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Information Technology and Efficiency in Disaster Response: The Marmara,Turkey Earthquake, 17 August 1999

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ABSTRACT

This report presents preliminary findings from a field study of disaster response operations following the Izmit, Turkey, earthquake of August 17, 1999. First, it briefly states the initial conditions of the earthquake in western Turkey. Second, it briefly documents the sites and organizations visited during an eight-day field trip (September 8-16, 1999) to Turkey to study the uses of information technology in disaster operations. Third, outlines the uses of information technology observed in disaster response operations following this event. Finally, indicates ways in which further research regarding technical characteristics of the information infrastructure may be used to facilitate interorganizational learning and coordination to produce innovative performance in disaster management.

This field study was undertaken with financial support from the U.S. National Science Foundation through a Quick

Response Grant administered by the Natural Hazards Research and Applications Center, University of Colorado, Boulder; the Research Center for Urban Safety and Security (RCUSS), Kobe University, Nada, Kobe, Japan; and the Office of Disaster Affairs, Government of Turkey.

On this trip, I was joined by Yesim Sungu, a doctoral student in public policy at the University of Pittsburgh, and Dr. Nobuyuki Yoshida, a civil engineer and colleague at RCUSS, Kobe University. Ms. Sungu's native language is Turkish, and she served as our translator for the entire period of the study. During our field visit to the disaster sites in the provinces of Istanbul, Izmit, and Adapazari, we were also joined by Zahide Colakoglu, a staff analyst in the Office of Disaster Affairs, Government of Turkey, Ankara. Ms. Colakoglu served as a representative of the Office of Disaster Affairs, and provided invaluable assistance in gaining the cooperation of local administrators for the study. The Office of Disaster Affairs also provided a car and a driver to disaster sites in the provinces of Istanbul, Kocaeli, and Adapazari, and in Ankara. The participation of Ms. Colakoglu, as well as assistance with transportation, were welcome contributions by the Office of Disaster Affairs, Government of Turkey, to the field study, made in recognition of Turkey's shared interest in the development of a Global Disaster Information Network (GDIN) and the possible use of this case as a demonstration project for the uses of information technology in disaster management.

BRIEF DESCRIPTION OF THE IZMIT EARTHQUAKE AND ITS CONSEQUENCES

At 3:02 a.m. on August 17, 1999, a severe earthquake struck western Turkey. The earthquake was caused by a rupture of the North Anatolian fault, with the epicenter located 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. The Turkish Earthquake Research Department upgraded the magnitude of the shock to 7.4 the next day. The location of the epicenter was 40.70N, 20.91E; depth: 15.9 km.

The earthquake caused heavy damage in the provinces of Istanbul, Kocaeli, and Adapazari, with the cities of Izmit, Golcuk, Yalova, Sakharya, Avcilar, Duzce, Sapanca, and Korfez, Akyazi, and Golyaka suffering severe destruction and collapsed buildings. As of September 4, 1999, the Crisis Management Center, Government of Turkey, Ankara, reported 14,936 dead and 24,024 injured. Four cities suffered the most deaths, with deaths reported in five additional cities. The fatalities by city are:

Table 1

City	Number of deaths
Golcuk	4,151
Kocaeli	4,083
Sakarya	2,646
Yalova	2,492
Istanbul	976
Bolu	264
Bursa	256
Eskisehir	85
Zonguldak	3
Total	**14,936**

The earthquake struck the most heavily industrialized region of Turkey, inhabited by 45 million people, or nearly two-thirds of the population of the country. At least 50,000 households were reported destroyed or heavily damaged. The region is the center of economic production for the country, and the damage caused by the earthquake heavily impaired economic production. In addtion there were severe losses to both the population and technical infrastructure of the country. Thus, this case was an important setting in which to examine the conditions that both facilitate and inhibit the evolution of rapid response systems following disaster.

