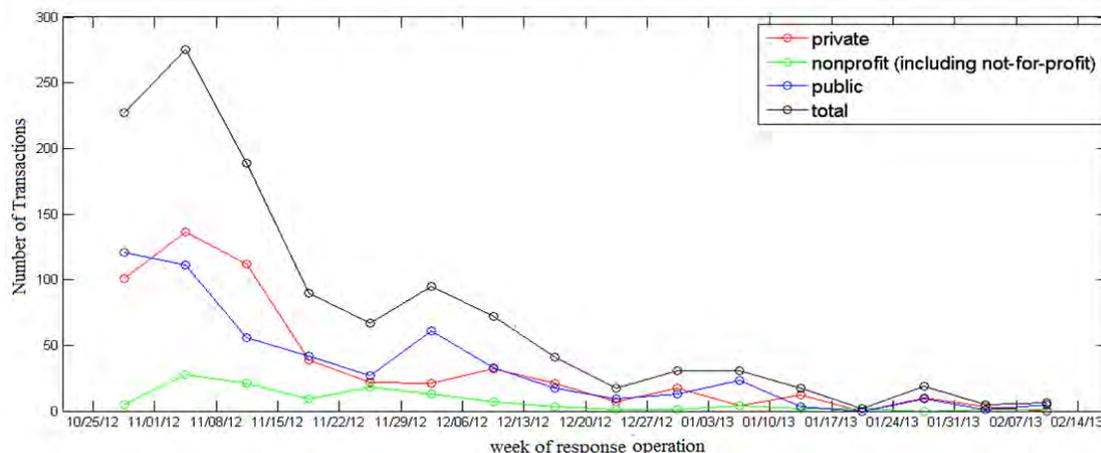
When Superstorm Sandy made landfall near Brigantine, New Jersey on the Atlantic Coast of the United States about 8:00 p.m. on October 29, 2012, it unleashed a cascade of damaging effects that rippled through the coastal communities and disrupted business operations in at least five states: New York; New Jersey; Connecticut; Delaware; and Maryland (Aon Benfield, 2013). The total economic losses caused by Superstorm Sandy in 2012 are estimated to be \$72 billion, including approximately \$30 billion of insured losses and roughly \$7.2 billion in payments made by the National Flood Insurance Program (Aon Benfield, 2013). Roughly 60 million people were directly affected by Sandy across as many as 24 states, many of whom lost their jobs or suffered damage to homes and businesses. The economic losses for the states of New Jersey and New York alone are estimated at \$66 billion (Aon Benfield, 2013). Given these figures, Sandy is second only to Hurricane Katrina in terms of estimated losses generated by a catastrophic disaster in the United States. The damage from the storm was most extensive in New York and New Jersey, states with the highest concentration of population and infrastructure directly in the path of the storm. New Jersey alone estimated approximately \$30 billion in losses, with losses in New York State estimated at \$33 billion, \$19 billion of which were reported for New York City, with losses in infrastructure, housing units, and transportation facilities (Aon Benfield, 2013).

The primary policies regarding disaster preparedness and response include the National Response Plan (FEMA, 2008a) and the National Incident Management System (FEMA, 2008b), which allocate legal responsibility for protecting life, property, and maintaining continuity of operations to public agencies. These documents have been updated several times following disasters in a continuing effort to improve performance of public agencies in extreme events. Yet, given the increasing frequency of major disasters and the recognition that public agencies cannot accomplish this goal alone, FEMA has articulated a goal of building resilience for the ‘whole community’ (FEMA, 2011; Kaufman, 2012). This goal includes all organizations in the community, public, private, and nonprofit. In its intent, this goal represents an effort to change expectations for responsible actions to mitigate hazards from focusing primarily on public organizations to including all sectors of the community, private, and nonprofit organizations as well. The test of this shift in national goals and policies is demonstrated by the actual response operations documented in response to Superstorm Sandy.

