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RESEARCH OVERVIEW: EMERGENCY RESPONSE

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INTRODUCTION

The social science literature on emergency response activities following major disasters, which now spans approximately fifty years of empirical research, encompasses a wide range of topics (for reviews and representative work, see Drabek, 1986; Drabek and Hoetmer, 1991; Dynes and Tierney, 1994). Those topics include:

1. Immediate societal impacts: disaster-related deaths and injuries and the factors associated with mortality and morbidity; housing impacts and the need for emergency shelter and temporary housing; secondary impacts, such as fires and hazardous materials releases; and impacts on businesses and economic activity. Studies also focus on the factors associated with differential levels of disaster vulnerability, such as poverty, substandard and overcrowded housing, and risk factors for death and injury.

2. Organizational, interorganizational, and intergovernmental communication and coordination during the emergency response period: how responding organizations and levels of government gather, share, and use disaster-related information, establish response priorities, and develop and carry out procedures for mobilizing resources and addressing the problems they encounter during the emergency period.

3. The performance of key emergency tasks: the actions different social units and organizational entities (individuals, households, groups, organizations, and interorganizational and intergovernmental networks) undertake in order to deal with disaster-generated problems. Such activities include rescuing victims and recovering bodies, providing emergency medical care, assessing damage, providing emergency shelter and temporary housing, and containing secondary hazards. The literature also includes studies on the emergency activities of crisis-relevant organizations such as fire departments, emergency management agencies, search and rescue units, and hospitals.

4. Response by the general public during the emergency period: post-disaster behaviors and activities of community residents, including behavior during and immediately after disaster impact (warning response, self-protective actions, occupant behavior, evacuation, etc.), use of emergency shelter, public involvement community response activities, and volunteer behavior.

5. Utilization of post-disaster emergency and short-term recovery resources by disaster victims: patterns in the public's use of disaster-related services, such as emergency shelter, emergency medical care, crisis counseling, and disaster assistance, as well as the factors that influence service utilization.

6. Crisis-related organizational adaptation and innovation: the ways in which various social units attempt to adapt and change in response to crisis-related demands. These patterns include expansion, in which existing organizations try to improve their performance by taking on new

members or volunteers; extension, in which existing organizations assume new tasks they had not performed prior to the disaster; and emergence, which involves the formation of new groups and intergroup networks. Modes of adaptation can also include improvising new strategies for handing disaster-related problems, introducing new technologies, and identifying previously untapped resources.

7. Factors that affect the nature, extent, and effectiveness of response activities: For individuals and households, such factors have been shown to include socioeconomic status, race, ethnicity, disaster knowledge, social networks, the extent of pre-disaster preparedness, and previous disaster experience. Influences on the response activities of organizations and governmental entities include the extent and quality of pre-disaster planning and training, prior disaster experience, disaster severity, the principles or assumptions on which response planning is based, the resources that organizations have been able to devote to planning for and responding to disasters, access to needed technology and resources, and their ability to resolve interorganizational and intergovernmental conflicts during the emergency period.

REVIEW AND DISCUSSION OF RESEARCH FINDINGS

The eight papers on emergency response that were submitted for this conference all fall into at least one, and usually more than one, of these seven categories. With respect to disaster impacts, the paper by Antoine Kazzi and a group of co-authors focuses on the earthquake injuries and medical complaints treated by one hospital emergency department in the epicentral area and the implications the observed patterns of hospital use may have for disaster emergency medical planning. Two papers, by Michael Lindell and Ronald Perry and by Guna Selvaduray, provide data on one type of secondary impact, the hazardous materials releases that occurred as a result of the earthquake. The Lindell and Perry paper also discusses what hazardous materials handlers are currently doing to mitigate future hazmat problems.

Papers by Louise Comfort and Richard Priesmeyer and by Joanne Nigg deal with the structure and functioning of the emergency response system, focusing on intergovernmental strategies and patterns that developed to handle the complex and pressing demands the earthquake generated. James Goltz's paper looks at how government agencies, utilities, and corporations that participated in the CUBE system used the real-time seismic information CUBE provided during the post-disaster response and early recovery periods. Gabriela Vigo and Dennis Wenger compare data on the emergent search and rescue activities that developed following the Northridge earthquake with data they had previously collected on search and rescue groups in the Mexico City earthquake. The final paper in this group, by Kimberly Shoaf, Linda Bourque, and Loc Nguyen, uses survey data to identify factors associated with residents' use of disaster assistance services.

