An Interdisciplinary Quick Assessment Strategy to Support Decision-Making in Disaster Operations: The Costa Rica Earthquake, April 22, 1991

Louise K. Comfort
Graduate School of Public and International Affairs
University of Pittsburgh

Submitted to the Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, in fulfillment of requirements for a Quick Response Research Grant, November 9, 1994.

ACKNOWLEDGEMENTS

I acknowledge, with warm thanks and appreciation, the many men and women in Costa Rica who I interviewed for this study. Given the norms of professional confidentiality, I will not name them, but they included staff from the major public organizations involved in emergency response, academic researchers and administrators, and representatives from private and nonprofit voluntary organizations. I also acknowledge the the Natural Hazards Research and Applications Center, Boulder, CO for a Quick Response Grant to support this research, especially Mary Fran Myers of the Center for her patience and good will in regard to the preparation of this report, and Leslie Mohr, at the Graduate School of Public and International Affairs, University of Pittsburgh, for her thoughtful and diligent assistance to this research.

An Interdisciplinary Quick Assessment Strategy to Support Decision-Making in Disaster Operations: The Costa Rica Earthquake, April 22, 1991

Louise K. Comfort
University of Pittsburgh

Efficiency in Disaster Response Operations

This report presents findings from a quick response study to Costa Rica following the April 22, 1991 earthquake in the Valle de Estrella, on the Caribbean slope of the Cordillera de Talamanca, close to the southeastern border with Panama. The earthquake registered 7.4 on the Richter scale of surface wave magnitude,[1] the most powerful earthquake recorded in this century of Costa Rica's significant seismic history. The overall cost of damage caused to infrastructure, losses in export, commercial wood, commercial soils, housing and social infrastructure were estimated at US $965 million, close to US$ 1 billion (Bermudez, 1993:3-5). This sum represents approximately 7% of Costa Rica's Gross National Product, a substantial loss for a nation of 2.6 million people.

The research design proposed for this quick response study addressed the problem of efficiency in disaster response operations. Repeated studies of decision-making in disaster operations have identified the problem of accurate, timely, information to support decision-making as one of the primary needs of

---

[1]Local magnitude, Ml, was reported as 7.2. These calculations were reported by the Seismological Department, University of Costa Rica. EQE International, Inc. 1991. The April 22, 1991 Valled de la Estrella Costa Rica Earthquake: A Quick Look Report. (May): p.3.

disaster managers. The problem is compounded in complex environments where decision processes in disaster operations necessarily cross disciplinary, organizational and jurisdictional boundaries. The problem is further compounded by the necessity to update and aggregate incoming information regarding the impact of the disaster event upon the affected community, its population and infrastructure with existing knowledge of the community, in order to provide timely, valid information to support policy making in disaster operations.

The research design proposed for this study sought to develop an interdisciplinary quick assessment strategy that would assess the capacity of a stricken community to respond to a disaster event in five critical disciplines: public policy and management, medicine, public health, engineering, and information processes. While other disciplines are relevant, these five disciplines were selected as essential to any disaster response. Timely assessment of conditions in the disaster environment from these five disciplinary perspectives is essential to mobilizing efficient response to disaster. Three components were envisioned for the quick assessment strategy: 1) identification of the information requirements for assessing the capacity of the affected community to respond to disaster both within and across the five disciplines; 2) design of an interdisciplinary, interorganizational format to process the incoming information from a specific disaster and transmit it to appropriate disaster management personnel in their respective organizations and jurisdic-

tions; and 3) design of a set of procedures for validation of incoming information, as well as continuous review and integration of this information with existing knowledge about the affected community.

This research design, developed to apply to a generic problem in disaster response, underwent some modifications in its implementation to fit the actual context of disaster operations following the April 22, 1991 earthquake in Costa Rica. This report presents the findings from a 14-day quick response trip to Costa Rica, April 24, 1991 - May 8, 1991. The report is organized in three parts: 1) the context of the disaster and identification of the major functions and organizations involved in disaster response; 2) the information processes used in disaster operations as they were observed through organizational interactions and on-site interviews; and 3) the validation of professional observation of these information processes through content analysis of professional reports and newspaper accounts of disaster response operations.

