

University of Delaware
Disaster Research Center

Preliminary Paper
#260

EMERGENCY RESPONSE: LESSONS LEARNED
FROM THE KOBE EARTHQUAKE

Kathleen J. Tierney
James D. Goltz

1997

Emergency Response: Lessons Learned from the Kobe Earthquake

Kathleen J. Tierney, Disaster Research Center, University of Delaware

James D. Goltz, Center for Advanced Research and Planning, EQE International, Irvine, CA

Overview of Disaster Impacts and Emergency Response Issues

The Kobe earthquake of January 17, 1995 was the most devastating natural disaster to strike Japan since the Great Kanto earthquake and fire of 1923. A total of 6,279 persons died as a result of the earthquake; nearly 90% of the deaths occurred as a direct result of building collapse, and the remainder were due largely to the fires that broke out following the earthquake. The greatest loss of life occurred in the cities of Kobe (4,484), Nishinomiya (1,107) and Ashiya (453). An estimated 34,900 people were injured (Hyogo Prefecture, 1996). Vulnerability was related to age and gender; residents 60 years of age and above were significantly more likely to die in the earthquake than those who were younger (International Federation of Red Cross and Red Crescent Societies, 1996). With the exception of children under ten, more women than men were killed in every age group (The Wheel Extended, 1995).

Over 136,000 housing units were destroyed in the earthquake or subsequently demolished, and more than 300,000 persons lost their homes (Hyogo Prefecture, 1996). Utility services were disrupted throughout the impact region. More than 1.3 million households were without water, 2.6 million lost electricity, 860,000 were without natural gas, and 300,000 lost their phone service (Goltz, 1996). Economic losses were extensive. The synthetic shoe industry centered in fire-ravaged Nagata Ward suffered enormous damage. The Port of Kobe, Japan's largest container facility and the sixth largest cargo port in the world, was effectively shut down. Direct physical damage resulting from the earthquake is expected to exceed \$100 billion (Chang, 1996).

The earthquake occurred not in the Tokai region, where the next great earthquake was anticipated, but rather in an area in which seismic hazards had not been a major focus of governmental or public concern. Due in part to the fact that damaging earthquakes have been relatively infrequent in the Kansai

region, Kobe was not well-prepared for a major earthquake. The intensity of the ground shaking, the characteristics of the built environment, and the geography and human ecology of the area combined to maximize damage and social disruption and make the emergency response following the event especially difficult.

The response-related demands the earthquake presented would have been extremely daunting even under the best of circumstances. The extent of the damage to the highway and rail transportation systems and the volume of debris in the streets created major traffic congestion and blocked emergency vehicle access. Disruption of communication systems and the sheer magnitude of the damage to structures and roadways made early situation assessment difficult. Building collapses crushed or trapped an estimated 20,000 people.

The approximately 300 fires that broke out in the impact region following the earthquake far exceeded the capacity of local firefighting resources. Firefighting efforts were severely hampered by the sheer number of fires that started (over one hundred in the city of Kobe following impact), water shortages that developed due to breaks in the water distribution system, inability to use fire hydrants, blocked and debris-filled roads that prevented access to fires, and the need to divert fire service resources for search and rescue (Scawthorn and Cowell, 1995; United Nations Centre for Regional Development, 1995). Lifeline failures left the majority of the population in the impact area without water, gas, or electricity. Hundreds of thousands of people, including a large elderly population, were forced out of their homes. During the peak demand period between January 20 and 24, more than 342,000 persons in Hyogo Prefecture sought refuge in 1,153 shelters (United Nations Human Information Network, 1996). Two years after the earthquake, the population of the city of Kobe has declined by approximately 96,000, or 6% overall; Nagata Ward, a particularly hard-hit section of the city that experienced extensive fire damage, has lost an estimated 30% of its population (Chang, 1996).

Japan's long history of fires, floods, earthquakes, tsunamis, and landslides, together with its uniquely tragic experience in World War II, have helped shape a culture that anticipates and is able to deal effectively with catastrophe. Following the earthquake, residents of the affected region showed great forbearance and adaptability in an immensely difficult situation. Consistent with patterns observed in other disasters worldwide, most search and rescue was undertaken by

community residents; officially-designated rescue agencies such as fire departments and the Self Defense Forces were responsible for recovering at most one quarter of those trapped in collapsed structures (United Nations Centre for Regional Development, 1995). Spontaneous volunteering and emergent group activity were very widespread throughout the emergency period; community residents provided a wide range of goods and services to their fellow earthquake victims, and large numbers of people travelled from other parts of the country to offer aid. Estimates of the number of people who engaged in volunteer activity in the impact area in the months following the earthquake range from 630,000 to 1.3 million (International Federation of Red Cross and Red Crescent Societies, 1996; The Economist, 1997).

