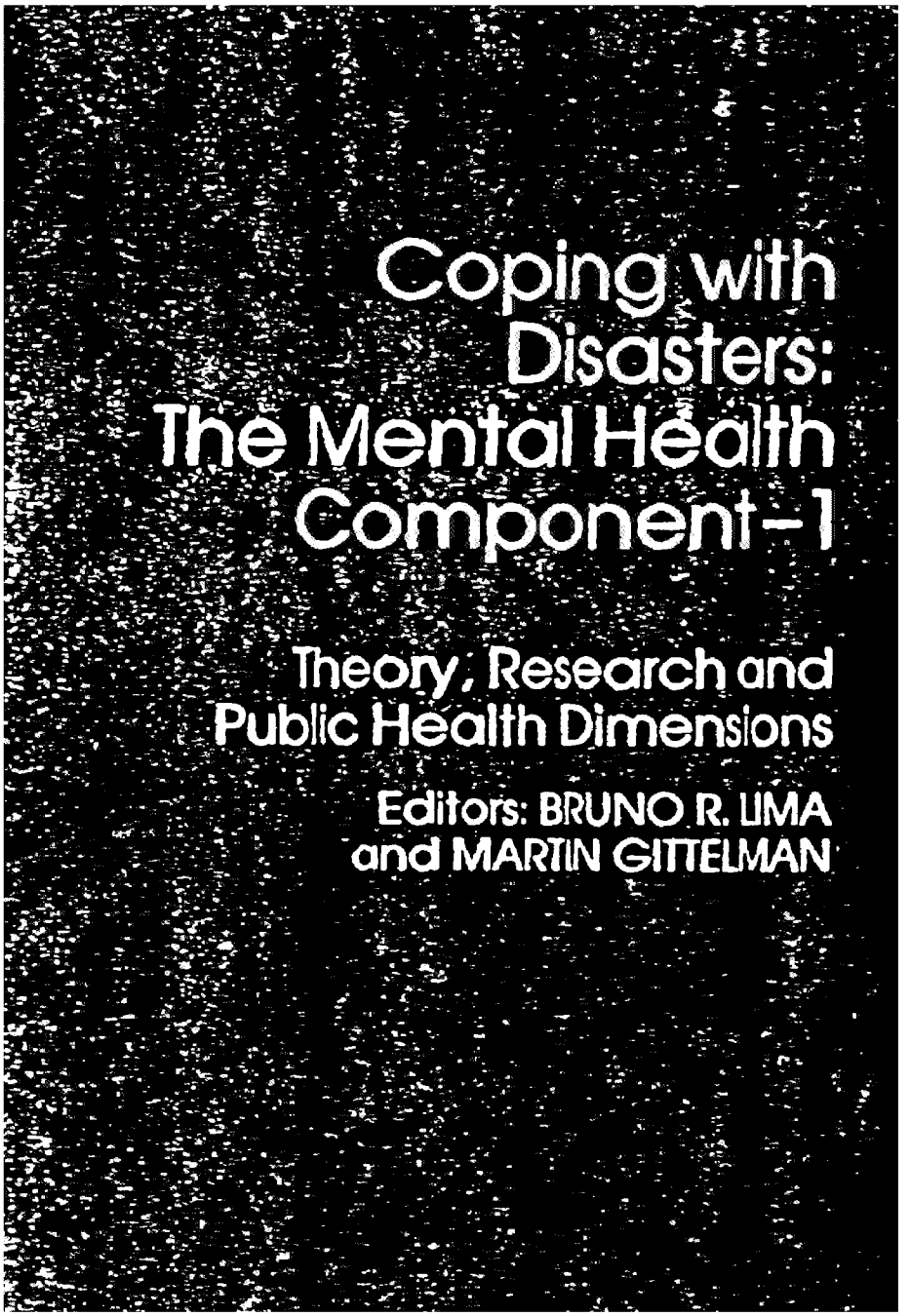

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Turning Conflict into Cooperation: Organizational Designs for Community Response in Disasters

The costs of organizational conflict in disaster operations

Conflict among organizations seeking to respond to the sudden, extraordinary demands generated by disaster is a recurring and well-recognized problem. News reports following disasters as diverse as the earthquakes in Mexico City (1985), San Salvador (1986), Napo Province, Ecuador (1987), and Armenia (1988), the oil spill in Valdez, Alaska (March, 1989), and Hurricane Hugo in Charleston, South Carolina (September, 1989) document disrupted communications among organizations, differing priorities, inconsistent procedures and contradictory observations regarding organizational response actions.[1] Interacting, these conditions generated delays in response operations in each event and contributed to ensuing high levels of anxiety and depression among the affected populations.[2] In each of these communities that suffered disaster, vulnerability to the specific hazards had long been established. Responsible members of scientific, professional, public, and private organizations were aware of the risks presented to their respective communities, and emergency plans had been initiated, to some degree, in each. Why, then, were the communities so ill prepared to cope with the actual events?

The difficulty lies in translating knowledge into action in the sudden, stressful, interdependent context of disaster. In this uncertain, yet urgent environment, response operations necessarily cross disciplinary, organizational, and jurisdictional lines. Conventional processes of decision and organizational management repeatedly prove inadequate to meet the extraordinary demands generated by disaster. Effective problem-solving in disaster environments requires a radically different approach.

Ironically, disaster has a positive aspect in the study of organizational interaction in response operations. It allows participating organizations and concerned citizens to review their actual community processes under stress in an effort to improve performance [5] in future disasters. This reflective assessment is critical to organizational learning [6].

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Here we shall examine the design of "inquiring systems" [7] for communities vulnerable to disaster. Such systems rely upon the learning capacity of the entire community, and consciously seek to organize activities to achieve a common goal—for example, protection of life and property in the event of disaster. Participants rely upon feedback mechanisms to assess separate actions taken simultaneously and to inform, in turn, successive steps to reach their shared goal. An inquiring system may also inform the dynamic shifts in command/exchange relationships [8] critical to effective disaster management.