The Context of Costa Rican Disaster Operations, April 22, 1991

By observable criteria, in April, 1991, Costa Rica had one of the most advanced emergency planning organizations with high potential for emergency response in Latin America. The Comision Nacional Emergencia (CNE) was operating from modern, well-designed offices in San Jose, with a professional staff that included experts in geology, engineering, medicine, and computer science affiliated with the University of Costa Rica, major national

industries, such as the Refineria Costarricense de Petroleo (RECOPE), and major hospitals in San Jose. The National Emergency Plan assigned the primary responsibility for managing and coordinating all activities relating to disaster to the CNE, which reported directly to the President of the Republic.[2] The CNE had recently invested in a $2 million computerized emergency information system, and was engaged in developing a hazards vulnerability analysis for the entire country.[3]

The CNE had established good working relationships with international agencies located in San Jose that were also working to improve disaster preparedness and response: the US Regional Office of Foreign Disaster Assistance, the Regional Office of the Pan American Health Organization, and the Regional Office of the League of Red Cross Societies. It had organized planning exercises for its staff and affiliated institutions at the national level. In short, the CNE had a well-trained staff who were working hard to carry out the mission of their agency as they understood it. The staff had developed an ambitious agenda for a small nation that was vulnerable to a range of serious hazards.

---

[2]National Emergency Plan. National Emergency Committee. San Jose, Costa Rica, 1991:4.1. Portions of the plan were translated and made available by Dr. Teofilo Sarkis as part of his report to the United Nations Interregional Seminar, Jakarta, Indonesia, December 13-18, 1993. Dr. Sarkis played an active role in Red Cross medical response in Limon during the disaster operations, April 22-28, 1991.

[3]This system, the Emergency Information System, was purchased with funds from the International Development Agency of Canada. Interview, Luis Diego Morales, Director of Planning, CNE, April 26, 1991.

It had prudently allocated scarce resources and early efforts in preparedness and training to the area of highest perceived risk and heaviest concentration of population, the Meseta Central which included the capitol city of San Jose.

When the earthquake occurred on April 22, 1991, the CNE assumed its legal obligations to coordinate response to the disaster. Nonetheless, by April 25, 1991, the third day after the severe earthquake, it was clear that there had been inadequate information gathered to support effective response to the city of Limon, the isolated towns of Limon province, and the canton of Turrialba, areas that suffered the heaviest damage.[4] President Rafael Calderon announced that he was assuming direct control of disaster operations and placed two of his Cabinet ministers, the Minister of Agricultura y Ganaderia and the Minister of Vivienda y Asentatmientos Humanos, in charge of disaster operations in the province of Limon. The CNE would play a support role to the government ministries in the conduct of disaster response and recovery operations.[5]

This set of events, which effectively reversed the role of the CNE according to the National Emergency Plan and the expectations of its president and executive director, illustrated vividly the dynamics inherent in the research question I had come to study: the design of an interdisciplinary quick assessment

---

[4]La Nacion, April 25, 1991: pp. 4A, 6A, 8A, 11A

[5]Press conference conducted by Humberto Trejos, M.D., President, CNE, April 25, 1991, 6:00 p.m., San Jose, Costa Rica.

strategy to support effective action in disaster response. Occurring in the first days of my observation of disaster operations in Costa Rica, these events influenced the subsequent course of my study. Clearly, existing information processes had failed to provide the CNE with timely, accurate information to support response action, but why and how had this occurred, and what conditions were specific to this earthquake in contrast to the procedures outlined in the formal National Emergency Plan? My own observations of the CNE in operation and interviews with the executive director, director of planning, director of operations, and staff on site led me to reject the negative judgment of the CNE offered by the media and others[6] and to search for other conditions which may have contributed to this marked shift in an evolving emergency response system.