The outpouring of public concern for victims of the earthquake was without precedent in Japanese society. In contrast with the United States, volunteer activity--either during disasters or in non-disaster contexts--is not widespread in Japan. Low rates of participation in volunteer activities appear to have both cultural and structural sources. Culturally, members of Japanese society tend to a much greater sense of social obligations to their families and to other groups with which they are associated on a regular basis, such as schools and business firms, than to strangers. Volunteering has actually had a long history in Japan, but citizen involvement in voluntary organizations declined following World War II, as the state and its large bureaucracy increasingly took on functions that had previously been performed in the non-governmental sector. That decline was particularly marked in the nation's urban centers (The Economist, 1997).

The extensiveness of volunteer efforts in this particular earthquake event has been attributed to several factors, including the severity of the disaster; the tremendous evidence of need among the victim population; intense media reporting; and the fact that the earthquake occurred during a break between academic terms, so that students were freer to travel to the impact area. Perhaps because large-scale volunteer activity was not anticipated, government plans had not considered ways of incorporating volunteers into the overall emergency response. Local governments in the impact area varied in the extent to which they coordinated with the volunteer groups that formed after the disaster. Some jurisdictions established close links with emergent groups, while others officially recognized their existence but engaged in only limited coordination, and still others allowed newly-formed volunteer networks to operate but

avoided official contact with them (Atsumi, et al., 1996; Atsumi, 1996). A number of the citizen groups that emerged following the Kobe event have continued to exist as organizations, and some of those groups provided volunteers to aid in the response to major oil spills that occurred in the Sea of Japan and Tokyo Bay in 1997.

The intergovernmental and interorganizational response following the earthquake has been widely criticized. Given the pervasiveness of the earthquake hazard in Japan and the resources that have been devoted to earthquake prediction, preparedness, and public education the Tokai region, the expectation was that cities in Japan would be capable of coping effectively with a major earthquake. Researchers, the public, and particularly the Japanese press were dismayed when the Kobe event uncovered major deficiencies in the preparedness and response system. Indicative of the press reaction is an editorial that ran in the Japan Times just over a week after the earthquake which concluded that "[t]he Hanshin Great Earthquake has forced all Japanese to recognize that this country does not have a reliable crisis management system" (Japan Times, January 26, 1995).

The problem was not that Japan and the jurisdictions affected by the earthquake lacked a general framework for managing disasters. The 1961 Disaster Countermeasures Basic Act provides the statutory authority for disaster management, including disaster response, relief, and recovery operations. A Central Disaster Prevention Council (CDPC) exists at the national level to coordinate the hazard management activities of federal ministries. The law calls for another body, the headquarters for disaster countermeasures (HDC), to be established when a disaster occurs; that group was activated on the day of the earthquake. The Emergency Countermeasures Headquarters, a second cabinet-level group set up on January 19 to direct response and recovery activities, met over a three-month period following the earthquake to facilitate relief and recovery activities (United Nations Centre for Regional Development, 1995).

Although federal legislation provides an overall structure for planning and response, local governments in Japan have the primary authority for disaster management. Each prefecture and local jurisdiction has a Local Disaster Prevention Council (LDPC) that is responsible for the development of area-specific disaster plans. The 1961 law stipulates that heads of

municipalities have responsibility for disaster response planning and for setting up emergency response offices when disasters occur. Such offices were established in Kobe and more than a dozen neighboring municipalities as well as at the prefectural level within a few hours after the earthquake. (For an overview of the structures developed for coordinating and managing disaster operations in Japan, see National Land Agency, 1988).

Rather, negative evaluations of government performance have centered on the lack of a rapid situation assessment at levels of government where major decisions needed to be made and on delays in the mobilization of critical resources and the initiation of key response tasks. Local officials in Kobe City and Hyogo Prefecture were initially unaware of the magnitude of the disaster because of major communications problems and traffic congestion that made movement difficult throughout the impact area, and because so many emergency responders and public officials were also disaster victims themselves. Lacking effective communications links and accurate information from the impact area, the government of Prime Minister Tomiichi Murayama also failed to comprehend the severity of the situation for a number of hours and consequently was slow in committing needed resources.