**FINDINGS**

**The Response System**

By all accounts, public organizations performed well in response to the threat of the approaching storm, reporting broad public warnings, closing down airports and transportation facilities, and organizing for immediate response to public facilities at risk. However, the substantial impact of the storm fell on businesses. Figure 2, based on content analysis of digital news reports summarized by week of response operations, reveals a pattern of slightly lower entry of private organizations into disaster operations compared to public organizations in week 1, followed by a modest increase and then dropping to almost parallel frequency of reports. Professional reports cited significant losses for business organizations (Aon Benfield 2012; Dun and Bradstreet, 2012; Cohn/Reznick, 2012). Actions by nonprofit organizations were reported with lower frequency as responding to local needs (Krauskopf, Blum, Lee, Fortin, Rosenthal, 2013).

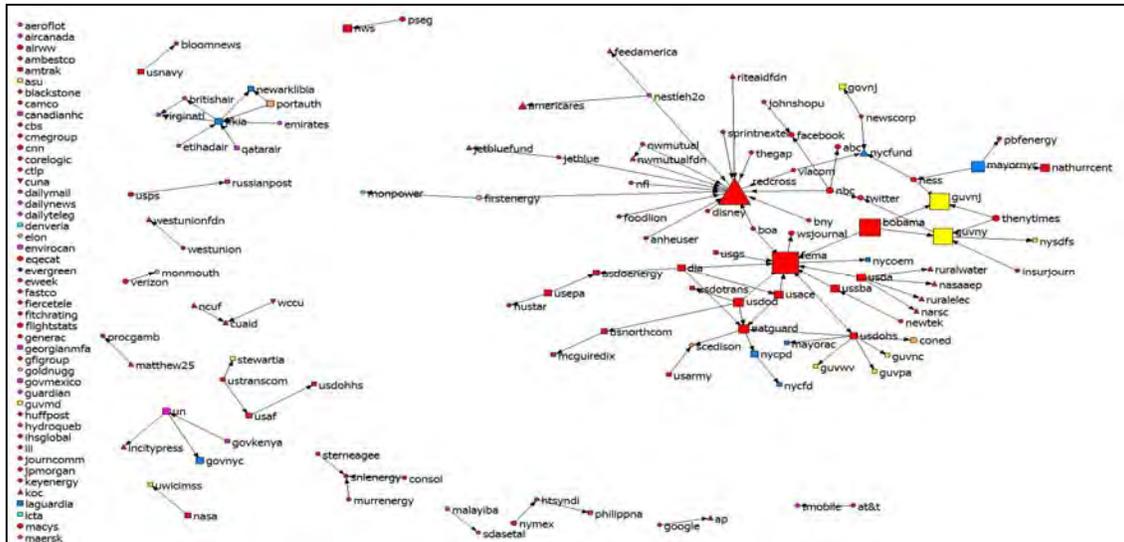


**Figure 2. Organizational Engagement in Response Operations, by Sector and Week**

*Proceedings of the 11<sup>th</sup> International ISCRAM Conference – University Park, Pennsylvania, USA, May 2014*

*S.R. Hiltz, M.S. Pfaff, L. Plomnick, and P.C. Shih, eds.*

The network map, Figure 3 below, shows a moderately dense cluster of organizations on the right, dominated largely by national organizations, shown in red. FEMA plays a central role as the lead public organization engaged response operations, with the Red Cross playing almost an equal role for nonprofit organizations. Barack Obama, US president, plays a lesser but still highly visible role in interacting with key players. The governors of New York and New Jersey also have active roles in the response operations. Largely detached from the core network are private organizations, represented in the diagram by circles. More noteworthy is the number of private organizations included in the long, truncated list of organizations on the left side of the map, as having little or no interaction with other organizations. This map reveals a marked asymmetry in interactions among the organizations reported as affected by, or interacting with, other organizations to create a system response to warnings and damage from the storm. This pattern of interactions likely documents an asymmetry in information flow among the organizations engaged in response operations as well.