SITES/ORGANIZATIONS VISITED

I arrived in Istanbul at 11:30 p.m. on September 8, 1999, and Dr. Yoshida arrived separately just after midnight. We were met at the airport by Ms. Sungu and Ms.Colakoglu. We began our field study the next day, September 9, 1999, and concluded it on September 16, 1999. Since Dr. Yoshida and I had different research interests, we followed substantially different schedules, but shared some important interviews and visits. We decided to focus our field study on the four cities that had suffered the most damage and to conclude our study with visits to national ministries in Ankara. Following is a list of sites and organizations that I visited during this eight-day field trip:

Thursday, September 9, 1999, Istanbul
9:00 a.m.: Ali Toklu, General Directorate, Office of Disaster Affairs, Ankara
11:00 a.m.: Omer Suvari, Vice-mayor, Avcilar District, Istanbul
2:30 p.m.: Mustafa Erdik, Director, Center for Earthquake Engineering, Bogazi University
4:00 p.m.: Kandilli Observatory, Bogazici University, Istanbul

Friday, September 10, 1999, Kocaeli, Izmit Province
10:30 a.m.: Faruk Tumer, General Director, Office of Disaster Affairs, Kocaeli Province
11:00 a.m.: Nafis Bal, General Director, Public Works and Settlement
12:30 p.m.: Halim Dedeoglu, Coordinator, Kent Kurultayi (an umbrella organization representing 650 nongovernmental organizations that provide social services in disaster)
1:30 p.m.: Mr. Memduh Oguz, Governor, Izmit Province (Dr. Yoshida and I shared this interview with Professor Akabayashi's team from Tokyo Metropolitan University; Y.Sungu and Z.Colakoglu served as translators.)
2:30 p.m.: Ozer Kenar, Rektor Yardimcisi, Kocaeli University
3:30 p.m.: Aysun Ozyurt, Department of Education, Kocaeli University
4:00 p.m.: Emergency Operations Center, Izmit, Kocaeli Province
4:05 p.m.: Coordinator, Ministry of Health, Izmit, Kocaeli Province
4:15 p.m.: Vice Director, Rural Affairs, Izmit, Kocaeli Province
4:30 p.m.: Interview, Yusuf Yilmaz, Director, Civil Defense, Kocaeli Province

Saturday, September 11, 1999, Golcuk and Yalova, Izmit Province
11:30 a.m.: Cumhur Ersoy, Kaymakam (Town Governor), Golcuk
2:00 p.m.: Major, Turkish Army; Administrator, Tent City, Golcuk
4:00 p.m.: Yalova Crisis Management Center
4:15 p.m. Kaymakam, Termal (town close to Yalova)

Sunday, September 12, 1999, Adapazari Province
11:00 a.m.: Idris Kurtkaya, Vice Governor, Adapazari Province, Sakarya
12:00 noon: Press Briefing, President of Turkey, Suleyman Demirel, Tent City, Sakharya
1:30 p.m.: Tent City, Sakharya
1:45 p.m.: Yusef Bozel, Kizilay Board Member and Surgeon, Ankara, at Kizilay Headquarters, Tent City, Sakharya
2:30 p.m.: Saban Koludra, Kizilay General Manager, Ankara, at Tent City, Sakharya
4:00 p.m.: Idris Kurtkaya, Vice Governor, Adapazari Province, Sakharya

Monday, September 13, 1999, Istanbul City
9:00 a.m.: Istanbul City Crisis Management Center
10:00 a.m.: Ibrahim Tari, Vice Director, Civil Defense, City of Istanbul
11:15 a.m.: Aziz Sasa, Emergency Communications Officer, Vice President, Turkish Radio Amateur Club (TRAC)
12:30 p.m.: Nasuh Mahruki, President, AKUT, volunteer search-and-rescue team (telephone interview)
1:15 p.m.: Erhan Akol, Coordinator, Planning and Organization, Public Works and Settlement, Istanbul Province
2:30 p.m.: Emergency Operations Center, Istanbul City

Tuesday, September 14, 1999, Ankara
9:00 a.m.: Huseyin Guler, Deputy Director, Office of Disaster Affairs, Government of Turkey
11:00 a.m.: Rusen Keles, Department of Political Science, Ankara University
1:15 p.m.: Cevat Geray, Department of Political Science, Ankara University
2:00 p.m.: Yuzel Ozgun, General Director's Office, Civil Defense, Government of Turkey
4:00 p.m.: Nuray Curanci, Psychologist, Disaster Management Center, Middle East Technical University
7:00 p.m.: Rusen Keles, Department of Political Science, Ankara University

