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Introduction

The persistent inability of communities to learn from earthquakes and other types of disaster presents a major policy problem for disaster reduction and response. This chapter examines the conditions and characteristics that contribute to, or inhibit, learning processes following disaster. Specifically, it will inquire into the conditions that lead to innovation by communities that are exposed to continuing risk in reducing their vulnerability to future disasters. It will focus on learning that occurs within and between organizations, recognizing organizations as actors that both facilitate, and inhibit, learning in disaster processes of mitigation, response and reconstruction. It also examines the wider set of agents that are involved in disaster mitigation and response in Turkey from the perspective of complex adaptive systems (CAS). This perspective acknowledges the emerging set of interactions among individuals, organizations, machines and policies as shaping the capacity of communities to assess and reduce their exposure to seismic risk

Communities that experience major disaster usually engage in a period of review and reflection to determine the factors contributing to the event. The purpose of such review and reflection, ostensibly, is to learn from the event, in order that factors contributing to the damage can be changed to lessen the likelihood of recurring disaster. Professional organizations, such as the Earthquake Engineering Research Institute, have continuing programs of research in which professional engineers and other researchers examine systematically the conditions that contributed to the failure of buildings, lifeline systems, bridges, roads, dams and other systems under the impact of major earthquakes.[1] Yet, the historical record of communities actually translating lessons learned from previous disasters into policies that reduce risk from future seismic events is weak (Comfort 1999; Comfort et al. 1999). While single organizations may make changes in their practice based upon experience gained in prior disasters, the transmission of that experience across a range of public, private and nonprofit organizations to change community-wide practice is rare. With regrettable frequency, the same conditions of vulnerability in the built and policy environments are reconstructed following the event, leading to the near inevitability of recurring disaster. This situation is particularly characteristic of communities that experience continuing exposure to seismic risk, but relatively long periods between major earthquakes.[2] The question of whether communities learn, and if so, how, represents a major gap in the field of crisis management and policy.

2. Theoretical Background

Organizational theorists differ on whether organizations learn, and if so, how and under what circumstances. Chris Argyris (1982; 1993) and his colleague, Donald Schon (1983; 1987), active proponents of organizational learning, acknowledge that individuals learn, but contend that the processes of information exchange, reflection and feedback within an organization result in a shared base of goals, knowledge and practice that constitutes organizational learning. That is, individuals working within a given organization observe and adopt a preferred set of

practices and norms that constitute a distinctive, organizational approach to problem-solving and performance. Other theorists argue that what is attributed to organizational learning is rather a factor of heuristics (Kahneman, Slovic and Tversky 1982), chance (Cohen, March and Olsen 1972) or leadership (Schein 1992). That is, organizations can only reflect the actions, beliefs and practices of their individual members. In the judgment of these theorists, it is the individuals who learn, if learning occurs, and any consequent change in individual actions is interpreted as merely change in organizational practice.

Current advances in information technology have altered the operational environment for both individuals and organizations, and create a wider basis for learning through sociotechnical systems. Sociotechnical systems include the mechanisms of communication and information storage, retrieval, dissemination and exchange as components of the system. Such components provide timely access to, and ease in transmission of, information within the system, and significantly increase the range of interactions among individuals within organizations, and among sets of organizations in reference to a common event or problem. The systematic communication of information across organizational networks builds a common perspective among their members on current problems and techniques for addressing them (Graber 1992), creating a basis for broader collective learning. Increasingly, organizations are integrating into their operational procedures opportunities for wider exchange of information among their members, graphic display of information using Geographic Information System techniques, and timely evaluation of performance and feedback on proposed strategies for action. These procedures use the convenience and technical ease of e-mail, exchange of electronic files, real-time chat formats, and access to distributed knowledge bases (National Research Council 1996) to create opportunities for organizational learning and change that did not exist 15 years ago. These sociotechnical advances lead to a reconsideration of organizational learning and raise the potential for collective learning among large populations, offering a powerful means of changing policy and practice for communities exposed to seismic risk.

 For example, the use of computers for recording losses in lives and property following earthquakes as well as incoming contributions of disaster assistance enables practicing managers to match the types of assistance available to needs of the families that suffered losses more appropriately. The computers become "agents" in the emerging disaster response system, enabling human managers to access relevant information more quickly and easily as a basis for their decisions. Human managers, supported by technical means of communication and information dissemination, are able to address citizens' needs more effectively and efficiently within the same constraints of time and resources. Individuals, responding to timely, reliable information, are better able to adjust their own behavior and practices to reduce risk and improve performance.

As sociotechnical systems increase the number of interactions among their components – individuals, organizations and machines – around a given social or policy problem, the evolving system becomes a "complex adaptive system." Such systems are characterized by recurring patterns of interaction among individuals with different levels of responsibility operating in organizations at different locations but focused on a common goal. They are constrained by limits of tolerance in their operations at each level that, if exceeded, propel the whole system to rearrange its components in a new form of order to increase its effectiveness in performance

(Bak 1996). This process of adaptation, or learning, is critical for communities exposed to recurring seismic risk

The concept of complex adaptive systems (CAS) offers a fresh perspective on the inability of communities to learn from recurring risk. Rather than focus on the intransigence of individual managers or the inadequacy of existing organizations, policies or resources, this perspective recognizes the full set of components – individuals, organizations, policies and technical resources - as components of a distinct system that is engaged in sustaining or solving a specific problem. Robert Axelrod and Michael Cohen (1999) present a theoretical framework for the study of CAS. They introduce three key concepts that distinguish CAS from other types of organizational arrangements: 1) agents, 2) strategies, and 3) populations. Agents have the ability to interact with their environment, including other agents who may be individuals, organizations, machines, or computer programs. A strategy is the manner in which an agent responds to its environment or seeks its goal. A population represents the pool of possible resources, or clientele, or components that are involved in, or affected by, the agents' actions. The activity of the system represents a process in which the agents interact with one another, drawing from a pool of possible actions, and select from available resources the strategy that has the best "fit" or match to its desired goal. The interactions are iterative, with the continuing process resulting in a system that adapts to the demands and resources of its environment more effectively. The system "learns" in that poor strategies or performance is rejected and fit performance is rewarded and continued. The benefit of this perspective is that it offers multiple ways of constructive intervention in the community's learning process. The weakness is that it likely cannot be controlled by any specific agent. The challenge, stated aptly by Robert Axelrod and Michael Cohen (1999), is "harnessing complexity." That is, it may be possible to recognize dynamic patterns in evolving complex systems in communities exposed to seismic risk and to intervene in this process in constructive ways to avoid major catastrophe, but it is not possible to control the process precisely.

3. Methods of Analysis

We build upon concepts developed by Chris Argyris and Donald Schon, together and separately, and propose that organizations do learn through shared goals, timely information exchange, action, feedback, and reflection. We also note that organizations operating in disaster environments often lack the technical infrastructure and organizational design needed to support the processes essential to learning both within and among organizations. In the complex environment of disaster mitigation and response, learning is not likely to advance to the level of a collective understanding of risk where it alters community policy and practice to reduce that risk without significant development of a community information infrastructure. We acknowledge that the type of information infrastructure available to practicing managers shapes their capacity to learn from risk, and suggest that a sociotechnical system or CAS designed to facilitate information exchange among its agents increases the potential for collective learning. This argument, if valid, offers an important direction for policy innovation and change in mitigating future risk. We explore this argument in the context of actions taken by public, private and nonprofit organizations following the 1999 Turkey Earthquakes of 17 August (Marmara) and 12 November (Duzce). We examine the access to, and reliability of, the information infrastructure(Comfort 1999) available to practicing managers engaged in disaster operations in the two earthquakes, the gaps in each, and whether experience gained in the

Marmara Earthquake contributed to changes in practice for the Duzce Earthquake four months later.[3]

In this analysis, we undertake five tasks. First, we seek to identify the types of organizations involved, as well as the types of information technology that were available to practicing managers to support decision making, in response operations for both earthquakes. Second, we examine the kinds and extent of information available to disaster managers operating at different levels of responsibility during the response period following the 1999 Marmara and Duzce Earthquakes. Third, we review the timeliness and specificity of information exchange among participating organizations, the means available to support information exchange, and changes in organizational performance that can be attributed to learning from this exchange. Fourth, we identify elements of adaptive learning in the communities that experienced disaster as preliminary evidence of interorganizational learning and innovation. Finally, we assess the components of adaptive learning identified in the Marmara and Duzce Earthquakes against a model of complex adaptive systems that may be used to mitigate risk from future earthquakes.