In this specific set of disaster operations, the processes for gathering and analyzing information to support decision making at the national level in response to local needs were not fully in place at the CNE. Its major investment in a computerized information system was relatively new, and most of the data for the area affected by the earthquake -- the city and towns in the province of Limon and the Valle de Estrella -- were not yet entered into the computerized knowledge base for the system.

---

[6]I respectfully disagree with judgments made by Benjamin E. Aguirre in his report, "Social Aspects of the Costa Rica Earthquake of April 22, 1991":13. Examination of other sources and consideration of different aspects of the problem of management lead me to different conclusions regarding the role of the CNE in disaster preparedness and response in Costa Rica.

The CNE relied largely on the national telephone system for communication with outlying cities and towns, which went down immediately in some areas and was overloaded in others. Its radio system did not have the capacity to communicate across the mountains to the Atlantic coastal city of Limon and the smaller towns of Bataan, Matina, Sixaola and others in the affected area, nor did it have the transport capability to send helicopters immediately on reconnaissance flights to assess the damage. Neither did the local units of the Guardia Civil, Costa Rica's civilian response organization, have advanced communications capability. Local and provincial committees of the CNE were not yet developed and could not provide the two-way exchange of information regarding assessment of damage and communication of needs essential to mobilize national response action at the local level. In sum, the CNE had inadequate means for direct exchange of information between the stricken areas and its central office in San Jose and had little capacity for organizing local action in these outlying areas.

Ironically, the news media had both better equipment and better means of transportation for information search and damage assessment than the CNE, and early seized the lead in reporting the consequences of the earthquake to the wider population.[7] However, these reports, while timely, were made from a journalist's perspective and did not provide the kind of systematic,

---

[7]Interview, reporter for La Nacion, Limon, Costa Rica, April 27, 1991.

professional assessment of damage to the infrastructure and needs of the earthquake-affected populations essential for effective disaster operations.

Consequently, without adequate transportation and communication facilities to support an initial damage assessment, the CNE's information search regarding the impact of the earthquake in these outlying cities and towns yielded delayed, vague, and incomplete reports that provided little basis for informed action. The President's actions in assuming lead responsibility for disaster response and operations reflected his ability to bring wider resources to the task and to obtain a more timely, accurate, and detailed assessment of needs in the provincial regions.

The response and recovery system that evolved in the Costa Rican disaster operations was clearly nonlinear,[8] marked by discontinuities in communication, coordination, and organization in contrast to its predesigned, centralized, linear National Emergency Plan. That is, the response system was "sensitive to the initial conditions" (Prigogine and Stengers, 1984) of the disaster affected area -- the city of Limon and the towns, villages, ports, and banana plantations in the area -- and continued to evolve in unpredictable ways. However, within this

---

[8]There is a substantial literature on nonlinear, adaptive systems that presents cogently the primary characteristics of these systems. See, for example, S. A. Kauffman. 1991. Origins of Order: Self-Organization and Selection in Evolution. New York: Oxford University Press; L. Comfort. 1994. "Self Organization in Complex Systems." Journal of Public Administration Research and Theory, Vol. 4, No. 3 (July):393-410.

nonlinear system were sets of subsystems operating separately with reasonable stability and purpose. There was little coordination of action or shared information among them, but they did represent significant actions taken by separate groups in a self organizing approach to disaster response (Comfort, 1994:298-308). The next section will identify the emergence of the major subsystems and their contributions to a quick assessment strategy that informed action in disaster response.

Organizational Sub-systems and their Information Processes

When President Calderon assumed direct control of disaster operations, the formal organization of the CNE became a participating member of the disaster response system, rather than the active coordinator and manager of the system. Working under urgent demands for action, separate groups of organizations formed around common tasks and carried out their functions, often crossing jurisdictional boundaries within groups, but with relatively little interaction among the groups. Each group instead reported directly to the President. At least seven distinct sub-sets of organizations were identified that performed their own assessment of needs in the disaster-affected areas, and organized their actions accordingly. These subsets included organizations representing the five disciplines I had expected to study: public policy and management, medical response, engineering, public health, information processes, as well as two additional perspectives that proved especially important in this disaster: transportation and agriculture/commerce/industry. In this account, emergency response is treated as a sub-subset of

public policy and management, reflecting the urgent need for public action immediately upon impact of the earthquake. Each set of functions will be described briefly below. Some organizations performed functions in overlapping subsets, which will be noted in this analysis.