Wednesday, September 15, 1999, Ankara
9:45 a.m.: Office of Disaster Affairs, Government of Turkey
11:00 a.m: Polat Gulkan, Director, Disaster Management Center, Middle East Technical University
2:00 p.m.: Oktay Ergunay, former General Director, Office of Disaster Affairs, Governement of Turkey
3:30 p.m.: Satilmis Karagoz, Assistant Director, Technical Operation and Maintenance Department, Turk Telekom
6:30 p.m.: Return to Istanbul

Thursday, September 16, 1999
Depart Istanbul

USES OF INFORMATION TECHNOLOGY IN INTERORGANIZATIONAL RESPONSE TO DISASTER

This study explored the degree to which different types of information technology affect efficiency in interorganizational response to disaster. It examined the ways in which the technical characteristics of the information infrastructure facilitate the communication and learning processes among the many organizations engaged in disaster response, and the extent to which these processes contribute to innovative performance in a rapidly evolving disaster response system. The study had four research objectives:

1. To identify the information infrastructure used to support interorganizational coordination and performance in disaster response;
2. To identify, if possible, the frequency, direction, and duration of communications among the set of organizations participating in disaster response;
3. To assess, if possible, the extent to which technical and organizational characteristics combine to produce a shared knowledge base that supports collective action in disaster operations;
4. To identify the points of disruption and/or delay in information processes for the disaster response system and the consequences for interorganizational performance.

In order to achieve these objectives, the following research questions were posed:

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?
4. To what extent did increased efficiency and effective performance in disaster response actions (days 1-21) facilitate timely transition to recovery from disaster?

Three types of data were and are being sought for this study. First, operational logs, situation reports, and documentary records for a representative set of 30 organizations that participated in response operations are being gathered. This information is the most difficult to obtain, and the collection process is still underway. Second, with the assistance of Ms. Sungu and Ms.Colakoglu, I conducted a set of semistructured 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. Finally, we will also review professional reports as well as the media coverage of this event, using both print and Internet sources, to corroborate the survey and documentary data. This analysis began on August 17, 1999, and is continuing. This preliminary report is based primarily on findings from the set of semi-structured field interviews listed above by location and organization. It summarizes the findings from this survey in reference to the four research questions stated above.

Information technologies used in disaster response operations

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 during which the technical facilities available to practicing managers varied greatly.

Days 0-3
The set of managers universally reported that standard communications were not functioning on the first day after the earthquake, and only sporadically and in very limited areas in days two and three. Electrical power was out, telephone communications were down, the only means of getting information was through short-wave radio. By days two and three, electricity was partially restored in some parts of the heavily damaged cities of Izmit, Avcilar, Golcuk, Adapazari, Yalova. During this period, several types of emergency communications were used.

Amateur and short-wave radio
The first type was two-way radio, made available within hours of the earthquake by Turkish Amateur Radio Club (TRAC), which created a network of radio base stations that relayed information among the 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 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 Izmit region. However, data included in the model for the Izmit region were 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 be used only 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 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; it was 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 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 a central computer in Ankara. This network was already in place and operating prior to the main shock. Some substations 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, by day four, 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.

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, personnel engaged in disaster operations, equipment and 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 World Wide 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 were 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 conducting detailed damage assessment and providing 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 city 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 a nearby military base.

By the second week, crisis management centers were operating at each governmental level - town, 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.

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 is 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.

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. TRAC is proposing 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 operation centers. Kizilay is using 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 is using 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.

Relationship between performance in response operations and timely transition to recovery

Disaster operations were just moving into recovery as this 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 underway in the seriously affected cities, such as Golcuk, Izmit, and Sakharya. Issues of public health, sanitation, and immediate shelter still demanded time and attention. The issue of transition to recovery cannot be separated from the size and scope of the disaster, and in the case of Turkey, this 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 a city, e.g. the rapid location and establishment of 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 an effective strategy as shown by previous experience; in this instance, the strategy was employed to mobilize the resources of the very people most affected.