Effective post-disaster response is predicated on an understanding of the nature and severity of disaster impacts-- where the most serious impacts are, what problems need immediate attention, and what victims of the disaster urgently need. However, the Kobe earthquake caused such extensive disruption of communications and transportation networks that an accurate situation assessment was impossible. Among the problems emergency responders faced were a widespread loss of telephone service; damage that rendered the prefecture's radio system and fax communications inoperable; and loss of back-up power for key emergency functions. Both intra- and inter-agency communications were so disrupted that launching an effective, co-ordinated response was not possible in the hours following impact. According to one researcher, in Kobe city "[t]he devastation of the municipal government's emergency radio systems and public telephone system prevented disaster-relief agencies from accurately determining the disaster's extent during the first and most critical phase following the earthquake (Hiroi, 1995: 4). Another post-disaster report concluded that "[i]mpact assessment was the major problem encountered by all response agencies at all levels of government" (Wellington City Council,

1995).

In a situation resembling what occurred in the U. S. following Hurricane Andrew, the provision of aid to local jurisdictions was stalled because of delays in transmitting the prefecture's official request for assistance from the federal level. The slow response can be attributed both to a concern at all levels with following preestablished procedures and to the widespread communications problems described above.

Other critiques focus on fundamental problems with underlying emergency management assumptions and the manner in which planning and response were approached. Perhaps because of cultural practices that stress in-group solidarity and foster an inward orientation generally (expressed in the Japanese concept of *ie*), interorganizational preparedness and response measures tended to be underemphasized. Consequently, governmental and other crisis-relevant organizations may have been reasonably well-prepared internally for some disasters but not prepared to coordinate with other organizations and groups on key response tasks. For example, organizations providing different lifeline services were reportedly not well-linked with one another, and were generally not well-linked with local governments (Johnson and Eguchi, 1995).

Planning efforts that had been undertaken at the prefectural and community levels also appear to have focused more on other hazards than on earthquakes. In the Greater Kobe area, recent preparedness efforts had focused on responding to hazards associated with severe winds, typhoons, and landslides. Because of Japan's experience in the 1923 earthquake and in World War II, emergency response planning has also been driven by major concerns about fire. The neglect of the earthquake hazard seems incomprehensible in retrospect, since there are a number of known active faults in the region. However, large earthquakes had not affected the Kobe-Osaka area since the 1940s, and the last highly damaging event that struck the Kansai region was the Keicho-Fushimi earthquake in 1596. The Kobe case illustrates how threat perceptions and planning activities tend to be shaped by recent and frequent disasters, rather than the entire range of events a region might expect to experience.

Additionally, disaster preparedness activities had evidently not been directed toward handling catastrophic or near-catastrophic events. The emergency plan that was in place in Hyogo Prefecture at the time of the earthquake was geared

toward responding to a less intense and much less damaging earthquake. As a consequence, the prefecture found it necessary to replace its disaster management plan on January 20, as the response was ongoing, to deal with severe problems such as massive transportation disruption, the enormous number of people in need of shelter and temporary housing, the need for large numbers of building inspectors to assess damage, and the need to distribute emergency supplies. Pre-disaster planning had simply not taken into account the kinds of demands that the Kobe event placed on the system.

That the resources of the Self Defense Force (SDF) were not initially mobilized until nearly 24 hours after the earthquake was another major source of criticism. Some accounts point to the lack of an official request for assistance from the prefectural governor as the reason for the SDF's sluggish response. Others argue that the necessary request had been forthcoming, but mobilization was slow because of logistical problems and the overwhelming size of the event. However, the root cause of the failure to use military resources effectively in this disaster may ultimately lie in attitudes about the role of the military in Japanese civil society. The public in general and many local governmental bodies are ambivalent or even downright hostile toward the SDF. Thus, while the SDF typically does play a role in disaster response, its use in domestic crises is controversial. Military forces are generally not well-linked to local preparedness efforts and do not participate in disaster drills and exercises, except at the invitation of local jurisdictions. Although the prefecture reportedly had some degree of contact with the SDF prior to the earthquake, the City of Kobe did not. Once the SDF was mobilized, the situation was further complicated by its lack of experience in earthquake operations, equipment shortages, and transportation difficulties (United Nations Centre for Regional Development, 1995).