The analysis is documented by two sets of field interviews conducted between September 8 - 15, 1999 following the Marmara Earthquake (Comfort, Sungu and Colakoglu 1999) and April 28- May 5, 2000, following the Duzce Earthquake (Comfort and Sungu, 2000). These two sets of interviews were designed to solicit the kinds of information sought by managers with different responsibilities in disaster operations at different levels of jurisdictional authority as specified in the formal National Disaster Law No. 7269 adopted by the Government of Turkey.[4] The interviews also document the means of communication used and the technical infrastructure for decision support available to them, as well as the kinds of disruptions and obstacles that managers faced in acquiring relevant information and the kinds of information available or missing at critical stages in the response process. Further, the interviews provide data on the basic premises that managers used in selecting information as a basis for action. Although based on a limited set of data, this analysis is presented as an initial effort to identify the basic information infrastructure available to practicing managers prior to the Marmara and Duzce Earthquakes, and to assess the range and limits of that infrastructure in facilitating communication and coordination among managers with different levels of responsibility at different locations in the evolving disaster response system for Turkey. More extensive and systematic research will be needed to understand fully the dynamics of interorganizational learning in disaster environments.

4. The 1999 Turkey Earthquakes: Marmara, August 17, 1999 and Duzce, November 12
The 1999 earthquakes in Turkey offer a rare opportunity to examine processes of intra- and interorganizational learning among practicing managers in response to disaster. The devastating Marmara Earthquake was a region-wide event. The earthquake struck northwestern Turkey at 3:02 a.m. on August 17, 1999. It was caused by a rupture of the North Anatolian Fault, with the epicenter located at Latitude: 40.70N, Longitude: 20.91E; depth: 15.9 km. near the town of Golcuk in the city of Izmit in the province of Kocaeli, at the eastern end of the Marmara Sea. The initial reading of the shock was 6.7 on the Richter scale, a measure that was upgraded the next day by the Turkish Earthquake Research Department to 7.4 Richter. The duration of shaking

registered 45 seconds, a long period of seismic movement. The earthquake caused heavy damage in the cities of Avcilar-Istanbul, Izmit, Sakarya, and Yalova and the towns of Golcuk, Duzce[5], Sapanca, Korfez, Akyazi and Golyaka suffering severe destruction and collapsed buildings. On September 4, 1999, the Crisis Management Center, Government of Turkey, Ankara reported 14,936 dead and 24,024 injured. Golcuk, Izmit, Sakarya and Yalova suffered the highest losses, with deaths reported in five additional cities.[6] Bogazici University updated these figures on September 9, 1999 and listed the total number of deaths as 15,135.[7] Other reports have estimated the number of deaths to be over 17,000.

The Marmara Earthquake struck the most heavily industrialized region of Turkey, inhabited by approximately 17 million people, or 23% of the population of the country. At least 55,000 household units and businesses were reported destroyed or heavily damaged. At least 600,000 people were dislocated from their homes. The region is the center of economic production for the country, and the damage caused by the earthquake heavily impaired Turkey's economic activity. Illustrating the interdependence of technical and social modes of failure, the economic losses exacerbated the severe losses to both the population and technical infrastructure of the country. The total losses in built infrastructure and socioeconomic costs were estimated at $16 billion, or about 7% of Turkey's Gross Domestic Product.[8] The magnitude of this event makes it an important case in which to study the conditions that both facilitate and inhibit the evolution of organizational learning following disaster.

Ten cities and towns in the heavily industrialized region of northwestern Turkey suffered serious damage simultaneously from the earthquake. Mobilizing response operations to meet the needs of hundreds of thousands of residents of the devastated communities necessarily involved the exchange of information at multiple levels: within each of the ten communities , between the major cities and the central administration in Ankara, between the smaller towns and their provincial governments, and between the provincial governments and the central administration. In addition, there were multiway exchanges among the ten damaged communities, the provincial governments, and the central government, as well as between private and nonprofit organizations at local, national and international levels of operation. These exchanges created the opportunity for learning experiences by managers at each level of responsibility and operation, and for direct observation of action patterns that evolved within and among the organizations. The set of interactions among individuals, groups and organizations participating in disaster response operations following the Marmara Earthquake represent an emerging complex adaptive system for seismic response in Turkey.

While the nation was still grappling with enormous demands for recovery and reconstruction following the Marmara Earthquake, a second major earthquake struck Duzce, a town of approximately 80,000 in Bolu Province at 6:57 p.m. on November 12, 1999. The earthquake, registering M=7.2 Richter, occurred on the Duzce Fault, a segment of the larger North Anatolian Fault system (Bogazici University 1999). Duzce, located approximately 75 kilometers east of Adapazari, a city at the edge of the Marmara Region, had suffered losses in the 17 August 1999 event, but realized some benefits as well. Buildings damaged in the August earthquake had been vacated, limiting loss of life for the Duzce earthquake. Preliminary reports of the number of dead in the Duzce Earthquake totalled 759, and the number of injured 4,949 (Turkey/US Geotechnical Reconnaissance Report 1999). Nearly 10,000 buildings were damaged or destroyed in the region, many weakened by the earlier earthquake. Although the heaviest losses were in Duzce and

nearby Kaynasli, other towns and cities in the vicinity were also affected. Bolu, Akcakoca, Zonguldak and Adapazari, towns within a range of 75 km. in either direction from Duzce, incurred damage from the earthquake. Losses in these towns were not as overwhelming as in the cities affected by the Marmara Earthquake, but the Duzce Earthquake seriously disabled the communities and increased substantially the overall toll from earthquake damage to the nation.

At national, provincial and local levels of disaster operations, many of the same public, private and nonprofit managers were involved in both earthquakes. Local, provincial and national managers responding to urgent needs in Duzce had observed the interactions, both positive and negative, of organizations engaged in response and recovery operations in the earlier Marmara event. The two events, occurring in close sequence, serve as an important indicator of local, provincial and national capacity to translate insights gained from experience in the Marmara Earthquake into practice following the Duzce Earthquake.

5. The Evolving Disaster Response System: Organizational Actors in the Marmara Earthquake
Following the Marmara Earthquake, a total of 144 organizations was identified through newpaper reports (*Cumhuriyet*, Istanbul, August 17 - September 7, 1999) and interviews with practicing managers (September 8 - 15, 1999) as participating or contributing to disaster operations. This list
is partial, as no private organizations were included in these reports. Yet, we use this information to indicate the types of organizations that were involved in disaster operations, and the kinds of communication and coordination strategies that were needed to mobilize and manage the response operations. Of the 144 organizations identified, 61, or 42.3% were public organizations. This group included 27 national ministries and departments, 10 provincial or municipal offices, and 24 cities and provinces that contributed personnel and assistance to disaster response and relief operations. Nonprofit organizations represented a smaller proportion, 20, or 13.8% of the total number. This group included charitable organizations, professional organizations, universities and hospitals. The largest group were international organizations, 63, or 43.7% of the total. This group included nations that sent search and rescue teams, field hospitals, medicine, tents, blankets, and cash, as well as other international scientific and humanitarian organizations. The full list of organizations identified is listed in Appendix A.