FURTHER RESEARCH ON LINKING THE INFORMATION INFRASTRUCTURE TO INTERORGANIZATIONAL LEARNING AND COORDINATION IN DISASTER MANAGEMENT

Systematic research needs to be done to demonstrate the capacity for increasing efficiency in disaster operations by linking information technologies appropriately to organizational response operations. Although strong qualitative evidence suggests this is the case, a carefully designed model based on the actual conditions of the Izmit earthquake would document the rate of change and the extent of such anticipated increases. Such a model has been proposed through a demonstration project that would use the Izmit earthquake of August 17, 1999, as a case study. The project would involve the creation of an international, interdisciplinary research team, involving seven universities in Turkey, the United States, and Japan. The proposed demonstration project was been placed on the agenda for the conference of the Global Disaster Information Network (GDIN) scheduled for Ankara, Turkey, April 25-29, 2000. Funding for the project was sought by the U.S. GDIN Committee. A brief outline of the proposed project is attached as Appendix A.

Funding for GDIN and the proposed demonstration project was dependent on approval of a budget measure by the U.S. Congress. Regrettably, that funding was not approved in November, 1999, as anticipated. The individuals and organizations initially interested in this demonstration project considered other options that could be pursued for the GDIN. With no funding but strong professional commitment to the concept of a GDIN, a small group of participants from seven research centers in the U.S., Turkey, and Japan proposed a mini-workshop for the Ankara Conference that would focus on detailed reports of disaster operations from the Marmara earthquake and presentation of information technologies that are relevant to disaster reduction. The workshop would create an opportunity for international discussion regarding the development of a workable research strategy for a global approach, and would seek funding for a demonstration project on the uses of information technology in disaster mitigation, response, and recovery.

The Mini-Workshop on Uses of Information Technology was held on Thursday, April 27, 2000, at the GDIN conference in Ankara. The agenda for the workshop is included in Appendix B. The workshop included an interactive, live chat session with 32 participants in Ankara, researchers from Kobe University, the Sony Systems Research Center in Tokyo, the University of Pittsburgh, and 26 participants in a virtual audience who logged on from different locations in several nations. I gratefully acknowledge Amy Sebring and Avagene Moore of the Emergency Information Infrastructure Partnership (EIIP) for their voluntary support of this effort.

APPENDIX A

The Izmit, Turkey Earthquake: A Demonstration Project for the Global Disaster Information Network Conference
Ankara, Turkey, April, 2000

International Collaboration in Disaster Response

The devastating Izmit, Turkey, earthquake (M=7.4 Richter) at 3:02 a.m. on August 17, 1999, provides an unwelcome, but powerful case study in which to demonstrate the potential collaboration of the international research community to provide timely, valid, scientific information to support disaster mitigation and response. I propose to use this case to develop a demonstration project for the Global Disaster Information Network Conference that is scheduled for Ankara, Turkey, in April, 2000. The proposed project would use the current capacity of information technology to draw upon the interdisciplinary expertise of six universities in three nations to provide decision support in response to the extraordinary demands for timely field operations to meet the needs of the affected population.

At the May 1999 GDIN Conference in Mexico City, there was general consensus among the participants that the concept of GDIN was well understood and widely accepted by participating nations. The proof of the concept, however, is whether it could be implemented successfully in actual situations of seismic or other kinds of risk. I propose the following outline as a "proof of concept" demonstration that would use the actual events, location, and characteristics of the Izmit earthquake to illustrate the kinds of decision support that could be made available to local, regional, national, and international organizations to facilitate their coordination in disaster response and recovery operations.