Some critics also argue that deficiencies in preparedness and response can be traced in part to policies and practices that encouraged overreliance on pre-event mitigation as a solution to the earthquake problem. Many earthquake accounts expressed shock that damage and disruption were so intense and widespread in a metropolitan region with so many modern and presumably state-of-the art facilities. The belief that modern engineering practices would ensure an "earthquake-proof" society may have instilled a false confidence on the part of both government and the public at large.

The Kansai region was not prepared for a major earthquake, and the conditions local responders faced during the emergency were completely outside their experience. Approximately 40% of the employees of Kobe city government were victims of the disaster, and only about 20% of the city's workers were initially available to assist with the response. Damage and transportation disruption made it extremely difficult for response personnel to reach their posts, and even when they did, they had little solid information on which to base decisions (Wellington City Council, 1995). More than a quarter of a million disaster victims needed emergency shelter, food, and other basic services, but an effective system of shelter management and supply distribution had not been instituted prior to the earthquake (Kameda and Hayashi, 1995; United Nations Centre for Regional Development, 1995).

At the same time, it is important to note that the Kobe earthquake was a near-catastrophic event that would have created massive difficulties for even the best-prepared intergovernmental and interorganizational response system. The earthquake placed excessively high demands on the emergency management system while at the same time doing such damage to key elements in that system (such as interorganizational and intergovernmental communications linkages) that initially it was not possible to launch an effective response.

The United States has not experienced a disaster comparable to the Kobe earthquake since the San Francisco earthquake and fire of 1906. Even Hurricane Andrew, arguably the most severely damaging disaster the nation has faced in contemporary times, provided no precedent for the kinds of problems that would be created if an event like Kobe were to occur in a major U. S. population center.

That the emergency response following the Northridge earthquake of 1994 was generally well-handled is no cause for complacency. The Kobe event was many orders of magnitude more severe than Northridge and was qualitatively different in terms of the demands it placed on the response system. Along almost any dimension--the number killed, injuries, the number left homeless and in need of food and other basic services, the need for search and rescue and fire suppression, damage to transportation systems and the lifeline infrastructure, and economic impacts--Northridge was a minor event by comparison. Additionally unlike Kobe, the Los Angeles area had extensive recent disaster experience, including experience with damaging earthquakes, and the City and County had been systematically

developing earthquake response and recovery measures for more than a decade.

A more appropriate comparison would be to ask what the likely consequences would be if an earthquake accompanied by comparable levels of ground shaking were to strike Memphis, Charleston, or the Seattle area. Oakland is a city that resembles Kobe in terms of its topography, settlement patterns, and transportation infrastructure. A significant tremor on the Hayward Fault could produce many of the same kinds of impacts that were observed in the Kobe event. The Earthquake Engineering Research Institute's newly-released planning scenario (1996) projects that following a magnitude 7 earthquake on the Hayward Fault, the occupants of 150,000 to 200,000 housing units will need emergency or temporary housing, natural gas service will be extensively disrupted, and about 60% of East Bay customers will lose water for periods ranging from days to months. A large earthquake in the New Madrid Fault Zone could have catastrophic consequences because so much of the built environment in the Central U. S. lacks seismic resistance. The United States cannot claim with any degree of confidence that it would be able to cope effectively with the kinds of response-related problems the Kobe earthquake presented, especially if such an event should occur outside California.

Lessons for the United States

The lessons learned from the Kobe earthquake validated many assumptions policymakers and emergency planners have been making about major earthquakes and underscored the importance of measures that are already under way to deal with such events. The earthquake also indicated a need for shifts in emphasis to handle the demands associated with catastrophic and near-catastrophic events. We will first discuss those areas in which the earthquake reinforced the need to continue with initiatives that are already under way and then turn to considering where more needs to be done.

1. Continued emphasis on preparedness and response planning. While mitigation is still the preferred way of reducing earthquake losses, the U. S. should not rely on engineering solutions to the exclusion of providing support for preparedness and response. A balanced approach is needed that recognizes that no matter how much the built environment is made earthquake-resistant, earthquakes will still continue to kill, injure, and produce damage and disruption. Existing buildings

and infrastructure present the greatest hazard, and only effective response planning can deal with the problems future earthquakes will produce.