These conference papers do not, of course, represent all the studies that have been conducted on response-related topics following the Northridge event, and some investigators are still in the process of analyzing their data, so their findings are not yet available. However, even taking this other work into account, it is clear that studies on the emergency response and social scientific studies in general constitute only a tiny fraction of the research that has been conducted on Northridge. Given all that could have been studied, the range of topics covered is quite narrow, and with some exceptions, the research that was conducted is modest in scope and level of effort.

Despite these limitations, research on emergency response issues in the Northridge earthquake has made important contributions. First, with respect to earthquake-related injuries and medical complaints, the findings reported in the Kazzi, et al. paper on utilization of hospital emergency care following the earthquake must be interpreted with caution, because of methodological limitations in the study that the authors acknowledge. However, the data do suggest that the need for emergency treatment peaked shortly after disaster impact, with lacerations, trauma, and orthopedic injuries predominating, and that this peak demand period lasted only a day

or two. This is basically the same pattern that was seen in the Bay Area following the Loma Prieta earthquake. Kazzi et al. find that after the first day or so, visits to the hospital emergency department remained higher than usual for several days, but by this time, patients were more likely to report other more medically-related complaints, such as respiratory and heart problems, rather than injuries.

Data from a much larger study on injuries and other health problems treated at hospital emergency departments throughout the impact area are currently being analyzed, and the results of that study will be more comprehensive. However, based on this paper and on analyses of the health impacts of other recent U. S. earthquakes, one conclusion that can be drawn is that the bulk of the demand for emergency treatment following major earthquakes will occur in the first twenty-four hours after impact. This means that the need for emergency treatment, particularly the care of trauma-related injuries, will have to be addressed by local health-care service providers. Outside resources, such as federally-organized disaster medical assistance teams, do have a role to play, but that role likely won't involve the provision of trauma care, because by the time those resources arrive, those kinds of injuries will already have been treated by health care providers in the immediate impact area.

The findings from this study and other research on U. S. earthquakes point to the need for enhancing the response capacity of local hospitals and other providers of emergency care, because these organizations will be responsible for handling the highest volume of earthquake injuries and health problems in the critical post-impact period. A catastrophic earthquake that would render local health care resources incapable of treating casualties would pose an entirely different set of challenges. However, with the possible exception of the 1906 San Francisco event, we have not yet seen an earthquake of this kind in the U. S.

Moving on to another type of direct earthquake impact, the documentation of earthquake-induced hazardous materials releases has been more extensive for the Northridge earthquake than for any other earthquake disaster, and the data bases that researchers have assembled will prove useful for earthquake risk analysis and loss estimation. The two papers on hazmat releases used different methodologies and data sources, so they contain different estimates on the incidence of releases, and also slightly different conclusions about the sources of post-earthquake hazmat problems. Guna Selvaduray's analysis, which estimates that there were just under 400 hazmat releases in the two counties he studied, Los Angeles and Ventura, suggests that the sources of post-earthquake hazmat emergencies are quite varied. For example, he found that laboratories at universities and other educational institutions were quite vulnerable to hazmat spills and also to fires. These kinds of settings would likely have presented a serious safety hazard had the earthquake occurred during a time when classes where in session. Selvaduray's paper also points out the need for better hazmat incident record keeping and for stepped-up mitigation efforts by hazmat handlers.

The other paper on hazardous materials releases, by Lindell and Perry, which focused more specifically on facilities that produce and handle hazardous substances, indicates that both physical damage and lifeline loss, especially loss of electricity, were problems at many of these facilities. These authors identified 134 locations in Los Angeles County where there were hazmat problems. Among these were 60 emergency incidents, of which 10 were classified as major. Like the Selvaduray paper, Lindell and Perry's paper contains detailed information on the types of incidents that occurred and on the sources of those problems. It also discusses the difficulties these incidents presented for emergency responders.

Surveying hazmat facilities following the earthquake, Lindell and Perry found that facilities in high shaking intensity areas and those that experienced physical damage and other problems when the earthquake occurred were no more likely than other facilities to have carried out post-event mitigation and preparedness measures. Social science research suggests that while in many cases disaster experience does stimulate higher levels of preparedness, this doesn't invariably occur. Evidently the Northridge experience didn't provide that impetus for the organizations Lindell and Perry studied.