The demonstration project would use the Interactive, Intelligent, Spatial Information System (IISIS) prototype that is currently under development at the University of Pittsburgh as its basic design. This prototype, described in detail in other papers (Comfort et al., 1999), builds upon a body of research on seismic risk over the past decade (Comfort, 1999a). It essentially links three types of information technology to create a disaster-specific knowledge base that can provide timely, valid information to practicing managers as conditions change for the community and the demands for coordinated action increase. The three technologies include: 1) interactive communication via both Internet and secure intranet networks; 2) GIS and remote sensing imagery to provide graphic representation of changes in the area; and 3) intelligent reasoning by the computer to provide estimates of known losses or the probabilities of likely changes that could result from interdependent consequences generated by the earthquake, e.g. fires following earthquakes, failures in transportation networks, hazardous materials releases, or public health needs. Appropriate uses of the technology create an informed knowledge base for practicing managers to improve the efficiency and effectiveness of their response and recovery operations after a disaster event, but more importantly, to reduce the vulnerability of the community to such events before they occur.

The effective implementation of a prototype decision support system depends, fundamentally, on the quality and validity of the knowledge base that characterizes the impact of the event under study upon the affected community and region. Equally, it depends upon the technical capacity to represent this information to practicing decision makers in a form that they can understand and use under the urgent time constraints, and often damaged field environment, of disaster operations. The complexity and dynamic evolution of disaster operations require a continually adaptive decision support system, with new information updating changing conditions to enable practicing managers to make the most effective and efficient use of scarce resources and time. I propose a demonstration project for GDIN that would demonstrate the capacity of six universities, each representing a small network of researchers from different disciplines, that would focus on creating an interdisciplinary knowledge base that could provide constructive decision support for some of the major questions posed to practicing managers in reference to the Izmit earthquake. The six universities would include the University of Pittsburgh, George Washington University, Ankara University, Bogazici University, Kobe University, and the University of California, Berkeley. Each university, in turn, has research centers and interdisciplinary research groups that could contribute substantially to the actual development of the demonstration model.

For example, at the University of Pittsburgh, development for the demonstration project would be located at the IISIS Lab in the Center for Social and Urban Research, with participating faculty and students from the Graduate School of Public and International Affairs, School of Information Science, and Department of Computer Science. At George Washington University, we propose the Center for Crisis Management in the School of Engineering; at Ankara University, Turkey, the Department of Political Science and Public Administration; at Bogazici University, Istanbul, Kandilli Observatory and School of Engineering; at Kobe University, Japan, the Research Center for Urban Safety and Security; and at the University of California, Berkeley, the Institute of Governmental Studies and possibly the Pacific Earthquake Engineering Research Center. The intent of this proposal is to create an international, interdisciplinary working group to develop a demonstration model for decision support for an environment that has experienced severe seismic disruption.

To develop a successful demonstration project on the Izmit earthquake for the April conference, the work would need to begin immediately. Indeed, at several of the proposed universities, work is already underway. Since the development tasks involved are both organizational and technical, I suggest identifying researchers who have the needed skills at the respective universities, and using the structure of the IISIS prototype to coordinate the exchange, representation, and sharing of information among the participants. The information technology will facilitate the organizational development of the model.

To coordinate the development effort, I suggest forming a working group of six, with one representative from each university, who would in turn serve as a liaison to the subset of researchers at his/her respective university regarding the technical issues, substantive disciplinary content, organizational coordination, and general development of the model. Each university may wish to establish subworking groups for technical and organizational issues. Each university would also be encouraged to invite practicing managers from their respective communities to review the selection of data and sequence of information search and exchange processes that would be involved in an actual event. In this way, we would obtain valid review of the content and sequence of information search and exchange processes from at least six different metropolitan communities, four of which are exposed to significant seismic risk.

While the specification of tasks and a schedule for their completion will need to be discussed and confirmed by each of the six participating institutions, I propose as a preliminary outline the following set of tasks and schedule:

Data Collection:

1. Identification of the kinds of information that practicing managers seek at different time phases of disaster response by discipline, e.g. for seismology, it would likely include a scientific description of the seismic event:
   time:
   location:
   magnitude:
   depth:
   duration of shaking:
   This same type of information would be collected for at least six disciplines: structural engineering, emergency medicine, public policy, lifelines, communications, sociology (characteristics of the affected community). Other disciplines are clearly relevant: geography, architecture, meteorology, public health, law, international policy and administration. Choices could be made on which types of information were most relevant to decision support for

the Izmit earthquake.
2. Identification of the kinds of existing knowledge sources that can provide critical information needed for decision support, e.g. these may already exist in university research centers or be accessed through them. For some types of information, it may be necessary to create sample databases for the demonstration. The area under study would be the 200 sq. km. area southeast of Istanbul along the North Anatolia fault, including the cities of Izmit, Golcuk, Adapazari, and Istanbul.
3. Identification of the major organizations that would be involved in disaster response operations at local, regional, national, and international levels for the affected area.
4. Identification of the existing information infrastructure that was available to support the multi-way exchange of information among participating organizations.