Turkey had a National Emergency Plan in effect prior to the earthquake, and the Office of Disaster Affairs activated the National Crisis Center in the Prime Minister's Office. Other key Ministries and departments, Public Works and Settlement, Office of Disaster Affairs, Health, Foreign Affairs, and Transportation also activated their own Crisis Centers.[9] The primary authority, resources and direction for disaster operations, implemented according to the National Disaster Law No. 7269, lay with the national agencies. This policy was reflected in practice by the large number of national organizations reported as actively involved in response operations during the first three weeks following the earthquake, 29, in comparison to the smaller number of local government offices, 11, a ratio of nearly 3 to 1. The significant number of nonprofit organizations engaged in response operations represented the interest and commitment of the professional, charitable, humanitarian and research organizations to the magnitude of this event. The high number of nations contributing assistance and personnel to the disaster operations marked the care and concern of the international community for the Turkish people in this sobering disaster. But the mobilization and management of 144 organizations working in ten

communities in response to the needs of hundreds of thousands of people affected by the earthquake proved a massive effort. The information infrastructure in place in Turkey prior to the event necessarily shaped the communication and coordination processes among the responding organizations and the populations they sought to serve.

6. Status of the Information Infrastructure in Disaster Operations, Marmara Earthquake[10]
The technical telecommunications infrastructure in Turkey was seriously damaged by the Marmara Earthquake, but the concept of information infrastructure conveys a much broader meaning of how information is sought, recorded, stored and transmitted to support decision processes among public, private and nonprofit organizations. That is, the daily practice of managing information to support decision making regarding public affairs and the existing patterns of communication and cooperation prior to the earthquake represent a sociotechnical process in which the organizational patterns are supported by technical means. When the technical means are severely damaged, organizational practices are also changed. In this study, we examine ways in which the technical characteristics of the information infrastructure did or did not facilitate the communication and learning processes among the many organizations engaged in disaster response, and the extent to which these processes did or did not contribute to innovative performance in a rapidly evolving disaster response system.
In our interviews with practicing managers, we posed three basic questions:

1. How many and what types of information technologies were used by which organizations engaged in the information search, integration, analysis and dissemination, and interactive communication processes during disaster response operations?
2. In what ways did these technologies increase or decrease the exchange and utilization of information among the participating organizations during the response period (Days 1 - 21) after the disaster event?
3. To what extent did increased exchange and utilization of information facilitate adaptive change among organizations participating in disaster operations to increase efficiency and effective performance in the complex, evolving disaster response system?

With the assistance of Ms.Colakoglu, we conducted a set of semi-structured interviews with 21 managers in public, private and nonprofit organizations who were involved in the conduct, management, or evaluation of disaster response operations following the earthquake. We also reviewed professional reports as well as the media coverage of this event, using both print and Internet sources for 21 days after the event to corroborate the survey and documentary data.

The number and type of information technologies used in disaster response operations varied by time phase in disaster operations, the immediate tasks confronting the practicing managers, and the level of technical equipment and skills available for use during disaster operations. Survey responses identified three basic periods in disaster operations in which the technical facilities available to practicing managers varied greatly. Reports of the managers are summarized below.

Days 0-3: The set of 21 managers unanimously reported that standard communications were not functioning on the first day after the earthquake, and only sporadically and in very limited areas on days two and three. Electrical power was out, telephone communications were down, the only means of getting information was through amateur and short-wave radio. By days two and

three, electricity was partially restored in some parts of the heavily damaged communities of Izmit, Avcilar, Golcuk, Adapazari, and Yalova. During this period, several types of emergency communications were used.

Amateur and short wave radio:
The first type of emergency communications was two-way radio, made available within hours of the earthquake by Turkish Radio Amateur Club (TRAC), which created a network of radio base stations that relayed information among different disaster sites, the Governors' Offices, and the Prime Minister's Disaster Operations Center in Ankara. Radio traffic, however, was heavy and full of noise. The second was the two-way radio system operated by the Police, but this system was effective only within the Police organization. The third was the radio network operated by the military. Again, it was accessible only to military units participating in response. Police and military units did relay urgent messages for other organizations to other sites, but such messages needed to be received by police or military units at that site and delivered in person to the intended recipient. Public radio provided information on the disaster for those with battery-operated or short wave sets. Communications were severely limited for virtually all organizations during this period.

Satellite telephones:
Two incoming international search-and-rescue teams brought satellite telephones with them. These telephones worked to a limited extent, but essentially served the teams that brought them. The satellite phones arrived on days two and three, and provided communications to a very limited number of users. In addition to equipment brought by international teams, Turk Telecom brought a limited number of satellite phones to the disaster region. The kaymakam and tent city personnel at Golcuk had access to a satellite phone. The Izmit Emergency Operations Center also had access to a satellite phone, and the kaymakam in Yalova reported use of a satellite phone on the first day following the earthquake.

Cell telephones:
During the first three days, the base stations used by cell phones were either damaged or totally overloaded. This means of communication proved largely unworkable in the early hours of disaster response, but as the bases were restored, it became an important means of communication within local areas.

National Emergency Information System Damage Estimation Model: The Office of Disaster Affairs in Ankara has a damage estimation model for seismic risk, and staff ran the model for the city of Kocaeli. However, data included in the model was over ten years old and did not reflect the new construction and development in the area. Consequently, the model had an error factor of approximately 20%, and could only be used for a very rough estimate of damage and losses sustained. It could not be used reliably to guide disaster response operations.

Aerial Photography:
The city of Yalova activated its emergency plan, which included a helicopter overflight to assess the damage. Aerial photographs taken during this overflight provided an accurate view of the damage and were used to guide disaster operations in Yalova. In Kocaeli Province, a military helicopter was tasked to fly over the disaster area to provide aerial photos of the damaged area. These photos were used to identify communities that needed assistance and also to locate

possible sites for tent cities and debris disposal. These aerial photographs provided vital information to disaster managers regarding the extent of damage to the area.

Geographic Information Systems:
Only Istanbul Province had a Geographic Information System (GIS) under development, initiated in April, 1999. The system was not sufficiently developed to be used in the first days of response operations. The Office of Disaster Affairs staff in Istanbul or Ankara did not use GIS in response operations. They do not have the technical personnel to develop and maintain such a system.

Remote Sensing/Satellite Imagery:
Remote sensing images were requested on the second day following the earthquake in order to provide spatial images of the deformation created by the earthquake and the damage to the affected cities. Regrettably, these images still had not been received – either from the U.S., France, or the European Community – by September 15, 1999. The Office of Disaster Affairs received word that the images had been taken and processed and would be relayed to them by September 16, 1999. This late delivery meant that the data were not available to guide search and rescue operations during the urgent first phase of the disaster.

Turknet
The Seismology Section of the Earthquake Research Department, Government of Turkey, operates Turknet, a network of 19 seismology stations located throughout Turkey. This network monitored the aftershocks and transferred data electronically to the central computer in Ankara. This network was already in place and operating prior to the main shock. Some sub-stations in the network were affected by the earthquake, but these were repaired immediately and the network continued to monitor the aftershocks in the region. More than 2,400 aftershocks of varying magnitudes were recorded, as of September 4, 1999. This seismic monitoring network provided valuable scientific data for the study of this event.