2. Continued emphasis on intergovernmental and interorganizational planning and response initiatives. One of the major strengths of the U. S. response system is its emphasis on linkages among agencies at the federal, state, and local levels, as well as between those levels. Future preparedness efforts must continue to stress interorganizational dimension of emergency management. As many post-disaster studies have shown and as the Kobe disaster clearly demonstrates, agencies accustomed only to working as relatively autonomous units will find interorganizational coordination difficult if joint operations with other agencies are not worked out and practiced in advance. The Federal Response Plan is an example of an effective preparedness initiative, as are efforts in the state of California to standardize emergency response procedures across jurisdictions and organizations. Preparedness strategies such as developing comprehensive community response plans, mutual aid agreements, and memoranda of understanding and conducting multijurisdictional drills and exercises should be encouraged. Similarly, the emphasis on public-private sector collaboration, particularly with key crisis-relevant organizations such as lifeline service providers, should continue.

3. Continued emphasis on planning for catastrophic and near-catastrophic events. A disaster like the Kobe earthquake or the major events that could occur in cities Los Angeles, the Bay Area, Seattle, Memphis, Charleston is qualitatively different from events like Northridge or Loma Prieta. Disaster preparedness efforts should still focus on the types of events that are most likely to occur, such as routine flooding and moderate earthquakes, but at the same time it is also necessary to continue to consider qualitatively different kinds of preparedness and response strategies that are based on worst-case scenarios. Managing the aftermath of catastrophic earthquake will involve the kinds of decisions that are not routinely faced in less severe events. For example, it is important to develop ways of prioritizing the restoration of transportation systems, manufacturing, and other commercial and economic activities to lessen social and economic impacts; establishing criteria for repair and reoccupation of large numbers of damaged structures, including those that would in less severe circumstances not be occupied for safety reasons;

and devising strategies for providing both short-term and more permanent housing for large numbers of displaced residents.

Despite decades of research evidence to the contrary, the assumption is still widespread in the hazards reduction/emergency management community that large-scale disasters simply involve an extension of the demands that accompany routine, everyday emergencies. Preparedness initiatives are needed that stress the unique challenges presented by catastrophic disaster events.

4. Increased emphasis on earthquake loss reduction in moderate- and high-risk areas that lack recent damaging earthquake experience. In the U. S., both earthquake hazard mitigation and emergency preparedness and response efforts have overwhelmingly concentrated on the state of California and its major cities. While understandable, in some ways this is comparable to Japan's emphasis on prediction and preparedness planning for the Tokai region, which may have diverted attention away from other potential problem areas. Efforts to enhance earthquake loss reduction in California should certainly continue, but not at the expense of other vulnerable parts of the country such as the Pacific Northwest, the Wasatch Front area in Utah, and the new Madrid Fault Zone. Such efforts need to be expanded, especially in light of the extreme vulnerability of the built environment in these areas. Special targeted initiatives are needed in other areas of seismic risk because, like Kobe, communities without recent earthquake experience will invariably discount the hazard unless actions are taken to encourage and sustain local interest. Organizations like the Central U. S. Earthquake Consortium and the Center for Earthquake Research and Information at the University of Memphis perform an important role in informing the public and keeping earthquakes on the public agenda in vulnerable regions outside California.

5. Increased efforts to improve data and information management. The Kobe earthquake highlighted the importance of obtaining and disseminating information, particularly in the immediate aftermath of a major earthquake or other disaster. One of the major problems experienced following that event was the inability to obtain accurate *assessments of damage and disruption*. Confusion about the disaster's severity and scope resulted in delayed requests for and provision of emergency assistance. Rapid post-impact damage assessment can enhance emergency response efforts, for example by helping direct

response resources to areas of greatest need and by indicating what types of resources and personnel are needed for an effective response. The earthquake also illustrated a continuing need for better ways of *communicating with the public* during the emergency period to disseminate aftershock warnings, information on road closures and alternate transportation routes, where and how various emergency services can be obtained, and other emergency-relevant information.

6. Increased emphasis on ensuring that key response resources in all regions of the U.S. maintain functionality in the event of a major earthquake or other disaster. It is clearly neither cost effective or politically feasible to adopt measures to seismically strengthen the entire built environment nationwide. In some areas of the country, the most prudent strategy to manage the hazards associated with some structures is to simply leave them alone and let natural attrition take care of the problem over time. However, there are many structures in areas of high and moderate seismic that are so important that they warrant special seismic safety programs and initiatives. Steps should be taken to make sure that throughout the nation critical facilities, communications networks, and other emergency-relevant resources can survive and remain operational following earthquakes and other disasters. The Kobe earthquake showed the problems that can develop when the resources needed for effective crisis management don't survive or can't function following disaster impact. Similarly, in some recent U. S. disasters, notably Hurricane Andrew in southern Florida and Hurricane Hugo on St. Croix, critical community emergency resources sustained such severe damage that response operations were undermined.