The present analysis will review three cases of earthquake disaster operations in terms of the potential for initiating inquiring systems within the respective communities: Napo Province, Ecuador (1987), Leninakan, Armenia SSR (1988), and the San Francisco Bay area, California (1989). We shall explore the utility of an inquiring system as a means of increasing the capacity for informed community response to a disaster and thus reducing the level of anxiety and lingering tragedy among the population. We shall also review the cases in terms of designing a global inquiring system to address continuing problems of seismic risk.

Inquiry and inquiring systems

An inquiring system is fundamentally a means of organizing information and communications processes in order to solve problems for a specific group. There are several types of inquiring systems, but the one that appears most relevant for disaster management is the Singerian model [7. Pp. 200–201]. It may serve the dual goal of enabling action and facilitating adaptation by community members and response organizations to the dynamic environment of disaster.

Four premises underlie a Singerian inquiring system. First, it is goal-seeking—that is, the system is designed to serve a specific purpose for the members of its group, for example, the protection of life and property in event of disaster. Second, the system is an open-ended process. Inquiry is continuous, for as one problem is solved, it uncovers another that needs solution. Third, the system is enabling, as interaction between information and its users creates new knowledge and allows the latter to choose appropriate means to attain their desired ends. Fourth, the system fosters cooperation. To function appropriately, a Singerian inquiring system critically needs a cooperative environment [7. P. 200]. Inquiry is essential to create cooperation and, conversely, cooperation is needed to create inquiry.

Optimally, a Singerian inquiring system stimulates and reinforces learning within the group. System norms are ethical, for irresponsible actions disrupt the system and stop the goal-seeking process. While a Singerian system is vulnerable to disruption, the corrective process of inquiry would focus on the source of disruption as a problem needing solution. Through inquiry, the problem would be solved and the goal-seeking process would continue. The cost of disruption is time lost from inquiry.

A Singerian model builds on the natural process of inquiry characteristic of human beings seeking to understand the environment in which they live [9].

ships of both command and exchange [8]. The urgency of time requires relationships of command [16]. Hierarchy in military discipline, designed for use on the battlefield, represents the classic example of command relationships. The uncertainty of outcomes reinforces relationships of exchange [8]. Mutual aid agreements between fire or police departments in a given geographic region represent examples of exchange relationships. Urgency plus uncertainty drive the search for innovative combinations to meet the unpredictable demands of disaster environments. Both types of relationship are needed to serve differing functions in disaster management. Consequently, relationships among managers of organizations with disaster responsibilities, their respective personnel, and the populations they serve will vary with both time and function in disaster operations.

Maintaining the appropriate balance between command and exchange in disaster operations requires continual adjustment both among the emergency organizations legally responsible for protection of life and property and between the set of response organizations and the population of the affected communities. This balance varies with the degree of uncertainty in the operating environment and the degree of relevant information available to the responsible disaster managers. The balance needs to be maintained not only for each primary function performed in disaster operations but also within the total set of disaster functions performed in interaction with community residents. Creating the knowledge needed to adjust this balance appropriately in terms of both community needs and capacity for action is essential in each disaster and critical for effective disaster management.

Organizational designs for disaster response

Although the goal in every disaster response process is the same, protection of life and property, different means are used to achieve it. Balancing the detailed specification of tasks for action with the integration of concurrent outcomes into a coordinated response process in a dynamic disaster environment poses an extraordinarily complex problem for disaster managers. Practicing disaster managers recognize that the organization of disaster response actions influences the quality of service delivered to the affected population.[4]

Organizational interaction between response agencies and affected populations is a reciprocal process [13], varying with the scope, complexity, and severity of the disaster. Earlier research [17] has identified the shifting dynamic between command and exchange [8] in decision processes in disaster management. This dynamic defines both style and content of the interaction between response organizations and affected populations over the cycle of disaster management [18]. Varying demands are placed upon citizens and agencies in each of the four phases of this cycle—mitigation, preparedness, response, and recovery—yet all require collective action.

Although serving different demands for action, five primary functions[5] recur in each phase of disaster management. They are:

(1) communication of information regarding the event and the immediate goal of disaster operations;

(2) assessment of needs and the status of the community;
(3) mobilization of resources, personnel, and equipment for action;
(4) performance of tasks in accordance with stated priorities;
(5) feedback on performance in the process.[6]

Each of these functions involves a continuum of interactions among participants in the disaster operations process, ranging from objective command to subjective exchange [8]. Further, each disaster operations process is likely to generate a different balance of command/exchange relationships among the set of functions involved. As interactions veer toward the command ends of the continua for the set of management functions, the organizations participating in response and recovery operations are likely to be more efficient but fall into conflict. Differences among disciplines, organizations, or jurisdictions, suppressed under command relationships but left unresolved, are likely to generate misunderstanding of terms, misinterpretation of directions, and mistakes in action. As interactions move toward the exchange ends of the continua, disaster operations are likely to achieve greater cooperation, but be more time-consuming, and hence fail to meet urgent needs. Time taken to achieve consensus after the disaster occurs subtracts invaluable time from action. Finding the appropriate balance between command and exchange on each function and, further, within the set of functions for a given disaster environment is the task of design in disaster management. It is not likely to occur by chance.

The style, content, and timing of disaster preparedness activities necessarily shape the likely alternatives for response actions in actual events. Organizational managers confront the uncertain task of designing, before disaster strikes, the learning activities most likely to guide effective response actions when a disaster occurs. Coping with uncertainty compels us to consider radical alternatives when standard means of organizational performance would be inadequate to respond to the demands generated by a catastrophic event. By analyzing actions taken in previous disasters, we may be able to develop improved models for community disaster response. With improved models and consequent gains in communitywide knowledge and skills, we may increase our capacity for disaster response and recovery at the community level.