The first three days were both the most urgent in terms of conducting life-saving search-and-rescue operations and the most chaotic in terms of organization of response operations. To a large extent, the lack of coordination among the multiple organizations that converged at the scenes of heaviest damage in the disaster area was due to a lack of adequate communication and consequently, accurate information on where and how to mobilize search and rescue operations.

Days 4 - 7:
While Turk Telecom had partially reinstated telephone communication through central communication centers in key cities in the disaster area over the first three days, by Day 4 they had successfully reinstated telephone communications in major areas. They used mobile communications units to restore basic operations while they repaired the lines. Cell phone bases were being restored, and cell phones were operating within limited ranges. Central government ministries had communications largely restored, but many local governments had limited access to telephone lines. Nonprofit organizations also had limited access to telephone lines during this period.. Motorola Company distributed Iridium satellite telephones, but these telephones need an open area for clear transmission, and they did not function well for most uses in the disaster environment[11].

During this period, 26 international search-and-rescue teams arrived from 21 countries to offer assistance to search-and-rescue operations in the difficult context of collapsed concrete buildings and severely damaged infrastructure. This was an operating environment in which information was critical, but in most cases, extremely limited. Some international teams brought their own communications equipment, but not all. Turkish Amateur Radio Club (TRAC) operators sought to provide communications between the teams and the local Emergency Operations Centers, but not all international teams had radio equipment or operators trained in international standards.

The need for detailed information on local infrastructure, building floor plans, location of equipment and trained personnel was crucial to the mobilization of disaster operations. In most cases, this information, if available, was located in paper files and official emergency plans, which were not always current. The local response organizations suffered a double blow, as many of their own personnel were injured or killed, and knowledge gained from local experience was then unavailable to personnel who arrived from outside the area to assist the damaged cities.

Incoming managers kept daily logs of actions taken, number of personnel engaged in disaster operations, types of equipment and amount of supplies used, but these logs were largely informal records written on paper under the stress of emergency conditions.

After the response operations began to stabilize, managers at town and provincial levels began to establish electronic records to document disaster operations and to organize the information for their respective jurisdictions to submit to the Crisis Management Center operating under the jurisdiction of the Prime Minister. These reports, coming from all the disaster-affected cities and provinces, allowed the Office of Disaster Affairs to create a profile of the overall event.

During this period, the Earthquake Research Department, Government of Turkey, created a WEB page to make information on the event available to the national and international community via the Internet. The URL for this Web page is: http://www.deprem.gov.tr/kocaeli/kocaelieq.htm The data on this WEB page was updated as conditions changed in order to provide current information to all interested parties. This continuing account of the earthquake and its consequences was followed extensively by organizations within Turkey and within the international community as a basis for providing assistance to the residents of the affected area.

Days 8 - 21:
After the first week, communications were largely restored, and information needs shifted to the formidable tasks of detailed damage assessment and reimbursement for losses of life and property; managing the distribution of aid – both national and international; managing the tent cities that were created for people who lost their homes; managing the demolition process for the severely damaged and collapsed buildings, and planning and managing the reconstruction process. These activities are vulnerable to distortion under the stress of disaster, and require timely, accurate processing of information to maintain credibility of government operations in a difficult environment. Computers were being used at all levels of government, but it remains a formidable task to organize the information processes so that the transmission of information among the levels of government and between the affected people and the government is clear,

accurate and timely. This process was underway, but not fully established at most levels of government. The provincial government of Yalova had established an organized process for managing its information, and the response operations were moving to recovery in an orderly and efficient way. The City Government benefited from experienced personnel and contributions and assistance from the near-by military base.

By the second week, Crisis Management Centers were operating at each governmental level – town, city, province, national – as well as in most participating ministries and organizations. The network of Crisis Management Centers both gathered and circulated a great deal of information orally through meetings and individual contacts. Although formal records were often not kept, these meetings proved to be valuable means of sharing information, building consensus, and gaining a more accurate perception of both needs and capabilities of people affected by this disaster.

7. Kinds and extent of information available to practicing managers at different levels of responsibility
A striking characteristic of the response system following the Marmara Earthquake was the extent to which critical information regarding the status of the damaged Marmara cities and towns and their affected populations did not reach the upper levels of the national ministries until two days after the event. On the first day, there was no communication with the damaged cities. On the second day, limited communication was established between Ankara and the disaster area, and only then did the Office of Disaster Affairs learn the true scope of the disaster. After the third day, direct communication between the Ministries in Ankara and the disaster area was re-established, but the gaps in communication in the first three days severely limited timely response to the disaster. The effect of this gap was accentuated by the centralized management of disaster response specified in Turkey's Disaster Law, No. 7269, intended to facilitate rapid national response to an urgent disaster.

8. Information exchange and utilization among organizations participating in disaster response
While the field interviews provided no direct, quantitative measure of information exchange and utilization related to technologies available, all 21 managers made strong, qualitative statements regarding their inability to transmit, receive, or access information from other sources during the first three days when communications were largely unavailable. Without the technical infrastructure for communications, coordination of action among the many organizations with responsibilities for disaster operations was extremely difficult at best and painfully inefficient at worst. Our continuing search for action logs from the response organizations will provide more specific data on this critical question. Informed observation, reported by practicing disaster managers, indicates that coordination increases among response organizations proportionately with timely access to accurate information.

9. Adaptive change among organizations participating in disaster operations
Without quantitative measures of increased use of information technologies in disaster operations, it is difficult to establish that adaptive changes occurred as a result of such use. However, several practicing managers interviewed in the field study indicated they were making adaptive changes in their own organizations and also in interactions with others due to an inability to communicate with other organizations under the urgent requirements of disaster response. Civil Defense has decided to purchase satellite phones to facilitate communication and

coordination in disaster response. Civil Defense also has a model information system that it is proposing to develop, and has won early approval for the implementation of the system. The information system would use GIS and build detailed knowledge bases for known areas of seismic risk in the nation. TRAC proposed a set of requirements for international search and rescue teams that would enable them to establish immediate communication, and thus capacity for improved coordination with the local Emergency Operating Centers. Kizilay used computers to maintain records and facilitate management of the large tent cities, some with 12,000 to 20,000 residents. The Ministry of Foreign Affairs used computers to record the amount and type of incoming international aid, and to channel its distribution to those who need it most. These are instances of adaptive change that have occurred not only through increased use of information technologies, but more importantly through acute awareness of the disadvantages caused by not having these technologies readily available during disaster operations.

10. Relationship between performance in response operations and timely transition to recovery
Disaster operations were just moving into recovery as the Marmara Earthquake field study began. Search and rescue operations were largely over, as disaster operations moved past Day 21, but the heavy demolition work usually associated with response was still under way in the seriously affected cities and towns, such as Golcuk, Izmit, and Sakarya. Issues of public health, sanitation and immediate shelter were still demanding time and attention. The transition to recovery cannot be separated from the size and scope of the disaster, and in the case of Turkey, the Marmara Earthquake was a large, complex and catastrophic event. The chaotic first days of disaster operations likely generated conditions that placed greater demands on recovery. There are also likely instances in which quick actions taken through informed decision hastened the recovery of the city, e.g. the rapid location and establishment of the tent cities in Yalova, accompanied by a planning process for rebuilding. Engaging the people who suffered losses in the process of their own recovery, as demonstrated by Kizilay, is a strategy based on previous experience, but used in this instance to mobilize the resources of the people who suffered damage in their own recovery.

11. The Evolving Disaster Response System: Organizational Actors in the Duzce Earthquake
When the Duzce Earthquake occurred on 12 November1999 less than four months after the Marmara Earthquake, many of the personnel and organizations that responded had also been engaged in disaster operations in the 17 August event. For example, the Deputy Governor of Duzce had participated in disaster operations in Golcuk, one of the towns most heavily damaged in the Marmara Earthquake. He reported that he and his colleagues had learned a lot from their experience in the Marmara Earthquake, and had revised their own emergency plans accordingly.[12] One of their first tasks in response operations following the 12 November earthquake was to establish an information-processing center in order to collect information from different sources and to communicate reliable information to other organizations and the public.