Unless critical elements in the emergency response system are made disaster-resistant, it will not be possible to assess damage, dispatch needed resources effectively, or carry out other essential response tasks. Examples of structures and systems that must remain functional following disaster include emergency operations centers, emergency communications linkages and equipment, hospital emergency departments, fire and police stations, emergency shelters, structures critical to governmental operations, and emergency power sources. One of the main lessons of the Kobe earthquake is that ensuring the survivability of such facilities is an investment the nation must be prepared to make. Assessing the vulnerabilities associated with these facilities and systems should be given a high priority at all levels of government, and problems that can

interfere with post-disaster functionality should be addressed.

7. Increased emphasis on the distinctive hazard-related problems of complex urban environments. Kobe was the first near-catastrophic disaster to strike a modern, developed metropolitan area, and it revealed the unique vulnerabilities of complex urban regions. In Kobe, the built environment and the economic and social activity it supported were highly concentrated, highly interdependent, and at the same time highly vulnerable to disaster. Urban life depends to a great degree on sophisticated infrastructure, transportation and communications systems, and Kobe showed how devastating it can be when those systems fail.

Modern metropolitan areas are characterized by large-scale development and increasingly intensive patterns of land use, both of which put ever-larger numbers of people, structures, and economic and commercial activities at risk. Catastrophic and near-catastrophic disasters aren't simply bigger-sized emergencies; they are qualitatively different, posing qualitatively different challenges. Similarly, major urban centers like Kobe, Tokyo, Los Angeles, and the Bay Area aren't merely bigger-sized towns; they are highly complex environments in which the failure of a few small components may cause deadly and costly disruptions in large-scale systems. More attention needs to be paid not only to assessing the vulnerabilities associated with complex urban areas but also to making those settings more resilient and disaster-resistant. Special emphasis should be placed on better understanding the risks associated with the complex interrelationships and interdependencies that underpin social and economic activity in our largest cities, determining whether some of those risks are unacceptably high, and taking action to reduce losses.

8. Increased recognition of the key role community residents and locally-based organizations can play in the emergency response period. As was the case following the Armenia, Mexico City, Loma Prieta, and Northridge earthquakes, local residents bore most of the responsibility for extricating victims in collapsed buildings and provided other types of assistance in the first hours and days following the Kobe earthquake. Hundreds of thousands of volunteers were extensively involved in aiding victims throughout the emergency and early recovery periods. Community residents, local organizations, and emergent groups constitute important resources that can mobilize rapidly when a disaster occurs. Some jurisdictions in the U. S., such the City

of Los Angeles, have established programs for training community residents specifically for earthquake response. Governmental disaster response agencies should expand efforts to involve volunteers in the provision of emergency care and disaster relief, strengthen linkages with community-based organizations, and develop programs for training local residents in emergency response procedures.

9. Increased attention to pre-event recovery planning and the implementation of recovery strategies in the immediate aftermath of earthquakes and other major disasters. Following the Kobe earthquake, a number of recovery-related decisions were made almost immediately, certainly within days after impact.

Researchers have pointed out for some time that there is no real distinction between the response and recovery phases; disaster recovery actually begins during the emergency period. Initial decisions made during the emergency period concerning demolition of structures and building safety generally, lifeline repair and restoration, the location of temporary housing, acceptable levels of risk for repair and reconstruction, priority-setting and the allocation of resources to various community sectors, financial mechanisms to be put in place to facilitate recovery, and related issues have a direct bearing on recovery processes and outcomes. Relying on ad hoc decisionmaking procedures during the emergency period will likely create additional problems later in the recovery process. The time to devise recovery strategies is before rather than after a disaster occurs; plans and policies should already be formulated and officially adopted prior to a disaster, so they can be implemented when the need arises. Studies like the PEPPER project and planning initiatives like the development of the Los Angeles earthquake recovery plan constitute important advances in recovery management. An important lesson of the Kobe earthquake is that those types of activities should be expanded and intensified.