The four papers that deal with organizational, interorganizational, and intergovernmental response issues also contain a good deal of interesting and enlightening material. Drawing upon the literature on organizations, interorganizational relationships, and complexity, the paper by Comfort and Priesmeyer characterizes the post-earthquake response system as a complex adaptive system that during its peak period of operation consisted of nearly 400 organizations. The paper hypothesizes that this high degree of complexity was managed effectively because of the extensive and effective use of information technology during the response period and also because necessary training and organizational learning had already taken place prior to the earthquake. One important implication of this research is that little can be gained merely by making new technologies available to support response activity without first developing the organizational capacity to use those technologies effectively. The authors argue that response systems should appropriately be conceptualized as sociotechnical systems, and that the social or organizational components in those systems are as important as the technologies themselves. More generally, the paper also points to the need to develop and apply more abstract conceptual and theoretical frameworks to accurately characterize and explain how response systems function under high-demand conditions.

Joanne Nigg's paper on interorganizational and intergovernmental coordination during the emergency response period, which focuses on how three communities in the impact region coped with disaster-related demands, illustrates how much variation there is in the organizational configurations that form at the community level to deal with crisis situations. Case studies on the three communities found that they varied in the ways in which they implemented their emergency plans, as well as in the extent to which their response activities were integrated both horizontally and vertically. These findings are consistent with what other research on the U. S. emergency response system has found: patterns of response are diverse and are not consistent across jurisdictions, and even in situations where there has been prior planning, relations among levels of government are often problematic (Wenger, Quarantelli, and Dynes, 1986).

Nigg's research also indicates that some organizational response arrangements were more effective than others. Pre-disaster planning and prior disaster experience had a positive influence on the ability to manage response activities, but response patterns were also influenced by each community's unique historical situation, by everyday, routine patterns of interorganizational and intergovernmental contact, and also, importantly, by politics.

The idea that public and private sector organizations can benefit from receiving data on earthquakes in real time is now widely accepted, and there are several new initiatives in this area (e.g., Trinet, REDI, EPEDAT, and efforts by federal government agencies to develop advanced networks for transmitting data on hazards and disasters). James Goltz's paper on one real-time system, CUBE, indicates that CUBE was mainly used by organizations to monitor aftershocks following the Northridge event. Organizations didn't need data from CUBE to understand they were facing a major earthquake--that was obvious in this case--and the fact that the system did not function well in reporting mainshock data didn't significantly influence how they responded when the earthquake occurred.

One important issue raised in this paper is that improvements in earthquake monitoring and real-time communications technology will inevitably raise public and organizational expectations for the performance of these systems. How much to invest in these technologies, what to expect in the way of return on such investments, what assurances to give regarding performance, and the extent to which real-time systems can be relied on for decisionmaking during the immediate response period are significant policy questions and important areas for future study.

This is a valuable case study, but we still lack a more complete assessment of the entire range of new technologies that were used following the earthquake, how they were used and by which agencies, and the extent to which they improved the ability of organizations to respond. More broadly, it is important to understand the

factors that encourage the effective use of technology in responding to earthquakes and other disasters. These kinds of issues are especially important, since a number of technologies are currently being implemented and others are being proposed to enhance response capability and decisionmaking.

Northridge research both reinforced and expanded earlier findings on how the public responds in disaster situations. The massive volunteer response following the Kobe earthquake, in which an estimated 1 million people took part, illustrates the importance of the public as an emergency response resource in disaster situations. The emergence of groups that organize to meet disaster-related needs and perform emergency tasks is a common occurrence following disaster impact (Stallings and Quarantelli, 1985). Generally speaking, the larger and more disruptive the disaster, the more likely it is that emergent groups will become heavily involved in the emergency response. The paper by Gabriela Vigo and Dennis Wenger, which looked at search and rescue (SAR) following the earthquake, indicates that initial SAR activities were carried out by small, ad hoc neighborhood groups. The involvement of local community residents in SAR has been observed in other earthquake events, as well as in disasters of other types (O'Brien and Mileti, 1993; Wenger and James, 1994). The emergence of informal SAR groups was not as widespread in Northridge as in the 1985 Mexico City earthquake, which the authors also studied, largely because the latter event was a more serious earthquake that placed greater SAR demands on the emergency response system--demands the system was initially unable to meet. Compared with Mexico City, volunteer SAR groups in Los Angeles had fewer conflicts with officially-designated SAR units, and the transition from volunteer-dominated to officially-designated SAR groups was smoother, probably because pre-disaster planning was more extensive in Los Angeles.