Most importantly, many of the managers responsible for disaster operations in Duzce had met and worked with emergency response personnel from national and provincial organizations in the Marmara disaster operations. Consequently, emergency managers in Duzce knew what resources were available, where they were located, who to contact, and how to access them. For example, a military unit had stored supplies in Duzce that had been intended for use in the Marmara operations. Aware that needed supplies were in the immediate area, the General

Director of Civil Defense, Duzce, requested, and received, these supplies for quick response to the urgent needs of their affected population.[13] Emergency response personnel from many cities and provinces in Turkey arrived in Duzce within hours after the earthquake, demonstrating experience and training gained by their participation in the earlier Marmara Earthquake. International teams arrived the next day, bringing needed equipment and technical skills for search and rescue operations.

Through an analysis of newspaper reports for three weeks following the event (*Cumhuriyet*, Istanbul, November 13 - December 4, 1999) and a series of field interviews with practicing managers in Duzce and Ankara (May 1-5, 2000)[14], a total of 76 organizations were identified as participating in response operations to the Duzce Earthquake. This number included 15 national ministries, 27 provincial and municipal organizations, 10 nonprofit organizations and universities, and 24 international search and rescue teams and charitable organizations. This list, presented in Appendix B, is likely only a partial list, as the activities of many local organizations may not have been reported in the Istanbul newspaper. Yet, all of the national organizations, most of the nonprofit organizations and many of the provincial or municipal organizations included on this list had also participated in the Marmara Earthquake disaster operations. The laws regarding disaster operations and assistance that were in effect for the Marmara Earthquake were essentially the same for the Duzce Earthquake, but the awareness of the organizational personnel and citizenry had increased, resulting in more informed action and quicker response.

12. Status of the Information Infrastructure in Disaster Operations, Duzce Earthquake
The technical information infrastructure suffered similar damage following the Duzce Earthquake
as in the Marmara Earthquake of 17 August 1999. Telephone communications failed, bases for cellular phones were inoperative, and electrical transmission lines were knocked down. Turkish Radio Amateur Club (TRAC) again provided the only means of communication available on the first day following the earthquake. Responsible managers, informed by the experience of the Marmara Earthquake, acted quickly to request assistance from other agencies, e.g. Turk Telecomm and local military bases, that provided mobile communications units to the area.[15] By the third day, limited communication was available, although telephone lines were overloaded. By the fifth day, November 17, 1999, both electricity and communications had largely been restored.

The Turkish military also aided in damage assessment to the area by providing a helicopter that overflew the area to assess damage in the cities and towns and infrastructure of the region on the first day after the earthquake. This assessment was supplemented by observations made during a reconnaissance flight from Istanbul to Duzce made by the Turkey/US Geotechnical Earthquake Reconnaissance Team during their field trip, November 17-20, 1999.

Although the physical information infrastructure in Duzce prior to the 12 November earthquake was essentially the same as existed in the cities and towns affected four months earlier by the Marmara Earthquake, emergency managers adapted quickly to incorporate the use of computers and telecommunications to support data management, record keeping and decision making for the organization and distribution of disaster assistance and recovery operations.[16] Geographic information systems were not in place prior to the disaster, but managers in Duzce had learned of the potential of GIS to provide decision support in the Marmara Earthquake and were actively

considering the development of such a system for Duzce in May, 2000.[17] The Crisis Management Centers, central to Turkish disaster management under Disaster Law No.7269, were activated in each town and major response agency following the Duzce Earthquake, and functioned more effectively with knowledge gained from observation of the process during the Marmara Earthquake. In sum, public managers and emergency response personnel adapted the existing information infrastructure to the needs of the disaster environment more quickly and effectively following the Duzce Earthquake, given their experience and observations gained during the Marmara disaster operations.

13. Elements of Adaptive Learning from Earthquakes

Returning to the question of whether communities learn from their experience in earthquakes, the two cases in Turkey offer positive evidence of instances of organizational learning, although other factors inhibited region-wide systemic learning. Four factors in particular indicate evidence of adaptive learning. First, the enormous size, scope and impact of the Marmara Earthquake upon ten cities and towns simultaneously underscored the limitations of the existing information infrastructure to cope with an event of that magnitude. These obvious limitations led to widespread recognition of the close interdependence between means of communication, information access and exchange, and timely, informed decision making. The slow, inefficient response by government agencies to the Marmara Earthquake was widely observed, and acknowledged as the result of inadequate information processes. This observation was accepted as a major starting point for needed improvement in disaster mitigation and response by both government officials and citizens that benefited emergency managers in their requests for assistance following the Duzce Earthquake.

Second, the recognized need for improved community information processes led to the adoption of a wider perspective among policy-makers that included organizations, policy makers, machines, and lifeline systems as important components of the information infrastructure. This sociotechnical infrastructure, in turn, shaped the community's capacity to respond effectively to risk and disaster. This perspective, beginning to emerge in the aftermath of the Marmara Earthquake, developed more clearly in disaster operations following the Duzce Earthquake, as responsible managers moved quickly to put communications and information systems in place. They understood the importance of getting prompt, reliable information to the affected townspeople in order to enable them to cope with their losses more effectively.

Third, drawing on lessons learned from their experience in the Marmara Earthquake, emergency managers at national, provincial and local levels of government in Turkey recognized the centrality of information processes in facilitating the coordination of complex disaster response operations among the participating jurisdictions. Local officials acted upon this insight in managing the disaster operations in response to the Duzce Earthquake, and stated their commitment to the development of a GIS for the region to be used in reconstruction of the city and for mitigation of future risk [18]

Fourth, local officials in Duzce clearly considered new uses of information technology as a means of facilitating recovery for their community, with the entire population of 80,000 sleeping in tents immediately after the earthquake for fear of aftershocks, and many households experiencing serious trauma twice within the short space of four months. Major problems of restoring safe places to live and work, and replacing jobs lost through the destruction of

workplaces required new means of connecting with external sources of support and assistance. Information technology offered valuable access to a wider range of resources. Although these connections were still being initiated, national agencies in Ankara established Web sites accessible to the smaller cities to provide updated information on government programs and services via the Internet. This was clearly a new direction that contributed to the damaged communities' capacity to learn from their experience following the earthquake.

Conversely, while these factors facilitated organizational learning after the Marmara and Duzce Earthquakes, other factors inhibited the full evolution of learning processes. Many proved to be the obverse of conditions mentioned above, such as, inadequate communication facilities within and between participating response organizations; inadequate technical capacity and training for response personnel; inadequate means of information management or personnel with skills in information technology, communications, and analysis; and a relatively brief time for reflection, review and reconsideration of policy and practice over the scant period of four months.

15. Steps Toward Developing a Complex Adaptive System for Seismic Risk Reduction in Turkey
To what extent do the emerging factors of adaptive learning following the 1999 Marmara and Duzce Earthquakes in Turkey constitute the basis for continuing development of an effective system of seismic risk mitigation and response? Returning to the conceptual model of a complex adaptive system proposed by Axelrod and Cohen, we find preliminary concepts and practice that could be used to build a strong, resilient CAS to facilitate seismic risk reduction and response in Turkey. In their identification of components as central to the development of CAS, Axelrod and Cohen view interacting agents as basic to initiating strategies of change in policy and practice. An initial set of agents that are essential to changing policy and practice for seismic risk mitigation in Turkey has clearly evolved from the experience of the Marmara and Duzce Earthquakes. This set includes the list of organizations identified in disaster response operations presented in Appendices A & B, but also includes the subset of technical systems and programs that have been proposed for further development by the Office of Disaster Affairs, Civil Defense, and municipal offices of disaster preparedness. Further, it includes the non-profit organizations, both national and international, that are proposing programs of public education and training for residents of areas vulnerable to seismic risk. Although new agents may evolve, the existing set of agents clearly has begun the process of initiating change in systemic practice for seismic risk mitigation in Turkey.