Emergency Response.

Fortunately, in this disaster, the loss of life was remarkably low, given the magnitude of the earthquake. Although different figures were cited for the number of dead and the number of injured, the most consistent figures reported were 47 dead and 198 persons seriously injured in Costa Rica (EQE International, Inc., 1991; B.E. Aguirre, 1991; A. Lavell, 1993; T. Sarkis, 1993). The earthquake occurred on a Monday, April 22, 1991 at 3:57 p.m., with the major impact outside of the heavily populated area of the Meseta Central. In Limon, a city of approximately 75,000 residents that suffered the heaviest impact, buildings were largely one and two story wood-frame, concrete block, or concrete frame structures. Only one structure in Limon, the three-story International Hotel, completely collapsed, killing one man who was trapped inside. Eight other deaths were reported in Limon. More deaths occurred in the small towns of Talamanca (18) and Matina (20), where the structures were not as well built.

Search and rescue operations in Limon and the surrounding towns were largely carried out at the local level, by family, friends, local police and fire departments in the first few hours

after the earthquake. Trained urban search and rescue teams arrived from Switzerland and Great Britain with search dogs and special equipment, but by the time they arrived on Friday, April 26, 1991, there was no longer need for their services. Fires did break out, the most damaging at the RECOPE refinery near Moin, but local emergency response organizations effectively brought them under control.

Medical response.

The more urgent task in emergency response was setting up emergency medical facilities to care for the injured. Limon's primary hospital, Dr. Tony Fascio Castro Hospital, was damaged in the earthquake and declared unsafe for treating patients. Emergency care was established outside the hospital, but no surgery or treatment of serious injury could be performed. Patients requiring advanced medical care were transported by air to hospitals in San Jose.

Under the direction of a Red Cross physician, local medical personnel formed a hospital station at the airport to receive injured persons transported by helicopter from outlying towns and villages. Patients were stabilized at this airport station, and then transported by plane or helicopter to hospitals in San Jose for further treatment. A pharmacy was also established at the airport to provide ready access to medicine for injured patients transported to the airport from outlying towns, and, in turn, to make medicines available to patients in outlying towns which had been isolated by damage to the roads and bridges in the area.

Medical services offered by volunteer medical personnel were organized and provided to outlying communities via air transport, as needs were reported from reconnaissance flights.

Transportation.

Since Costa Rica has no military forces of its own that could provide heavy equipment for logistical needs, President Calderon requested transportation assistance from nearby nations. Nicaragua, Venezuela, and the United States Southern Command, based in Panama, provided military helicopters to assist with medical transport, reconnaissance of damaged roads and bridges, and transportation of needed supplies, water, and medicine to isolated towns and villages. The United Nations of Central America (ONUCA) also provided three helicopters for the transportation of injured patients and relief supplies. In addition to helicopters, the US provided a C-130 transport plane to carry relief supplies and heavy equipment to areas of need.

Transportation proved a crucial element of both emergency response and medical response, and the airport itself became an important locus of operations management and information exchange in this disaster. Local organizations established an operations headquarters at the airport, with radio communications, a fax machine, and telephones. This communications capability enabled direct communications with national ministries and organizations located in San Jose, as well as communications via radio to those villages that could receive and send messages. Personnel at this airport headquarters office recorded incoming supplies and

voluntary assistance from disaster relief organizations -- public, private, and nonprofit -- as well as reports of needs from outlying areas. In a spontaneous effort to match the flow of incoming supplies to reported needs from the disaster-affected towns and villages in the coastal region, this hastily established operations office organized a de facto communications exchange and record-keeping system that provided an important basis for informed decision. Professional guidance from the US Office of Foreign Disaster Assistance, which had established trusted relationships of long standing with the CNE, Red Cross, PAHO, ONUCA, and the Costa Rican ministries, served an important function in supporting the organization and operation of this office.[9] Accordingly, disaster relief supplies were received, stored, and dispensed to outlying communities from the airport in an increasingly ordered manner, as disaster operations progressed. As stated above, medical services to isolated towns in the disaster-affected area were coordinated from the airport through available air transport.