**Figure 3. Network map of the Sandy impact and response system: October 28 to November 3, 2012. (Symbols sized by number of transactions (more transactions = larger). Symbols shaped by funding source: public = square; circle = private; up-triangle = non-profit; down-triangle = not-for-profit / credit union. Symbols colored by jurisdiction: international = magenta; national = red; subnational = orange; state = yellow; substate = green; country = cyan; municipal = blue; local = purple.) Overall connectedness for this network: 10.3%.**

The content analysis of news reports from October 28, 2012 to February 13, 2013 also examined the type of transactions that were performed by organizations engaged in response operations. These transactions were coded in terms of the 15 Emergency Service Functions (ESFs) classified by FEMA to characterize the types of actions taken by organizations engaged in response operations. In addition to the 15 FEMA ESFs, CDM researchers identified four additional functions that distinguished different types of voluntary activities: 16) donation of funds; 17) donation of goods; 18) volunteering; and 19) reporting. Finally, a category of donation of services was added to distinguish among four types of donations: funds; goods; time; and services. The distribution of ESFs for the first eight weeks, the most intensive period of disaster operations, revealed that long-term community recovery was the most frequently mentioned function, with 210 out of a total of 1054 reports (19.9%); donation of funds ranked second, with 174 out of 1054 mentions (16.5%), and housing issues ranked third, with 96 out of 1054 mentions (9.1%). The reported frequency of these functions provides evidence that the most serious issues were related to the longer-term recovery process, while the more immediate response functions involving energy (7.2%), emergency management (6.6%), and transportation (5.8%) were resolved reasonably effectively within the first three weeks after the event. A full documentation of this analysis will be available on the CDM web site, <http://www.cdm.pitt.edu>.

The largely fragmented and disconnected role of business organizations in response operations to Sandy was documented further by a survey of business organizations in the three states most heavily affected by the storm, Connecticut, New York, and New Jersey. The survey, conducted by The Hartford Insurance Company (2013) which had clients in all three states, was based on a sample of 451 businesses ranging in size from 3 to 100 employees over a six-week period, January 3 – February 13, 2013, approximately three months after the storm. Findings from the survey reported that nearly three-quarters (74%) of the businesses had to close after the storm,

for periods of time ranging from one week to three months, and 52% of the businesses reported loss of sales and customers. Only 1 in 4 businesses had backed up their data, and only 1 in 5 businesses had emergency preparedness kits for their employees. These findings were further validated by qualitative semi-structured interviews with nine managers working at regional and county levels with Workforce Investment Board (WIB) programs that were directly involved in assisting unemployed workers and businesses recover from the disruption of extreme events.

The qualitative interviews were conducted in February and March, 2012 as businesses were coping with recovery from Sandy, but the interviewees were experienced WIB managers who had assisted in recovery efforts from other extreme events, including: Hurricane Katrina, 2005; the Missouri floods, 2011; and the Joplin Tornado, 2011. When asked for their assessment of response and recovery operations after these events, the WIB managers expressed strong dissatisfaction with response and recovery efforts at all levels – federal, state, and local. Referring to their experience with workforce dislocation following Hurricane Katrina in 2005, interviewees reported that an early version of the National Incident Management System (NIMS) had just been implemented, with little experience or training conducted at sub-national levels of operation. Katrina served as its first serious field test. In addition, there was little or no consideration of local businesses and their need to prepare for or recover from a disaster of this magnitude, coupled with a general lack of awareness of risk in the private as well as the public sector. Business leaders were unable to identify meaningful steps taken by public agencies to include business figures in regional emergency response planning. That lack of awareness, according to business leaders, led to unrealistic expectations about the ability of the federal response agencies to mitigate the effects of a major disruptive event along the Gulf Coast, and especially in the New Orleans metropolitan area. While communications are known to have been haphazard among public sector agencies, information sharing appeared to be almost non-existent between the public and private sector. This finding from the qualitative interviews is consistent with the outcome of our content analysis. From this experience of coping with inadequate preparation for the impact of disaster on business organizations following the Katrina disaster, WIB managers readily recommended practical steps for engaging business owners more directly with public managers at local and state levels in emergency planning for known hazards in their respective regions.