The next stage of developing strategies that can lead to effective change is also underway. This process is evident, for example, in the large program currently being financed by the World Bank as the Marmara Earthquake Emergency Reconstruction Project.[19] It is also evident in the plans of municipalities to revise their emergency plans and to develop the skills and technologies to support the continuous monitoring of seismic risk and its likely impact upon their communities.[20] But even as separate strategies evolve, it is clear that the coordination of these emerging strategies is vital to achieve a comprehensive, effective result. It is not clear, however, that the organizational functions within and among local, provincial and national jurisdictions are sufficiently developed to ensure this desired result.

Third, Axelrod and Cohen identify the role of populations as providing a range of choices in determining the "fitness" of a given strategy or action to achieve the desired change. The categories of populations relevant for seismic mitigation are still under development in Turkey. As the interactions among agents – public, private and nonprofit organizations, computer systems, GIS knowledge bases and international study and assistance teams – increase, different types of populations will evolve that will allow an important range of options for selection of strategies of action at different levels of responsibility and action. The critical factor in the evolution of complex adaptive systems is the process of choosing strategies for action that fit appropriately the needs of the population that is affected by them. Selection among different strategies of action is a difficult process for Turkish society, where a tradition of centralized government and respect for authority has led to long-standing patterns of acceptance of authoritative action without challenge. The failure of existing organizational mitigation and response strategies was evident in the Marmara and Duzce earthquakes, but there is some evidence that change is beginning to occur. After the Marmara Earthquake, 90 professional organizations, associations, foundations, nonprofit and voluntary organizations acted to challenge governmental authorities to improve performance in disaster relief activities and to acknowledge the substantive roles played by nongovernmental organizations in response operations (See Appendix C). This action was a significant expression of dissatisfaction with existing governmental performance and represents an organized effort by civic and professional groups to initiate change. While such popular expression is an important indicator of the need for change in governmental performance, Turkish disaster managers will likely face a continuing challenge to develop norms of informed choice that will enable responsible selection among alternative strategies of risk reduction within their communities based upon fitness in performance (Balamir 1999). This is exactly the process of "harnessing complexity" to which Axelrod and Cohen (1999) refer.

The capacity for informed selection among different strategies of action for risk reduction is further related to the clarity and acceptance of the overall goal for seismic risk mitigation for the society. This goal is not yet wholly understood or accepted broadly within Turkish society. Developing, articulating and disseminating the primary goal of seismic risk reduction and response is a major task for the evolution of a complex adaptive system in Turkey. This task runs counter to the traditional concept of fatalism that is deeply embedded in Turkish culture.[21] The "fatalist society," according to Murat Balamir (1999), is one is which the occurrence of natural disasters is accepted by the population as events that cannot be avoided. Consequently, little care is taken to minimize vulnerability to natural hazards or to reduce risk of hazardous effects upon the built and organizational infrastructure. Developing the awareness that choices are possible and the skills and
knowledge to distinguish "fit" choices from poorer choices are primary tasks for communities exposed to seismic risk.

*Conclusion*s
Our inquiry into organizational learning processes following disaster identified five major factors that contribute to creating an environment that supports the capacity of communities to learn from these traumatic experiences. These factors are:

A well-developed information infrastructure that is operational prior to the disaster. Such an

information infrastructure includes not only the technical equipment and machines to support the rapid search, exchange and analysis of information relevant to seismic risk and its impact upon the community, but also the organizational skills and training of relevant personnel to integrate timely information into action effectively.

Clear identification of the agents that are involved in the implementation of policy and practice for seismic risk reduction and response. This set of agents includes organizations, machines, policy makers and databases or computer programs that are capable of interacting to provide informed advice or a range of options for action under specified conditions.

Specification of a set of strategies that may be applicable in different locations under different conditions for risk mitigation and response, with definition of the criteria of "fit performance" as the basis for selection among the different strategies.

4. Means of identifying and organizing the different populations that are affected by the different strategies of action, including the means so identified as a `population' of means.

Clear articulation of the goal of a "learning society" as one that is capable of seeking new information, concepts and methods to reduce seismic risk as well as developing the skills, knowledge, and practice to sustain the society-wide learning process.

REFERENCES

Argyris, Chris. 1982. *Reasoning, Learning and Action: Individual and Organizational*. San
    Francisco: Jossey-Bass.
Argyris, Chris. 1993. *Knowledge for Action: A Guide to Overcoming Barriers to Organizational
    Change*. San Francisco: Jossey-Bass.
Axelrod, R and M.D. Cohen. 1999. *Harnessing Complexity*:
Bak, P. 1996. *How Nature Works: The Science of Self-organized Criticality*. New York:
    Copernicus.
Balamir, M. 1999. "Reproducing the Fatalist Society: An Evaluation of the "Disasters" and
    "Development" Laws and Regulations in Turkey." In Emine M. Komut, ed. *Urban
    Settlements and Natural Disasters: Proceedings of UIA Region II Workshop.* Ankara,
    Turkey: Chamber of Architects of Turkey. 1999: pp. 96-107.
Cohen, M.D., J.G. March and J.P. Olsen. 1972. "The Garbage Can Model of Organizational
    Choice." *Administrative Science Quarterly*. Vol. 17, No. 1(March):1-25.
Comfort, L.K. 1999. *Shared Risk: Complex Systems in Seismic Response*. Oxford and New York:
    Pergamon Press.
Comfort, L.K. 2000. *Information Technology and Efficiency in Disaster Response: The
    Marmara, Turkey Earthquake, 17 August 1999.* Boulder, CO: University of Colorado,
    Natural Hazards Center QR130. 28 June.
Comfort, L., Y. Sungu, D. Johnson and M. Dunn."Complex Systems in Crisis: Anticipation and
    Resilience in Dynamic Environments." *Journal of Contingencies and Crisis
    Management.* (Submitted, 1999: In press.)
Comfort, L.K., Y.Sungu and Z. Colakoglu. 1999. *"*Information Technology and Efficiency in
    Disaster Response: The Marmara, Turkey Earthquake, 17 August 1999." Kobe, Japan:
    Research Center for Urban Safety and Security. Field Research Report. November 20,
    1999.
Comfort, L.K. and Y. Sungu. 2000. "Information Processes in the Duzce Earthquake, 12
    November 1999. Field Research Report." Pittsburgh: University of Pittsburgh.
Cumhuriyet, Istanbul, Turkey. August 17 - September 7, 1999; November 13 - December 4,
    1999.
Earthquake Engineering Research Center of Bogazici University: http://www.koeri.boun.edu.tr/
    earthqk/losses.htm.
Government of Turkey. 1959. National Disaster Law No. 7269. Ankara: Turkish Parliament.
Government of Turkey. 1999. Web site: http://www.deprem.gov.tr/kocaeli/kocaelieq.htm
Graber, D.1992. *Public Sector Communication: How Organizations Manage Information.*
    Washington, DC: Congressional Quarterly, Inc.
Kahneman, D., P. Slovic, A. Tversky, eds. 1982. *Judgment under Uncertainty: Heuristics and
    Biases*. Cambridge ; New York : Cambridge University Press.
National Research Council. 1996. *Computing and Communications in the Extreme*. Washington,
    DC: National Academy Press.
Schein, E.H. 1992. *Organizational Culture and Leadership.* San Francisco: Jossey-Bass, 2nd ed.
Schon, Donald. 1983. *The Reflective Practitioner: How Professionals Think in Action.* New
    York: Basic Books.
Schon, Donald. 1987. *Educating the Reflective Practitioner:Toward a New Design for Teaching*

and Learning in the Professions. San Francisco, CA.: Jossey-Bass.