A model for community response to disaster

Traditionally, disaster management strategies have been highly centralized and directive.[7] Control is placed in the hands of a few experts, and other agencies and the general public are left relatively powerless. These strategies of command are efficient when the problems are well defined and all participants have the same training and level of understanding of the tasks. Effectiveness drops significantly, however, when conditions change and participants, rigidly bound to known rules of operation, are unable to adapt to shifting requirements for action. Conflict erupts, delays result, and opportunities for saving lives and protecting property are missed.

When uncertainty is high or commonality in training and experience among participants is low, a decentralized strategy of exchange appears preferable in disas-

ter management. Errors are reduced, shared experience in constructive response creates trust among participants, and adaptation to the dynamic conditions of disaster occurs more easily. Exchange of information, resources, and experience increases the likelihood of effective action. Efficiency drops, however, and the cost in additional time is critical in life-threatening events [21].

Identifying disaster as a risk shared by the community redefines the concept of disaster response.[8] In meeting a shared risk, disaster response necessarily engages all major organizations—public, private, and nonprofit—in a community and includes as participants all population groups in the area. As both the range of participants and the scope of actions involved in disaster operations increase, however, the degree of complexity also increases by orders of magnitude. Consequently, the search for organizational designs that facilitate action and allow adaptation in complex, uncertain environments becomes critical to mobilizing effective disaster-response operations at the community level.

In communities subject to seismic risk, as in Ecuador, Armenia, and California, seismologists estimate that severe earthquakes recur every 90–150 years, and moderate events, every 40–60 years [23]. Given the long time span between major events in specific locations, it is necessary to collect data on a global scale in order to understand the interactive processes among citizens, organizations, and the environment in communities at seismic risk.

Three earthquakes—in Ecuador (1987), Armenia (1988), and Northern California (1989)—are sufficiently close in magnitude and time to be comparable, but vary by nation, culture, infrastructure, and access to communications technology. Each disaster generated a different set of problems in its particular environment and precipitated different patterns of interaction between organizations and citizens in response and recovery. Yet all three events offer valuable insights into the continuing inquiry directed toward the shared goal of protecting life and property in zones of seismic risk.

Models of inquiry and interaction in disaster environments

The Ecuadorian earthquakes: Napo, Imbabura, Carchi, and Pichincha Provinces

On Thursday, 5 March 1987, two earthquakes occurred in Napo Province, Ecuador. The first was registered at 8:54 p.m. and measured 6.1 on the Richter scale. The second shock, more severe, occurred at 11:10 p.m. and registered 6.8. The epicenter was near the volcano Reventador in the mountainous region of Central Napo Province, some 85 kilometers from Quito.[9] Buildings swayed in Quito, but the event was not life-threatening in the capital city. Initial reports from outlying regions were slow in coming to responsible organizations in Quito.

By Saturday, 7 March 1987, an overflight of the epicenter area revealed extraordinary destruction in the Andean region of Napo Province. The earthquakes had

triggered a series of interdependent events, escalating the destruction enormously. Heavy rains in the preceding weeks had softened the soils; and the earthquakes, shaking the mountainsides, had caused massive landslides, destroying approximately 30 kilometers of the Transecuadorian Pipeline. Debris flows created natural dams in the rivers, causing flashfloods, destroying villages along the banks, and polluting the water supply for inhabitants of the region. Approximately 40 kilometers of the main highway that provided the only land route between the petroleum-producing region of Lago Agrio in eastern Napo Province and the markets of Quito were destroyed, as were secondary roads, the oil-pumping station at El Salado, and 7 bridges [24]. By 7 March 1987, reports of widespread destruction of housing in the Sierra region, on the western slopes of the Andes from the epicenter, had also reached Quito, adding more complete information to the assessment of damage for the nation.[10]

The total number of dead from the disaster was estimated at 1,000; 5,000 people were left homeless or in need of resettlement.[11] The earthquakes had created damage in three distinct zones, each with particular needs for differing types of knowledge and responsive action. The impact of the earthquake ricocheted through the society, as the event effectively shut off the transport of oil from the eastern oil fields to ports on the western coast, from which it was to be shipped to external markets. Oil production consequently was shut down. Without oil revenues, the national economy's revenue was cut by 50%. Many people were out of work. The price of gasoline increased sharply, seriously affecting people on fixed incomes far from the earthquake zones. Transportation to the eastern zone was limited to flights, which were costly, or to trips by river boats, which were dangerous.[12]

The event posed a challenging set of conditions for the study of inquiring systems. In terms of the three basic elements of an inquiring system, the goal—protection of life and property—was clearly accepted by all participants. The boundaries of the system, however, were less clearly defined; and the components, within the agreed boundaries, changed in both level of activity and influence on outcomes over the course of eight months following the disaster.

The problem of boundaries for an inquiring system was especially acute in the Ecuadorian case. The need for information was critical, yet the tasks of gathering, processing, and utilizing this information appropriately, given substantive differences in peoples, geographic regions, and needs for assistance, were extremely difficult. The incumbent president of Ecuador, Leon Febres Cordero, created a National Emergency Committee to direct disaster operations for the entire affected area. This committee included the ministers of health, finance, public works, energy, social welfare, and the environment and the state and provincial directors of emergency management. The boundaries of the disaster operations process and a possible inquiring system were declared to be national.

In practice, the three disaster zones had different problems of varying degrees of urgency that required different types of information, knowledge, and resources for solution. Action necessarily would have to be fitted specifically to each zone, and

the boundaries of inquiry for many of the residents remained in their respective zones. Yet, it was clear that the problems in each zone were interrelated, and that their interactions would have a profound effect upon the nation as a whole.[13] Consequently, the boundaries of inquiry shifted from zone to nation and back again, depending upon the function being performed in disaster operations.