Interestingly, the set of WIB managers interviewed in February and March, 2012 was responsible for implementing a program designed to assist employees who had lost their jobs primarily through economic dislocation, as authorized under the Workforce Investment Act of 1998. This law has no specific reference to loss of employment due to natural hazards, but rather was intended to support training and workforce development activities as different regions of the country experienced economic transition and change. The law does include a provision that, if a national emergency has been declared, the WIB operating in that region may apply for a National Emergency Grant (NEG). This allows the regional or local WIBs to use NEG funds for advertising job openings, employment training, and provides direct assistance to communities that have experienced severe business losses and enables them to initiate recovery operations quickly. While this is a small sample of expert managers, the findings illustrate a key role of the WIB in facilitating the recovery of businesses after extreme events. Figure 4 shows a Bayesian influence diagram that represents direct influence relationships among variables. The diagram shows the discrepancy between the prior assumptions specified in national policy that public agencies would coordinate their actions among all members of damaged communities and the actual, if impromptu, role that the Workers Investment Boards played in their communities. The diagram indicates the key function that the WIB served as a connecting link among many federal organizations and local agencies. It therefore performed a crucial role in meso-level business recovery. The WIB connected damaged businesses, employees who lost their jobs, and federal sources of economic assistance for recovery from extreme events.

From observations reported in the interviews, the WIB appears to be performing a critical function for community resilience not recognized in the formal plans of either FEMA or the WIA Law of 1998. The various regional and county WIBs are providing meso-level functions that link the resources of the federal agencies made available through a federal disaster declaration with a NEG authorized under the WIA Law of 1998 to provide resources and training to employees who lost their jobs due to the impact of a major natural hazard. Fligstein and McAdam (2013) note that such meso-level resource-linkages represent central functions enabling complex systems to adapt to changing conditions in their environment. While these actions appear to be the innovative response of WIB managers to extreme events that affected their clientele directly, the results have a beneficial effect on community resilience. The effectiveness of this strategy would likely be enhanced, were it included in preparedness activities before an extreme event occurred.

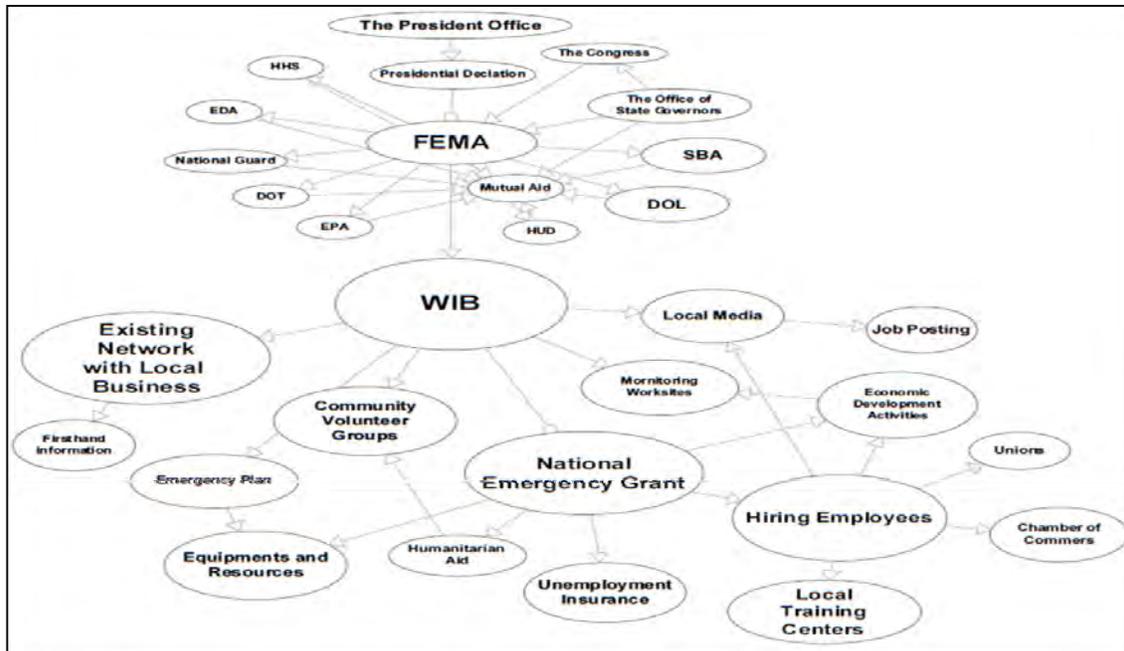


Figure 4. Bayesian Influence Diagrams showing direction of influence in decision making in disaster response for the affected workforce.