Engineering.

The engineering sub-set operated largely independently of the emergency response, medical response, and disaster relief organizations. The major damage from this earthquake affected the transportation infrastructure of the Atlantic Region, which severely disabled the dominant agricultural economy and commerce

---

[9]Professional observation and interviews with operations staff, Limon Airport, April 27, 1991.

of the Region by preventing the transport of agricultural products to the Port of Limon to be shipped to international markets. In turn, damage to the lucrative agricultural sector created severe damage to the economy of this small nation. This earthquake illustrated the destructive triggering effect of natural disaster upon the interdependent economic and social relationships of this still developing nation.

Eight bridges were destroyed or severely damaged, and approximately 225 kilometers of roads were deeply fissured by the earthquake.[10] These routes were essential to transport the important banana crop across the six rivers flowing from the Cordillera de Talamanca to the coast for shipping to external markets. Equally damaging, the Port of Limon, which handles approximately 80% of the shipping to and from Costa Rica, was disabled by an unusual uplift of one meter in the coastal floor. This tectonic phenomenon created the appearance of a "receding sea," in which the water level dropped significantly, leaving previous loading docks dry and inaccessible to incoming ships, and docked ships, previously floating in water, beached on dry land. Damage was also reported at the Port of Moin, on the Atlantic Coast, the principal entry point for petroleum into the country. Given the primary roles of banana production and export and energy production in the economy of the country, reconstruction and repair of the damaged bridges and the Ports of Limon and Moin assumed a

---

[10] Interview, Lt. Col Richard Price, USACE, San Jose, Costa Rica, April 28, 1991; La Nacion, April 27, 1991.

very high priority in the national recovery from disaster. The sub-set of organizations that formed the engineering group tasked to address this problem included international, national, and local organizations, both public and private.

Anticipating heavy expenditures in infrastructure reconstruction, President Calderon requested, and received, on April 23, 1991, a $60 million loan from the World Bank for emergency road and bridge repair.[11] He then requested a damage assessment of the failed bridges and an estimate of the cost of reconstruction. The US responded by sending a team of professional engineers from the US Army Corps of Engineers, Southern Command, based in Panama to conduct a technical assessment of the damage to the bridges. The assessment team, led by Lt. Col. Richard Price, USACE, included other professional engineers from the USACE, the Ministry of Obras Publicas y Transporte, and a private Costa Rican engineering firm. The group overflew all eight bridges in a US Army Blackhawk helicopter on Saturday, April 27, 1991.[12]

In this damage assessment, the engineering team checked the design of the original bridges against the soils structure, the expected traffic load, the tensile strength of the steel used in

---

[11] Situation Report No. 1, US Office of Foreign Disaster Assistance, April24, 1991: p. 2.

[12] With permission from the commanding officer, I had the unusual opportunity to join this reconnaissance team in their overflight of the damaged areas and to observe the technical team as they carried out this assessment. San Jose, Costa Rica, April 27, 1991.

the bridges, the size and depth of the pilings, and other construction requirements needed for seismic resistance. The kinds of information they sought were largely well-structured, technical questions which were needed to develop a set of professional recommendations for rebuilding the bridges. The group completed their analysis of the failed bridges and their designs for reconstruction and presented their report to President Calderon in the following week. The president accepted their recommendations, allocated resources from the World Bank loan, and the program of bridge reconstruction began very quickly. In this instance, the types of information needed for action were well-defined, the means of obtaining it were available, the information gathered was credible and accepted by the relevant groups, and action followed without delay.