The identification of components for inquiry shifted with the boundaries, often with the same people playing different roles in different arenas of action. The classic components of an inquiring system include decision makers, clients, and a designer [7. Pp. 47–49]. In this disaster, the legally responsible agencies could be seen as decision makers; the citizens, as clients; and those individuals who, within agency or citizen roles, took initiative for action, as designers. The distinctions became blurred as the communities became engaged in action. The shifting boundaries and consequent changes in the components of inquiry are clearly shown by the actual pattern of the disaster operations.

Zone 1 in Central Napo Province, the area of primary impact near the epicenter of the earthquake, incurred the heaviest physical damage but, fortunately, was sparsely populated. Some villages were totally destroyed and were not likely to be rebuilt along the river banks. Survivors were to be relocated to safer areas. Other communities suffered damage to schools, hospitals, and public buildings as well as private residences.

Community life needed to be restored, but resources were scarce in these roadway towns that were largely dependent on the crippled oil industry for jobs. Residents of these communities suffered from the cumulative anxiety of losing an already marginal economic existence coupled with fear of continuing to live in an unstable geologic area where the future could never be certain.

Response action initiated at the community level within the zone was clearly insufficient. The boundaries of inquiry in the search for solutions shifted from the zone to the national level, and then to the international level, before policy could be returned to the zone for implementation.

Zone 2, the Sierra, was more heavily populated; but damage was primarily to housing, with little actual loss of life due to the earthquake: 73,261 homes were reported destroyed or damaged in the earthquakes, and of those, approximately 80%, or an estimated 60,000, were in the Sierra. The regional cities and towns in these Andean highlands faced the longer-term problem of reconstruction of housing and community services in an area of seismic risk, again with marginal resources and the knowledge that earthquakes would recur.

Zone 3, eastern Napo Province, suffered relatively little structural damage and almost no loss of life from the earthquakes. However, the economy of the region was heavily dependent upon oil production; and with the disruption of the pipeline and transportation routes, many people became unemployed. Indian populations suffered from the devastation of the rivers, their primary source of water, food, and transportation. Colonists in the region, isolated from markets and supplies, lost income from their crops. Without jobs and cut off economically, commercially, and socially from the urban centers of the nation, residents of this area suffered a slowly

deepening economic crisis as the cost of lengthening isolation engendered by the earthquake altered their lives.

The problems facing the National Emergency Committee were extraordinarily complex. Each of the five functions listed above had to be accomplished within each zone of the disaster for the committee to be able to form an overall judgment of the comparative needs within the three zones. The committee required a comprehensive profile of the disaster in order to plan national strategies of operation with limited resources and personnel. The balance between command and exchange in the performance of each function was difficult to establish, for in the rural areas and small villages, there was relatively little formal organization or equipment among the population to carry out functions of disaster response for the entire community. Exchange was the most practical mechanism for collective action at the local level, and was reinforced by the Ecuadorian communal tradition of the *minga*, or cooperative work group. Yet, the tasks involved in recovery and reconstruction needed resources, skills, and professional design from national and international organizations, most of which expected to use relationships of command to increase efficiency.[14]

The five functions of disaster management to some degree created a subsystem of inquiry within each zone in order to get the work done.[15] The three subsystems, in turn, formed a larger system of national inquiry to guide the response, recovery, and reconstruction processes. In large part, this system of inquiry developed spontaneously after the earthquakes occurred. Although this system demonstrated genuine creativity on the part of both the organizational leaders and the citizens involved, costs in time, organization, and anxiety could have been reduced by prior design in a region where earthquakes were certain to recur.

Throughout the disaster operations, the functions in one zone affected performance in another. Performance at one level, for example, the community, affected resources allocated at another, national or international. Although patterns of systematic search for information and problem solving developed in all three zones and at all three levels of jurisdictional interaction, professional inquiry suffered from inadequate communications facilities and lack of a prior design. Natural inquiry, arising from perceived needs and commitment to action, produced constructive steps toward collective action. These steps could serve as a legitimate basis for developing a more systematic, comprehensive, knowledge base to assist decision makers and citizens in achieving their common goal more quickly in recurring seismic events, in Ecuador or other zones of seismic risk.

The Armenian SSR earthquakes

On 7 December 1988, two earthquakes struck northern Armenia, a southern republic of the Soviet Union. The first earthquake occurred at 11:41 a.m.; it measured 6.9 on the Richter scale, and its epicenter was near Nalban, a village in the northern mountains. Four minutes later, an aftershock of magnitude 5.8 on the Richter scale amplified the instability created by the first shock and increased the damage. The

fault had erupted over approximately eight kilometers in a strong vertical motion,[16] with some horizontal thrust movement.[17] In more than two thousand years of known seismic activity in Armenia, the 1988 earthquakes caused the most severe damage.[18]

Unlike in Ecuador, the earthquakes struck in a heavily populated zone and had devastating effects on 4 cities in northern Armenia—Spitak, Leninakan, Kirovakan, and Stepanavan—and 58 villages in the area. In minutes, hundreds of buildings collapsed; water, electricity, and communications were destroyed; tens of thousands of people were killed or injured; and hundreds of thousands of people were left homeless. Nearly one-third of Armenia's population of 3.5 million was affected to some degree by the earthquakes. Governmental organizations, unprepared for such devastation, struggled to devise appropriate responses to the immensity of human needs generated by the catastrophe.