ACKNOWLEDGMENT

Kathleen Tierney's contributions to this chapter were funded by National Science Foundation Grant No. INT-9512844, a "Center-to-Center" grant on post-earthquake recovery involving the National Center for Earthquake Engineering Research and the University of Tokyo's International Center for Disaster-Mitigation Engineering. James Goltz's contributions were supported by National Science Foundation Grant No. CMS 95-21-651, "Emergency Response and Early Recovery in the Hyogo-Ken-Nambu Earthquake of January 17, 1995." The authors alone are responsible for the

chapter's findings and conclusions.

REFERENCES

- Atsumi, Tomohide. 1996. "Disaster Relief Efforts by Japanese Governmental and Non-governmental Organizations: Impacts of the Great Hanshin Earthquake on Domestic and International Disaster Relief." Paper presented at the International Symposium on Disaster and Health, Manila, Philippines, October.
- Atsumi, Tomohide, Toshio Sugiman, Hisatoshi Mori and Ichiro Yatsuduka. 1996. "Participant Observations on Volunteer Organizations Emerging After the Great Hanshin Earthquake: Case of the Nishinomiya Volunteer Network and the Local NGOs Co-ordinating Team for the Great Hanshin Earthquake." Pp. 455-462 in Proceedings of the International Conference on Water Resources and Environmental Research, Vol. II.
- Chang, Stephanie E. 1996. Regional Economic Impact of the January 17, 1995 Kobe, Japan, Earthquake. Paper presented at the 43rd North American meeting of the Regional Science Association International, Washington, D. C., Nov. 14-17.
- Earthquake Engineering Research Institute. 1996. Scenario for a Magnitude 7.0 Earthquake on the Hayward Fault. Oakland, CA: Earthquake Engineering Research Institute.
- The Economist. 1997 "Japan: The Volunteers Step Forward." April 12: 34.
- Goltz, James. D. 1996. Emergency Response in the Great Hanshin-Awaji Earthquake of January 17, 1995: Planning, Mobilization and Interorganizational Coordination. Proceedings of the 11th World Conference on Earthquake Engineering.
- Hiroi, Osamu. 1995. "Earthquake Disasters: The Need for Robust Emergency Information and Transportation Networks." The Wheel Extended, No. 93: 2-10. Tokyo: Toyota Motor Corporation.
- Hyogo Prefecture. 1996. Phoenix Hyogo: Reconstruction from the Great Hanshin-Awaji Earthquake. Kobe: Hyogo Prefectural Government.
- International Federation of Red Cross and Red Crescent Societies. 1996. World Disasters Report 1996. New York: Oxford University Press.

Johnson, Laurie A. and Ronald T. Eguchi (Eds.) 1995. Kobe at Six Months: A Phoenix on the Horizon. Study Tour Report by U. S. and New Zealand Delegates to the Sixth U. S.-Japan Workshop on Earthquake Disaster Prevention for Lifeline Systems, Osaka, Japan, July 18-21. Irvine, CA: Center for Advanced Planning and Research, EQE International, Inc.

Kameda, Hiroyuki and Haruo Hayashi ((Eds.) 1995. An Integrated Framework on Urban Disaster Countermeasures Based on the Hyogoken-Nambu (Kobe) Japan Earthquake of January 17, 1995. Kyoto: Disaster Prevention Research Institute, Kobe University.

National Land Agency. 1988. Earthquake Disaster Countermeasures in Japan. Tokyo: Earthquake Disaster Countermeasures Division, Disaster Prevention Bureau, National Land Agency, Prime Minister's Office.

Scawthorn, Charles and Andrew Cowell. 1995. "Fire Following the Hanshin and Northridge Earthquakes: A Comparative Analysis." Paper presented at the 6th US-Japan Workshop on Earthquake Disaster Prevention for Lifeline Systems, Osaka, July 18-21.

United Nations Centre for Regional Development. 1995. Comprehensive Study of the Great Hanshin Earthquake. Nagoya: United Nations Centre for Regional Development, Research Report Series No. 12.

United Nations Human Information Network. 1996. "Hanshin Recovery Ontrack." Connections, Issue 1: 1, 12.

Wellington City Council. 1995. The Great Hanshin (Hyogo-Ken-Nambu) Earthquake of Southern Hyogo Prefecture, Japan, 17 January, 1995. Wellington, NZ: Emergency Management Office, Wellington City Council.

The Wheel Extended. 1995. "Data and Statistics: Details of a Disaster." No. 92: 10-25. Tokyo: Toyota Motor Corporation.