When asked to summarize the criteria used by the USACE in preparing its mission and in gathering data for its report, Lt. Col. Price listed six standard criteria used in any US military mission:

1. Clear statement of mission
2. Specific assignment of personnel who have the skills, knowledge, and capability to do the work
3. Detailed plan for logistics
4. Sufficient allocation of resources
5. Clear designation of administrative responsibilities
6. Designated time schedule for action

The actual content of the engineering criteria for the task is subsumed under the second criterion: personnel who have the skills, knowledge, and capability to do the work. The other five criteria all relate to means needed to carry out the task. The

effectiveness of the engineering mission and the ready acceptance of its recommendations for action by the interested parties indicates the value of this approach. When any one of these six criteria is not carefully met, Col. Price observed, the mission is likely to falter. The criteria, in effect, assisted the engineers in ordering and focusing the information needed for effective action among the participating international, national, and private organizations involved in the bridge reconstruction process.

In contrast to the clear and rapid identification, collection, and analysis of information for bridge reconstruction, quick assessment of damage and the development of an action strategy took a different form in reference to housing, a second engineering function. Approximately 850-1,000 homes were destroyed, leaving an estimated 3,500 people homeless. Shelters were established in parks and other public places, but the dominant response was to consider housing a matter for private or non-profit action. There appeared to be little coordination of housing services, except for the distribution of supplies of plastic and other materials extended through the Red Cross and other non-governmental organizations.[13] Most persons who suffered damaged or destroyed housing did not have insurance, and struggled to cope with their losses with help from family and friends. The housing damage was more diffuse than the infrastructure

---

[13] Situation Report No. 4, US Office of Foreign Disaster Assistance, Washington, DC, April 30, 1991: p. 4.

losses, affecting individual families who had no real means of articulating their needs collectively, and no strong leadership emerged at the local level to press for assistance in meeting these needs. Information remained scattered, and policy makers moved to more urgent, that is, more sharply articulated, demands.

Public Health.

The functions of public health in this disaster were closely related to the destruction of housing and damage to the lifelines infrastructure. Consequently, it was difficult to meet the urgent needs for clean water, protection from infectious diseases, and post traumatic stress counseling for the affected population without addressing the problems of safe housing, reconstruction of damaged water and sewer mains, and restoration of electrical power. In examining and devising workable courses of action for this interdependent set of problems, the local and provincial offices of the Ministry of Public Health played a major role.

The Ministry of Public Health had the most extensive and well-developed organizational structure of any of the national ministries in the province of Limon and the municipalities affected by the earthquake. Local and provincial Public Health officials had developed strong associations with the citizen clientele they served, and represented familiar and respected sources of assistance, counsel, and organizational guidance in the local neighborhoods. Local Public Health officials worked with municipal personnel to organize the delivery of clean water to neighborhoods with broken mains, advised citizens to boil

water before drinking, identified families with old, sick, or very young patients who needed special food, clothing, or medical assistance, and served as a vital local reference center for information, requests for assistance, and guidance in the distribution of relief materials and the reconstruction of damaged homes and towns.

In their organizational efforts, the local and provincial Public Health officials were supported with resources and relief personnel from the national Ministry and the Pan American Health Organization. The long-standing development of local and provincial services in public health care enabled this ministry to play a substantive role of guidance and support at the local level. Public Health staff, further, served an important liaison role in working with voluntary nonprofit agencies that contributed goods, services, and professional skills to the recovery process.

Agriculture/Commerce/Industry.

Although relatively sparsely populated, the Atlantic Region plays a major role in the nation's economy. The major banana plantations are located in the area and ship their produce through the Port of Limon. The nation's only oil refinery, RECOPE, is located near the Port of Moin. The banana plantations are largely owned by international companies that sought assistance directly from the Costa Rican Government. They also increased the Government's negotiating power with international monetary organizations such as the World Bank and International Monetary Fund. Although this group of private companies repre-