Summary figures offer a rudimentary profile of the scope of the disaster. Official reports listed the total number of dead as 24,542.[19] Attending Soviet physicians responsible for organizing the delivery of medical services in Maralik and Leninakan immediately after the earthquakes estimated the actual number of dead at 45,000.[20] The difference in figures was due, apparently, to difficulty in maintaining systematic records under disaster conditions. Moreover, the northern cities were crowded with approximately 170,000 refugees from the largely Armenian region of Nagorno-Karabakh who had fled from civil conflict in Azerbaijan. The refugees may not have been formally registered as residents, and therefore were difficult to identify. Consequently, the exact number of dead may never be known.

Statistics offer grim detail of the deadliness of the disaster. Civil Defense Armenia listed 39,795 victims extricated from the rubble. Of that number, 15,254, or 38.3%, of the victims were extricated alive. An additional 31,279 persons were reported injured.[21] A total of 119,318 persons were evacuated from the area, and of that number, 79,750, or 68.8%, were sent to other republics.[22] An estimated 8 million square meters of housing were destroyed, leaving 514,000 people homeless. Hospitals, schools, and factories were destroyed or damaged, others stopped functioning because of loss of water or power. Livestock was killed or injured; crops in storage and farming equipment were destroyed or damaged. The total loss for the area, affecting approximately 1 million people, was estimated at $16 billion.[23]

Could an inquiring system emerge in an environment of such devastation? The goal was clear: protection of life was the first priority and drove all response actions. The boundaries of the system were less certain. Although rescue and response actions were needed immediately in the heavily damaged cities and villages, the capacity to take such actions in those cities had been largely destroyed. In the small city of Spitak, for example, no building was left undamaged. The central telephone office was a tangle of broken wires. In Leninakan, approximately 80% of the buildings were damaged or destroyed.[24] Personnel from emergency response organizations were themselves victims of the disaster. Assistance was necessarily required from outside areas. The boundaries of the system needed to include sources of assistance as well as the area that needed help.

From Spitak, Leninakan, Kirovakan, and Stepanavan, the boundaries of problem-

solving inquiry expanded rapidly to include the official governmental organizations of the Armenian SSR, medical and professional organizations, and virtually all remaining citizens in the republic who could offer assistance, formally or informally. Beyond the Armenian Republic, inquiry extended immediately to the national level, involving All-Union officials, governmental organizations responsible for emergencies, medical and professional organizations, volunteers with needed skills, and solidarity contributions from other republics. President Mikhail Gorbachev, Prime Minister Nicolai Ryzkov, and Minister Yevgeni Chazov, head of the Soviet Department of Health, visited the disaster site and gave their immediate attention and support to disaster response efforts. The severity of the disaster prompted a major shift in the Soviet national government's previous position that left response primarily to the republic in which the disaster occurred.

The boundaries of inquiry for disaster operations extended well beyond the Soviet Union, as empathy and offers of support came spontaneously from other governments and scientific, professional, and volunteer organizations across the world. In all, 111 nations and 7 international organizations responded with assistance in some form.[25] Professional skills, heavy equipment, and specialized knowledge were needed to meet the massive needs generated in this disaster. The large and well-organized Armenian Diaspora responded swiftly with contributions in money, supplies, and, significantly, Armenian-speaking personnel to assist with the traumatic tasks of response and recovery.

As the boundaries extended, so did the components of inquiry. With the rapid increase in the number of participants and the scope of the response activity, the complexity of disaster operations increased geometrically. Out of the initial chaos, order did begin to emerge as All-Union representatives arrived to assist the shattered municipal services and heavily strained response organizations of the Armenian Republic.[26] The time required for organization, however, subtracted invaluable time from life-saving operations.[27] Under these extremely stressful conditions, the distinction between decision makers and clientele began to fade. Although governmental organizations were the primary decision-makers, the scope of the disaster was such that they simply could not respond to all needs. Consequently, citizens took the initiative again and again in the rescue of their family, friends, and neighbors. The obvious discrepancy was in lack of training, equipment, and experienced mastery of skills required for the rigorous demands of disaster response.

In the initial hours and days, the organizational capacity at the local sites of the disaster was so devastated that command relationships did not function.[28] Instead, relationships of exchange formed spontaneously, as family members and friends took what actions they could to rescue victims. At times, however, individual initiatives hindered the development of community response. For example, gasoline was extremely limited. Individuals drained the available supply of gasoline to transport injured family members and friends to hospitals in Yerevan. The action, however, left community ambulances without gasoline and hindered the organized transport of victims to medical facilities. Clearly, the extraordinary conditions required relationships of both command and exchange, but the net-

work of communications to enable such actions was extremely limited.[29]

Armenia had three zones of varying intensity of damage within one large geographic area of seismic impact. Within the zones, separate centers of operations supported the rescue efforts. The near-total destruction of communications, power, transportation, and medical facilities placed a serious constraint on disaster operations. For example, victims, when extricated from a collapsed building, still needed to be transported to hospitals in Yerevan, some three hours away by ambulance or car. While each of the five functions in disaster operations was carried out at multiple locations, levels of inquiry were required to support the performance of a given task, such as the delivery of medical care, carried out across disciplinary, organizational, and jurisdictional lines.

The tasks of organizing disaster response under these conditions of catastrophe were formidable. Inquiry began to focus on sets of problems, such as obtaining kidney dialysis machines for the treatment of crush syndrome. Other problems, such as disrupted sewage treatment facilities, were temporarily set aside because of the urgency of immediate needs, only to resurface later in exacerbated form. In this disaster, medical services were of primary importance, given the extraordinarily high number of victims, many with compound injuries, requiring treatment.

The cumulative burden of demands, left untreated or delayed in treatment under the stress of disaster conditions, resulted in the subsequent manifestation of physical and psychological symptoms among the surviving population. With trauma compounded by uncertainty for the future and grief experienced on a national scale, the level of stress deepened for many survivors over subsequent weeks and months. Needs that, for understandable reasons, could not be addressed during the actual response period recurred with fresh intensity in a later phase.