**CONCLUSIONS AND POLICY IMPLICATIONS**

Reviewing the findings from this analysis, we return to the initial question posed for this study: “To what extent did the communities affected by Superstorm Sandy achieve the goal of disaster resilience for the ‘whole community?’” Based on the evidence presented in this analysis, we draw four conclusions.

First, the data documented a substantial discrepancy in awareness of risk and preparedness for a severe storm between the business sector and the public sector, indicating a major gap in practice from the concept of whole-community resilience. This finding is documented both by the high degree of disconnectedness of business organizations from the overall network of organizations engaged in disaster response operations, as well as the substantial losses reported to business infrastructure, revenue, and operations.

Second, the analyses documented the technical capacity to assess information from a wide range of sources to track response operations mobilized by a large number of organizations to create a working profile of a disaster response and recovery system. This technical capacity, however, is not yet matched by the organizational capacity to use this information to monitor and guide response operations in real time. This clearly can be a potential for future exploration in developing effective methods of achieving community resilience.

Third, the data document the innovative and critical role of the WIB organizations to reach out to business organizations and use resources available to them through the WIA Law enacted for a different purpose to address the very immediate need of workforce training and employment in the urgent context of disaster recovery from this severe storm. In effect, the WIB organizations were creating a meso-level of organizational action between the federal agencies that offered resources for recovery and the micro-level of municipalities, neighborhoods, and individuals that needed assistance in planning and conducting recovery operations.

Fourth, the analysis documents the capacity of individuals, organizations, and communities to learn and adapt to challenging conditions if timely, valid information is readily accessible to them. This finding confirms earlier research on the critical role of providing a sociotechnical information infrastructure to enable communities to assess, monitor, and act to reduce the risk to which they are exposed (Carley and Harrald, 1997; Johnson, Zagorecki, Gelman, and Comfort, 2011; Comfort, Colella, Voortman, Connelly, Wukich, Drury, and Klein, 2013). This finding underscores the potential for building community resilience to disaster, but reveals the substantial investment in information technology and public education still needed to achieve this goal.

Returning to the four requirements for resilience stated earlier (p.2), the implications for increasing resilience to disaster on a national scale in the U.S. are clear. The key function in building resilience on a national scale is to engage individuals, organizations, agencies, and jurisdictions at micro, meso, and macro levels of action in a continuing process of monitoring risk and communicating relevant information regarding risk to responsible

*Proceedings of the 11<sup>th</sup> International ISCRAM Conference – University Park, Pennsylvania, USA, May 2014*  
 S.R. Hiltz, M.S. Pfaff, L. Plotnick, and P.C. Shih, eds.

members of the community. To carry out this function, it is essential to invest in a national information infrastructure that can support research, education, and communication regarding risk and recovery. These functions are interrelated, and one strengthens the other in a virtuous loop, but if it is not maintained through active elicitation and engagement, the loop is likely to break (Koppenjan and Klijn, 2004). Finally, all actors in this complex process share the responsibility for maintaining current knowledge of their own status, as well as awareness of the changing status of others at risk (Weick, 1993, 1995).

#### **ACKNOWLEDGMENTS**

We thank Ronald Painter and his colleague, Josh Copus at the National Association of Workforce Boards Office in Washington, DC, for their assistance in providing access to information and references for this study. We especially thank the experienced managers who participated in the interviews for this study, generously giving their time and insights. For reasons of confidentiality, attribution is not given for specific comments in the study. We also acknowledge our CDM colleague, Jungwon Yeo, for her contribution in conducting the Rapid Ethnographic Assessment of news articles from the Lexis-Nexus database.