Turkey/US Geotechnical Reconnaissance Team. 1999. "The 12 November 1999 Bolu-Duzce Earthquake." Ankara, Turkey: Disaster Management Implementation and Research Center, Middle East Technical University. http://www.metu.edu.tr/home.wwwdmc/1712eqs.e.htm;

United States Geological Survey. 1997. Significant Earthquakes. Denver, CO: National Earthquake Information Center.

World Bank. "Project Appraisal Document on a Proposed Loan in the Amount of US $505 Million to the Republic of Turkey for a Marmara Earthquake Emergency Reconstruction Project." Europe and Central Asia Region, Report No. 19844-TU,

APPENDIX A

Marmara, Turkey Earthquake, 17 August 1999:

Types of Organizations Involved in Disaster Response Operations

Public: Local

No.	Public: National	No.	(Provincial & Municipal)	No.	Nonprofit Organizations	No.	International: Public
1	Prime Ministry: Crisis Mgt Center	1	Governor's Office, Istanbul (appointed)	1	Kizilay: Red Crescent	1	Algeria
2	Min. of Health	2	Mayor, Istanbul (elected)	2	Turkish Pre-prepared Concrete Association	2	Australia
3	Min. of Energy & Natural Resources	3	Governor's Office, Kocaeli (appointed)	3	Chamber of Civil Engineers: Istanbul	3	Austria
4	General Directorate of State Hydraulic Works	4	Mayor, Izmit Municipality (elected)	4	Chamber of Geophysical Engineers	4	Azerbaijan
5	Min. of Public Works & Settlement	5	Governor's Office, Sakarya (appointed)	5	Chamber of Architects	5	Bahrain
6	Gen. Directorate, Disaster Affairs	6	Mayor, Adapazari Municipality (elected)	6	Chamber of City Planners	6	Bangladesh
7	General Directorate, Highways and Roads	7	Kaymakam, Golcuk (appointed)	7	AKUT: Search & Rescue Team	7	Belgium
8	Min. of Environment	8	Mayor, Golcuk (elected)	8	TRAC: Turkish Amateur Radio Club	8	Bulgaria
9	Min. of Transportation	9	Governor's Office, Yalova (appointed)	9	Marmara & Bosphorus Municipalities Association	9	Canada
10	Min. of Finance	10	Mayor, Yalova (elected)	10	Chamber of Commerce: Ankara	10	China
11	Min. of Foreign Affairs			11	Turkish Earthquake Foundation	11	Croatia
12	National Security Council			12	Izmit State Hospital	12	Cuba
13	Min. of Internal Affairs			13	Izmit City Congress	13	Czech Republic
14	Religious Affairs		*Provinces and Municipalities That Sent Aid*	14	Yildiz Technical University, Mountaineering Club	14	Denmark
15	General Directorate of Public Safety	11	Adana	15	Chamber of Industry, Istanbul	15	Egypt
16	General Directorate of Civil Defense	12	Afyon	16	New Yuksektepe Cultural Association	16	England
17	Turkish Electricity Production Corp.	13	Aksaray			17	European Space Agency
18	Turkish Electricity Distribution Corp.	14	Ankara			18	European Union
19	Turkish Coal Authority	15	Antalya	**No.**	**Universities**	19	Finland
20	Turkish Petroleum A.S.	16	Aydin	17	Kandilli Observatory, Bogazici Univ.	20	France
21	BOTAS, Natural Gas Distribution	17	Baliskesir	18	Bogazici Univ., Earthquake Engineering	21	Georgia
22	Turkish Armed Forces	18	Bartin	19	Istanbul Technical University	22	Germany
23	Min. of Agriculture & Rural Affairs	19	Bursa	20	Middle East Technical Univ.: Disaster Mgt. Ctr	23	Greece
24	Gen. Directorate, Rural Affairs	20	Canakkale			24	Holland
25	Turk Telecom	21	Denizli			25	Hungary
26	Prime Ministry, Housing Development Administration	22	Edirne			26	Iceland
27	Customs	23	Eskisehir			27	Iraq
		24	Isparta			28	Ireland
		25	Izmir			29	Israel
		26	Kastamonu			30	Italy
		27	Kayseri			31	Japan
		28	Kirsehir			32	Japan International Cooperation A
		29	Konya			33	Kazakhstan

30 Kutahya	34 Kirghizstan
31 Nigde	35 Korea
32 Sivas	37 Kuwait
33 Usak	38 Malaysia
34 Zonguldak	39 Mexico
	40 Moldavia
	41 Morocco
	42 New Zealand
	43 Northern Cyprus Turkish Republi
	44 Norway
	45 Poland
	46 Portugal
	47 Romania
	48 Russia
	49 Saudi Arabia
	50 Slovakia
	51 Slovenia
	52 Spain
	53 Sweden
	54 Switzerland
	55 Syria
	56 Turkmenistan
	57 Ukraine
	58 UNICEF
	59 United Arab Emirates
	60 United Nations: UNCR
	61 USA
	62 Uzbekistan
	63 World Bank

Total Number of Organizations Identified: 144

Cumhuriyet, 18 August - 7 September, 1999

Milliyet, 18August - 7 September, 1999

APPENDIX B

Types of Organizations Involved in Disaster Response Operations

No.	Public: National	No.	Public: Local (Provincial & Municipal)	No.	Nonprofit Organizations	No.	International: Public
1	Prime Ministry, Crisis Management Center	1	Governor's Office, Duzce Prov	1	Kizilay (Red Crescent)	1	Algeria
2	National Security Council	2	Duzce Municipality	2	Antalya AKUT Search & Rescue Team	2	Austria
3	Ministry of Health	3	Governor's Office, Bolu Prov	3	New Yuksektepe Cultural Association, SAR team	3	Belgium
4	Ministry of Internal Affairs			4	IZAS (Izmit Kitchen)	4	Bulgaria
5	General Directorate, Public Safety			5	Bolu State Hospital	5	Checzk Republic
6	General Directorate, Civil Defense	No.	Provinces and Municipalities That Sent SAR, Fire Teams and Aid	6	Chamber of Civil Enginneers, Izmir	6	Denmark
7	Ministry of Labor and Social Security	4	Ankara	7	Turkish Radio Amateur Club	7	England
8	Ministry of Transportation	5	Antalya			8	France
9	Ministry of Energy & Natural Resources	6	Aydin			9	Germany
10	General Directorate of State Hydraulic Works	7	Balikesir	No.	Universities	10	Greece
11	Min. of Agriculture & Rural Affairs	8	Bartin	8	Istanbul Technical University	11	Hungary
12	Gen. Directorate, Rural Affairs	9	Cankiri	9	Bogazici University, Kandilli Observatory	12	Ireland
13	Ministry of Public Works and Settlement	10	Corum	10	Middle East Technical University	13	Israel
14	Turkish Armed Forces	11	Denizli			14	Italy
15	Turkish Coal Authority	12	Edirne			15	Japan
		13	Erzincan			16	North Cyprus Turkish Republic
		14	Erzurum			17	Poland
		15	Eskisehir			18	Romania
			Istanbul			19	Russia
		16	Izmir			20	Slovenia
		17	Izmit			21	Sweeden
		18	Karabuk			22	Switzerland
		19	Kayseri			23	Ukraine
		20	Konya			24	UNICEF
		21	Manisa				
		22	Mugla				
		23	Samsun				
		24	Tekirdag				

25 Trabzon
26 Usak
27 Zonguldak

Total number of organizations identified through newspaper reports following the Duzce Earthquake: 76
Cumhuriyet, Istanbul, November 13 - December 4, 1999.