Eight months after the disaster, Soviet emergency physicians reported a sharp rise in the number of incidents reflecting a high level of stress among the Armenian population. In Leninakan, the number of reported heart attacks reported increased by a factor of three over the number reported for the same period before the disaster. The number of suicides also increased by a factor of three; and the number of acts of violence involving the use of weapons increased by a factor of ten.[30] These are estimated figures cited by informed professionals, but they indicate the profound, continuing needs among the surviving population that, unaddressed, escalate the costs of disaster.

Such needs require subsystems of inquiry within each zone, to focus on detailed investigation of specific problems, and integrating systems of inquiry among the levels of jurisdiction to coordinate action on community, republic, national, and international levels. The components of inquiry—decision makers, clients, and designers—shift to those who take initiative for action. Such a group did emerge in the Armenian disaster; it included government officials, citizens, and representatives of national and international organizations. It was defined by those who accepted responsibility for action in that harshest of environments and who sought to act upon the best information available to meet human needs.

The Armenian experience raises the question of whether actual performance to

protect lives and property in zones of known seismic risk would be increased by the design of a global inquiring system that crossed disciplinary, organizational, and jurisdictional boundaries *before* an event.

The Loma Prieta earthquake, Northern California

On 17 October 1989, at 5:04 p.m., a major earthquake struck the San Francisco Bay area of Northern California. The earthquake registered 7.1 on the Richter scale, and was located on the San Andreas fault, with an epicenter approximately 20 miles south of San Jose, California, in the Santa Cruz Mountains.[31] Although the epicenter was close to the heavily populated metropolitan area surrounding San Francisco Bay, with 5.5 million inhabitants, the buildings and infrastructure of the major Bay area cities, designed as they were to meet current standards of earthquake engineering, largely withstood the severe shock. The damage was sufficient, however, to prompt President Bush to issue a federal disaster declaration for the counties of Alameda, San Francisco, San Mateo, Santa Clara, Santa Cruz, San Benito, and Monterey, making federal disaster assistance available to the stricken counties, cities, and citizens.[32]

The earthquake caused major damage in the cities of Oakland, San Francisco, and Santa Cruz and the dramatic collapse of a section of the Bay Bridge spanning San Francisco Bay between the cities of Oakland and San Francisco. The seven-county disaster area registered 65 deaths.[33] A total of 2,750 people were treated in emergency rooms at 112 Bay area hospitals; but of that number, only 250 were hospitalized. Approximately 6,500 people were reported to be displaced from their homes, although reports of severity of damage varied by city and county. Distance from the epicenter, interaction between soil conditions and ground motion, type of building construction, and type of individual activity at the time of the event influenced the impact of the earthquake on the population of the Bay area. The City of Oakland, farthest from the epicenter, reported the heaviest toll in lives, 40 dead, and second highest cost in damage, $1.7 billion. This includes the number of victims from the collapse of the Interstate 880 freeway bridge and damage to downtown buildings, including City Hall.[34]

Emergency response actions focused on four major sites of construction failure: the I–880 freeway collapse in Oakland, the Bay Bridge collapse, a fire in the Marina District of San Francisco, and the the collapse of a shopping center in Santa Cruz. To a substantial degree, local emergency response organizations brought these incidents under control, with assistance and support from neighboring jurisdictions, through mutual aid agreements, and from county and state emergency response organizations.

The event brought a startling personal tragedy to the families and friends of those who died and a sobering alarm to residents of the region. Yet, with cautious relief, the population of the San Francisco Bay area acknowledged that they had survived a major earthquake with moderate losses in deaths, injuries, number of those made homeless, and destruction of human services and infrastructure.

Does the Loma Prieta Earthquake, given its strong magnitude but relatively moderate amount of destruction, indicate the presence of a Singerian inquiring system functioning in the San Francisco Bay area? Although representatives of public, private, and nonprofit organizations, scientific and professional organizations, voluntary groups, and individual citizens might not recognize it as such, there were clearly elements of a systematic process of inquiry informing public and private action in ways that limited the consequences of the earthquake for the metropolitan population.

Returning to the elements of a Singerian model, the goal of informed, cooperative action to protect lives and property against incidents of seismic risk was widely acknowledged and shared by residents and decision makers in the area. California is a region of known seismic risk. Scientific and professional institutions in the state, including those affiliated with advanced research universities in the San Francisco Bay area, have created a significant body of knowledge, from multiple disciplinary perspectives, regarding the consequences of a major earthquake on this heavily populated metropolitan region. This steadily developing body of knowledge has been communicated to both policymakers and the public through a variety of means. The State of California's Office of Emergency Services, for example, has increased its public education and training programs for emergency personnel from local municipalities and counties significantly over the past eight years.[35] There are gaps in the process, as demonstrated by the I–880 freeway collapse; but an increased level of public awareness of seismic risk and emergency preparedness was demonstrated repeatedly throughout the disaster operations.[36]

The boundaries of an identifiable inquiring system appear to encompass the nine-county Bay area, but extend as well to state and national levels in specialized areas and return to subsystems of inquiry for specific problems in local communities and counties. A density of overlapping patterns of communication and interaction, gained through common training and prior experience in disasters, was reflected among participating emergency response personnel. Drawn from throughout the state, the response teams shared professional standards and skills that facilitated coordination in the difficult response to the collapsed Oakland freeway structure.

Statewide, an informed and concerned citizenry has, for the past twenty years, voted to maintain strong building codes and to pass bonds for the structural reinforcement of schools and public buildings. Locally, an increasingly professional public service has reordered priorities to hire personnel to develop earthquake preparedness programs in cities such as Oakland and San Jose.