## REFERENCES

1. Aon Benfield. (2013) Hurricane Sandy Event Recap Report: Impact Forecasting.
2. Carley, Kathleen M. and Harrald, John. (1998) Organizational Learning Under Fire: Theory and Practice. *American Behavioral Scientist* January 1997/40: 310-332.
3. Comfort, Louise K. (2007) "Crisis Management in Hindsight: Cognition, Communication, Coordination and Control." *Public Administration Review*, Special Issue, Hurricane Katrina, December: S188-S196.
4. Comfort, Louise K. and Okada, A. (2013) "Emergent Leadership in Extreme Events: A Knowledge Commons for Sustainable Communities." *International Review of Public Administration*, Vol. 18(1), pp.61-77.
5. Cohn/Resnick Ltd. (2012) Hurricane Sandy: Beyond the Physical Impact on Businesses – and How to Recover. <http://www.cohnresnick.com/hurricane-sandy-beyond-physical-impact-businesses-and-how-recover#sthash.Ap8QoarW.dpuf>.
6. Dun & Bradstreet. (2012) Hurricane Sandy Disaster Impact Report. New York: Dun & Bradstreet, Inc. DB 3375, 11/12.
7. FEMA. (2011) A Whole Community Approach to Emergency Management: Principles, Themes, and Pathways for Action. FDOC 104-008-1. [http://www.fema.gov/media-library-data/20130726-1813-25045-0649/whole\\_community\\_dec2011\\_2.pdf](http://www.fema.gov/media-library-data/20130726-1813-25045-0649/whole_community_dec2011_2.pdf).
8. FEMA. (2008a) National Response Framework. <http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf>.
9. FEMA. (2008b) National Incident Management System. [http://www.fema.gov/pdf/emergency/nims/NIMS\\_core.pdf](http://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf).
10. Fligstein, Neil and McAdam, Doug. (2012) *A Theory of Fields*. New York: Oxford University Press.
11. Glass, Robert J., Ames, Arlo L., Brown, Theresa J., Maffitt, Louise S., Beyeler, Wlaler E., Finley, Patrick D., Moore, Thomas W., Linebarger, John M., Brodsky, Nancy S., Verzi, Stephen J., Outkin, Alexander V., and Zagonel, Aldo A. (2011) "Complex Adaptive Systems of Systems (CASoS) Engineering: Mapping Aspirations to Problem Solutions." Eighth International Conference on Complex Systems. Sixth IEEE International Conference on Systems of Systems Engineering (SoSE). Sandia National Laboratories, 3354 C.
12. Kaufman, D. (2012) Keynote Address: Natural Hazards Workshop. Broomfield, CO. July 15.
13. Koppenjan, Johannes and Klijn, Erik-Hans. (2004) *Managing Uncertainties in Networks: A Network Approach to Problem Solving And Decision Making*. Routledge.
14. Krauskopf, J., Blum, M., Lee, N., Fortin, J., Sesso, A., and Rosenthal, D. (2013) *Far From Home: Nonprofits Assess Sandy Recovery and Disaster Preparedness*. New York: Baruch College, City University of New York, October.
15. Mayer-Schönberger, Viktor and Cukier, Kenneth. (2013) *Big Data: A Revolution That Will Transform How We Live, Work and Think*. Boston: Houghton Mifflin Harcourt.
16. Pfeffer, Jürgen, and Carley, Kathleen M. (2012) "Rapid Modeling and Analyzing Networks Extracted from Pre-structured News Articles." *Computational and Mathematical Organization Theory*, Vol. 18(3), pp 280-299.
17. The Hartford. "Hartford Small Business Pulse: Storm Sandy." March 19, 2013. <http://www.thehartford.com/sites/thehartford/files/storm-sandy-infographic.pdf>.
18. The National Academies. (2012) *Disaster Resilience: A National Imperative*. Committee on Increasing National Resilience to Hazards and Disasters. Committee on Science, Engineering, and Public Policy. The National Academies Press. Washington, D.C.
19. Waugh, William and Tierney, Kathleen. (2007) *Emergency Management: Principles and Practice for Local Government*. Washington, DC: ICMA Press.
20. Weick, Karl E. (1993) The Collapse of Sensemaking in Organizations: The Mann-Gulch Disaster, *Administrative Science Quarterly*. Vol. 38, pp. 628-652.
21. Weick, Karl E. (1995) *Sensemaking in Organizations*. Thousand Oaks: Sage Publications Inc.