The Los Angeles Fire Department had been providing training in earthquake response to community residents for a number of years prior to the Northridge event. Vigo and Wenger suggest that many of these Community Emergency Response Team (CERT) trainees were active in SAR at the time of the earthquake. This was particularly true if their training had been neighborhood-based, rather than workplace-based. However, this latter finding might be attributable more to the time of day the earthquake occurred than to anything else. Had the temblor struck during regular working hours, workplace-centered groups might have played more of a role in the response.

The broader issue raised by this paper is how best to integrate community residents, informal social groupings, and emergent groups into the overall response effort. Social scientists have long pointed out that emergence is inevitable in disaster situations and that emergent groups have the capacity for providing various kinds of assistance to official response agencies. The challenge for planners is to identify ways of tapping this important resource.

The final paper on response-related issues, by Shoaf, Bourque, and Nguyen, is based on data collected in a large-scale survey of households in the disaster-stricken region, which focused on earthquake impacts and on various aspects of the public response. This paper, which concerns the factors that influenced the use of disaster assistance services by the public, draws upon a broader service-utilization literature that points to a range of socioeconomic, sociocultural, and social-psychological factors as important determinants of access to and use of services. Their research indicates that objective measures of the need for post-earthquake aid, such as physical damage and financial loss, are predictors of service utilization, but so are several other factors. These factors include home ownership, age (younger people were more likely to apply for aid), perception of oneself as a disaster victim, the amount of property damage in the surrounding neighborhood, and geographic proximity to disaster application centers. In other words, both barriers and enabling factors appear to be operating that mediate the relationship between losses and access to the resources needed to recover from those losses.

Like the other papers reviewed here, this paper answers some important questions while raising others. Did older disaster victims avoid using disaster services out of choice, or were those services less accessible or less appropriate for their needs? What accounts for the relationship between home ownership and use of services?

Are owning and renting proxies for other more significant socioeconomic variables, as the authors suggest? Since physical distance from disaster application centers appears to discourage service utilization, will telephone registration for assistance, which is increasingly employed following disasters, provide more equitable access to services? Or will increased reliance on telephones create new barriers for some disaster victims?

CONCLUDING OBSERVATIONS

Perhaps the most general conclusion that can be drawn about the emergency response research that was conducted following the Northridge earthquake is that there wasn't enough of it, either in terms of the topics covered, or in terms of the size of the projects that were undertaken. Many important topics were not addressed. To cite just a few examples, there were no studies on how private sector organizations coped with the earthquake, or on how they coordinated with public sector responders. No research was conducted on the response activities of community-based organizations, volunteer associations, or not-for-profit groups. There were no systematic comparative studies on organizations that carried out key response functions, such as fire departments, lifeline organizations, building and safety departments, or hospitals and other emergency-care providers, and we thus learned little about the factors that may have affected their response activities.

Although we do know that the response to the earthquake was organizationally complex, no studies have systematically analyzed the interorganizational networks that developed to carry out specific disaster-related tasks (e.g., building inspection, temporary sheltering, lifeline restoration, provision of emergency water to impacted areas). Northridge marked the first time the federal response plan was activated in a major earthquake event. As Comfort and Priesmeyer's paper shows, the federal government's response to the earthquake was rapid and massive. There is general agreement that the intergovernmental response to the Northridge event was quite effective--in part because of the moderate scope and severity of the event. However, we still lack a detailed understanding of which aspects of the response worked well and which did not, which of the major investments that were made in personnel, technology, and other resources actually paid off and which didn't, and what implications the response to this earthquake may have for future catastrophic and near-catastrophic events.

Because of the comparatively modest scale of many of the studies that were conducted--and scale is, of course, dictated largely by budgetary considerations--it is difficult to generalize their findings more broadly. Nevertheless, a great deal was learned, particularly from studies that were well-linked conceptually and theoretically to the broader emergency response literature and to more general social scientific research, that built on or attempted to replicate earlier empirical work, and that tried to incorporate a comparative dimension into their research designs.

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