As boundaries shift from community to metropolitan region to state and federal arenas of inquiry, and return again to the community level for action, the components of the inquiring system also change. In true Singerian fashion, the decision makers, clients, and designers begin to merge roles as policymakers, citizens, and professionals transform ideas into action. Circulating freely, information is enabling, and ready access to current information encourages citizens to take responsible action to protect themselves and others.[37] The design of systematic means of access to information about earthquakes and feedback from actions taken by princi-

pal organizations and citizen groups in the region have been part of an ongoing program for organizations such as the Bay Area Regional Earthquake Preparedness Program. Similarly, the Earthquake Engineering Research Center at the University of California, Berkeley, and the U.S. Geological Survey, Menlo Park, have contributed significantly to scientific knowledge about earthquakes in the region.

Interestingly, with increased training and ready access to information, the balance in performance of the five functions of disaster management shifted markedly toward exchange in this disaster. This pattern was observed in the most demanding and uncertain environments, as in the urban heavy rescue effort to salvage the victims of the I–880 freeway collapse. Interorganizational and interdisciplinary search and rescue teams were formed to cut through the forbidding tangle of concrete and steel to extricate victims, not because it was required by some external authority, as the coordinator of the Oakland Fire Department's team stated, but because it was necessary to do the work.[38]

A telling measure of performance was the response of the citizens to the event. With no prescribed roles, yet operating on the basis of prior awareness of earthquakes and the likelihood of danger, ordinary citizens responded with remarkable courage and generosity to the needs generated by the earthquake. At the site of the I–880 freeway collapse, for example, private companies located in the area brought heavy equipment to the scene within minutes. They improvised platforms with heavy containers and forklifts to elevate equipment to the upper levels of the freeway and to bring down injured victims. Neighbors risked their own lives to help strangers they had never met, demonstrating again the powerful ethical imperative to save lives in a disaster.[39]

With quick thinking and responsible action, citizens, public organizations, and private companies, working together, managed to rescue nearly all live persons from the collapsed freeway structure in about 11 hours. Fifty-six cars were located on the collapsed section of the freeway; approximately 200 persons were estimated to be on that stretch of freeway when it went down. Most walked away or were rescued during the first hours after the collapse; but 39 bodies were extricated in the painstaking effort to account for all missing persons. Hope was briefly renewed with the rescue of one survivor four and a half days after the event; the joy of rescue turned to sorrow, however, as the survivor succumbed to injuries sustained in the ordeal.

The search and rescue process was largely spontaneous in the first hours, and could doubtless have been improved with design. But the fact that the initial rescue was accomplished within hours, under the constraints of nightfall, with no electricity and limited communication, demonstrates the capacity for informed community response in a disaster.

Turning conflict into cooperation in disaster response

The record of performance reveals that the basic characteristics of an inquiring

system emerged to some extent in each disaster—in Ecuador, Armenia, and Northern California. All three shared the common purpose of saving lives and protecting property. The degree of openness in the process of inquiry varied among the three disaster sites; yet, in each set of disaster operations, previously existing patterns of organization were replaced with newly created ones in order to perform urgent tasks more satisfactorily. Though difficult to obtain in each setting, information, once available, proved enabling to the participants in the process. Finally, in the work performed, cooperation emerged repeatedly in the disaster operations in all three areas. In the *mingas* of Ecuador, the student work groups of Armenia, and the interdisciplinary search and rescue teams of Oakland, California, people quickly learned to cooperate in order to accomplish the extraordinarily difficult tasks of response to and recovery from disaster. Obstacles and conflict were also apparent; but in each disaster, participating personnel improved their performance significantly over the period of actual operations as feedback, indicating organizational learning, increased the general level of information and understanding of the problems.

Several conclusions can be drawn from these three cases in terms of future performance in disaster operations:

1. Rapid mobilization of response requires previous training, shared commitment, and common understanding of the tasks involved.

2. Building that response requires the creation of a communitywide knowledge system that makes available to responsible managers not only the physical resources but also the intellectual understanding of how to adapt available materials to actual needs in a disaster.

3. Exchange relationships, supported by timely, valid information from the disaster environment, are critical to implementing effective community response in a disaster.

4. Carefully designed information processes, or inquiring systems, increase the learning capacity of interdependent community organizations and improve the effectiveness of individual and organizational responses in a disaster.

5. Effective disaster response involves a radical shift in the perception of roles in which members of the community, united in common purpose with emergency response organizations, become part of a coherent community network of response that actively works to increase performance under disaster conditions.

6. Knowledge gained from managing disaster operations in environments that have experienced major seismic events may be pooled through a global inquiring system to inform policy and practice in other communities at seismic risk.

A primary function of disaster management is to identify points at which community residents may make the critical shift from passive victims to active participants in the disaster recovery process. Activities that engage noninjured residents of the community in active participation in rescue and other relevant operations are likely to contribute to successful recovery [4]. Conversely, if community residents are not informed or involved in constructive ways in the disaster operations process, they are likely to perceive themselves as victims and contrib-

ute to conflict among organizations participating in those operations.

Acknowledging the sources of organizational conflict in disaster response and transforming those sources into bases for cooperation among organizations is the first step toward strengthening organizational capacity for response in future hazardous events. A global inquiring system for communities at seismic risk would serve as an important resource in this process.

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Notes

1. The problem of organizational conflict has been addressed in separate studies of these disasters. Please see L. K. Comfort and other members of the Disaster Reanimatology Study Group, University of Pittsburgh, and the Institute of General Reanimatology, Moscow, USSR (1989) Learning from risk: Organizational interaction following the Armenian earthquakes. Paper presented at the 1989 Annual Conference of the American Political Science Association, Atlanta, GA, 31 August–3 September; see also references 1–3.

2. See the discussion by Bruno R. Lima in reference 4.

3. L. K. Comfort & Kean Namkoong (1989) Choice vs. control: Increasing organizational effectiveness in interdependent environments. Working Paper 89–24. Institute of Governmental Studies, University of California, Berkeley.