Cumhuriyet, Istanbul, September 1, 1999

Newspaper Campaign of Professional Organizations, Foundations, Associations and Voluntary Organizations urging the Turkish government to correct its mistakes in relief activities by acknowledging the role of civic groups and non-governmental organizations involved in response activities.

1. Foundation of the Union of 68 Generation
2. Mother-Culture
3. Ari Idea and Societal Development Foundation
4. Atakoy , Friends of Environment Association
5. Initiative for Enlightenment
6. Bebek Association
7. White Point Foundation
8. Bosphorus University Alumni Assoc.
9. Modern Cinema Actors/Actress Assoc.
10. Association for Supporting Modern Life
11. CARE-SIZ Movement
12. Cihangir Beautification Association
13. Stocking Producers Association
14. Alumni Association of School for Orphans
15. Civil Coordination for EQ
16. Peace with Nature Association
17. Mimar Sinan University, Academy of Fine Arts Alumni Association
18. DISK
19. Friends Solidarity Association
20. Academy of World Local Government and Democracy (WALD)
21. Egitim-Sen
22. ENSAR Foundation
23. Movie Producers Assoc.
24. Genc Halkevleri
25. HAYAD
27. Sculptor Association
28. Chamber of Interior Designers - Marmara branch
29. Association for Dissemination of Science
30. Human Rights Assoc. - Istanbul branch
31. Habitat for Humanity Assoc.
32. Assistance for Humanity Foundation
33. Istanbul Pharmacist Assoc.
34. General Secretary for Coordination of Istanbul Chambers of Professional
35. Istanbul City Theaters Artist Assoc.
36. Istanbul Chambers of Veterinary
37. Istanbul Help Group

38. KADER
39. Female Labor Valuation Foundation
40. Human Rights of Women Project
41. Quality Assoc.
42. Caricaturist Assoc.
43. Wholesale Bookseller Assoc.
44. Bookseller Assoc.
45. Kocaeli Chambers of Medical Doctors
46. Lokman Hekim Health Assoc.
47. M.S.M. Education Art and Culture Assoc.
48. MAZLUM-DER Istanbul branch
49. Chamber of Architect, Istanbul branch
50. Civil Servants Assoc.
51. MUSIAD
52. Nazim Hikmet Assoc.
53. METU Alumni Assoc., Istanbul Branch
54. Union of University Faculty Members, Istanbul branch
55. Union of University Faculty Members, Mersin branch
56. Union of University Faculty members, METU branch
57. Orhan Apaydin Democracy and Peace Foundation
58. PEN Writers Assoc.
59. Advertisers Assoc.
59. Advertisement Foundation
60. Rifat Ilgaz Culture Center
61. SINE-SEN
62. Civil Rights Assoc.
63. Social Democracy Foundation
64. Grassroot Movements
65. Theater Critics Assoc.
66. Theater Actors Assoc.
67. Tricot Producers Assoc.
68. Turkish Social Sciences Assoc.
69. TURK-IS
70. Turkish Kidney Foundation
71. Turkish State Opera, Theather and Ballet Workers
72. Turkish Education Volunteers Foundation
73. Turkish Economic and Social Research Foundation
74. Turkish Economic and Societal History Foundation
75. Turkish Handicapped Sport and Education Foundation
76. Turkish Erosion Prevention Foundation
77. Turkish Journalist Union
78. Turkish Clothing Industrialist Assoc.
79. Turkish Volunteers Foundation
80. Turkish Travel Agencies Assoc.
81. Turkish Movie and Audiovisual Culture Foundation
82. Turkish Publishers Assoc.

83. Turkish Writers Union
84. Turkish Greece Friendship Assoc.
85. Ugur Mumcu Journalism Foundation
86. National Strategy Club
87. International Plastic Arts Assoc.
88. University Faculty Members Assoc.
89. Yesilyurt Lions Club
90. Youth for Habitat

[1] See, for example, the series of interdisciplinary reports on causes of failure in the built environment, published by the Earthquake Engineering Research Institute in its program, "Learning from Earthquakes."

[2] For example, the city of Erzincan, Turkey, located in Eastern Turkey on the Anatolian Fault, has suffered severe damage from three major earthquakes in the 20th century, and over 1,000 earthquakes in its recorded history. U.S. Geological Survey. *Chronological Record of Significant Earthquakes*. Golden, Colorado.

[3] This account relies upon observations and experience reported by practicing disaster managers at city, provincial and national levels of administration in a set of interviews in Duzce and Ankara, Turkey, April 28, 2000; May 1 - 5, 2000.

[4] "Law Concerning the Precautions and Help to be Maintained against Disasters' Effect on Public Life." Law on Disasters, No. 7269. 1959. Ankara, Turkey: Turkish Parliament.

[5] After the Duzce Earthquake, 12 November, 1999, Duzce was declared a province.

[6] The fatalities were listed by city as:

Golcuk:	4,151
Kocaeli:	4,083
Sakarya:	2,646
Yalova:	2,492
Istanbul:	976
Bolu:	264
Bursa:	256
Eskisehir	85
Zonguldak:	3
	14,936

[7] Please see Web page, http://koeri.boun.edu.tr/earthqk/losses.htm.

[8] These figures were cited on the homepage of the Earthquake Engineering Research Center of Bogazici University: http://www.koeri.boun.edu.tr/earthqk/losses.htm.

[9] Interview, H. Guler, Deputy Director, Office of Disaster Affairs, Ankara, Turkey, September 14, 1999.

[10] This section relies heavily on a research report submitted to the Natural Hazards Center, Boulder, CO. "Information Technology and Efficiency in Disaster Response: The Marmara, Turkey Earthquake, 17 August 1999." QR130. 28 June 2000.

[11] Summary Report, Turk Telecom Network Recovery, 17 August 1999 Earthquake, Ankara, Turkey, May 3, 2000.

[12] Interview, Deputy Governor, Duzce, Turkey, May 2, 2000.

[13] Interview, General Director, Civil Defense, Duzce, Turkey, May 2, 2000.

[14] This field study to Ankara and Duzce was supported by a research grant from the Office of Research, University of Pittsburgh, April 24 - May 5, 2000, and a travel grant from the University Center of International Studies, University of Pittsburgh.

[15] Interview, Salmis Karagoz, Deputy Manager, Turk Telecom, Ankara, Turkey, May 3, 2000.

[16] Interview, Deputy Manager for Shelter, Welfare, Red Crescent, Duzce, Turkey, May 2, 2000.

[17] Interview, Deputy Mayor, Duzce, Turkey, May 2, 2000.

[18] Interview, Deputy Mayor, Duzce, Turkey, May 2, 2000.

[19] World Bank. "Project Appraisal Document on a Proposed Loan in the Amount of US $505 Million to the Republic of Turkey for a Marmara Earthquake Emergency Reconstruction Project." Europe and Central Asia Region, Report No. 19844-TU, Ankara, Turkey, November 1, 1999.

[20] Interview, Deputy Governor, Duzce, Turkey, May 2, 2000.

[21] Murat Balamir, "Reproducing the Fatalist Society: An Evaluation of the "Disasters" and "Development" Laws and Regulations in Turkey." In Emine M. Komut, ed. *Urban Settlements and Natural Disasters: Proceedings of UIA Region II Workshop.* Ankara, Turkey: Chamber of Architects of Turkey. 1999.: pp. 96-107.