4. Interview with Chairman, Department of Emergency Medicine, Skilfosovsky Institute of Emergency Medicine, Moscow, USSR, at the University of Pittsburgh, Pittsburgh, PA, 28 September 1989.

5. *Function* is used here in the teleological sense attributed to E. F. Singer, Jr., and Gregory Bateson—that is, elements are grouped together because they will produce a certain end result.

6. These characteristics draw upon both prior research and professional observation. See, for example, references 2, 15, and 19.

7. Legally mandated emergency plans identify functions in disaster response primarily for public organizations with mission responsibility to perform specific tasks during disaster operations. See, for example, reference 20.

8. The concept of shared risk leading to shared responsibility is presented in reference 22.

9. Interview with geological engineer, member of the Ecuadorian reconnaissance team, Instituto de Energia y Minas, Quito, Ecuador, 17 June 1987.

10. Interview with the Director, Peace Corps, Ecuador, Quito, Ecuador, 6 July 1987.

11. United Nations Economic Commission for Latin America and the Caribbean (ECLAC) (1987) The natural disaster of March 1987 in Ecuador and its impact on social and economic development. Report #87-4-406, 6 May. P. 1.

12. A detailed account of the organizational interaction in this disaster is presented in reference 2.

13. President Leon Febres Cordero stated, "...this is the most serious disaster in the history of Ecuador as a nation." *Hoy* (Quito, Ecuador), 10 March 1987, p. 1.

14. The Catholic Relief Services/CATEC program of disaster in Central Napo Province was a notable exception. Please see reference 3.

15. For a more complete description of task performance in the three zones, please see references 2 and 3.

16. Source: Professor of Civil Engineering, Yerevan Polytechnic University, Yerevan, Armenia, 24 March 1989.

17. Earthquake Engineering Research Institute (1989) Armenian earthquakes of December, 1988. Videotape. El Cerrito, CA: Earthquake Engineering Research Institute.

18. Professor of Civil Engineering, Yerevan Polytechnic University (see note 26).

19. Data provided by the Director, Civil Defense, Armenian SSR, Yerevan, Armenia, 21 March 1989.

20. Source: Chairman, Department of Emergency Medicine, Sklifosovsky Institute of Emergency Medicine, Moscow, USSR, at a seminar at the University of Pittsburgh, Pittsburgh, PA, 26 September 1989.

21. This figure was reported by the German Red Cross. Interview, Counselor, German Embassy, Moscow, USSR, 16 March 1989.

22. These figures were reported by the Director, Civil Defense, Armenian SSR, at a briefing at Civil Defense Headquarters, Yerevan, Armenia, 21 March 1989.

23. Figures cited regarding the impact of the disaster were presented by the Director of Civil Defense, as indicated in note 22.

24. Videotape cited in note 17.

25. Valentin Mikhailovich Nikiforov, Assistant Foreign Minister, USSR, as cited in *Ekho Planety* [The Planet's Echo] (Moscow, USSR), No. 7 (46), 11-17 February 1989, pp. 11-12.

26. The role of the All-Union representatives in supporting disaster response was reported by the Director of Civil Defense, Armenian SSR. It was also confirmed through direct observations by the chief of the British search and rescue team in an interview in Washington, DC, 9-10 May 1989.

27. The data provided by Civil Defense Armenia indicated that the number of live rescues increased significantly on days 3 and 4, after the heavy rescue equipment arrived, but dropped sharply after day 5, as people trapped in the rubble could no longer survive. These data are presented in reference 21.

28. The Civil Defense organization depended on the local capacity for action. When the local personnel were themselves victims of the disaster, the mechanism proved ineffective. Information from the briefing by the Director, Civil Defense, Armenian SSR, 21 March 1989.

29 Amateur radio operators voluntarily tried to set up communications linkages for rescue operations, but encountered great difficulty in doing so, according to reports in the Moscow publication *Radio* of March 1989 (pp. 5–7) and April 1989 (pp. 14–17).

30. Source: Soviet emergency physicians at seminar at the University of Pittsburgh, 26 September 1989.

31. Seismographic Station, Department of Geology and Geophysics, University of California, Berkeley (1989) The Santa Cruz Mountains earthquake of 17 October. Bulletin No. 3, 23 October.

32. *San Francisco Chronicle*, 19 October 1989, *San Jose Mercury*, 19 October 1989; *Los Angeles Times*, 19 October 1989.

33. Sixty-three deaths were reported by the California Office of Emergency Services for the seven-county disaster area (*The New York Times*, 25 October 1989, p 14) Buck Helms, rescued live from the Cypress Street collapse, and another injured victim subsequently died, bringing the total number of victims of the earthquake to 65.

34. Source Disaster Operations Center, City of Oakland, 23 October 1989.

35. Most emergency response personnel who participated in disaster operations at the Cypress structure in Oakland had qualified for the roles they assumed in disaster operations through training in the Incident Command System offered at the California State Training Institute, San Luis Obispo. Source interview with the Coordinating Officer, California Department of Forestry, at the Field Command Post, Cypress structure, Oakland, CA, 22 October 1989.

36. This observation was made by several news analysts and journalists for the national press See, for example, accounts in *The New York Times*, 19–29 October 1989.

37. The local newspapers presented daily accounts of citizens helping citizens, directing traffic, organizing shelters, and contributing time and skills to community recovery projects. *San Francisco Chronicle*, 18–29 October 1989; *Oakland Tribune*, 18–29 October 1989.

38. Source: interview with Coordinating Officer, Oakland Fire Department, Field Command Post at the Cypress structure, Oakland, CA, 22 October 1989.

39. Source: interviews with emergency response officers at the Cypress Street Field Command Post for the disaster operations on 22 October 1989.

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