Using the data collected from this process, it will be essential to engage in a set of interrelated tasks. These tasks are organizational and technical, but they are, in most cases, interdependent, so that one cannot be successfully performed without the appropriate accomplishment of the other. These are, briefly, outlined as follows:

Organizational Tasks:

1. Once the relevant data have been identified, they need to be checked for consistency, currency, accuracy, and validity. This means provided "metadata" or "data about the data" that will enable practicing managers to determine the utility of that data for their purposes. These questions would include providing the following information: What is the source of the data? When were they collected? In what form are they stored? If in electronic form, what were the hardware, software, projection (for spatial data) that were used in creating the electronic file. If there are security measures or restrictions on their use, what are they and under what circumstances or conditions are the data available to disaster managers?
2. When the data have been verified as valid, it will be necessary to determine who is responsible for maintaining the data and to obtain any permissions that are needed to access the data.
3. It will be necessary to determine what level of training or technical skill will be required for ready, skilled access to the data from multiple sources, and many locations, and to establish a set of criteria for checking the validity of information as it is being submitted to the event knowledge base.
4. Given a complex design for accessing data from multiple sources across different time zones, it will be necessary to develop an organizational diagram that will show the most efficient means of integrating information from separate sources into a disaster-specific knowledge base for this event.

Technical Tasks:

1. Once the relevant data have been identified, the relevant organizations who need access to the data have been identified, and the relevant permissions for data exchange have been granted, the technical team will assess the network of existing hardware and software to determine the most efficient and economical means of data exchange. This group will produce a system diagram for the information flow among the participating centers. For the initial demonstration, we hope to link at least six university centers for interactive data search, exchange, and analysis.
2. After the system diagram has been reviewed and approved by the participating university centers, the technical team will establish the working database links among the six centers. Each center would be responsible for integrating data accessed from separate databases at its university for transmission on the network.
3. The technical team would be responsible for maintaining appropriate measures of security for the transmission of data. All data so supplied would be used only for humanitarian purposes and would be directed only toward operations to support the specific disaster event.
4. The technical team would also develop a series of examples that demonstrate how data can create a cumulative, synergistic learning path, as data produced from one analysis feed decisions regarding another, related problem. We expect to see not only decision makers learning, but the analytical capacity of the system of interacting knowledge bases leading to new insights among the researchers as well as the decision makers.

APPENDIX B

Mini-Workshop Global Disaster Information Network (GDIN) Conference
Middle East Technical University, Ankara, Turkey
April 27, 2000

0930-0935	**Opening Remarks:** "Creating a Global Network of Research Centers for the Study of Seismic Risk" Louise Comfort, University of Pittsburgh, Pittsburgh, Pennsylvania, USA
0930-1000	**Overview:** "Conditions, Characteristics and Consequences of the Marmara Earthquake, 17 August 2000" Polat Gulkan, Director, Center for Disaster Management and Implementation Research, Middle East Technical University, Ankara, Turkey
0930-1100	**Panel 1: Technical and Organizational Failures/Community Costs**
	"The Impact of the Marmara Earthquake upon Kocaeli: The Role of Kocaeli University in a Damaged Community" Ozer Kenar, Rektor Yardimcisi, Kocaeli University, Kocaeli, Turkey
	"Information Search and Exchange in Disaster Operations: The Role of the Office of Disaster Affairs in the Marmara Earthquake" Huseyin Guler, Deputy Director, Office of Disaster Affairs, Government of Turkey, Ankara, Turkey
	"The Impact of the Hanshin Earthquake upon Kobe, Japan: The Establishment of the Research Center for Urban Safety and Security, Kobe University, Kobe, Japan" Takashi Okimura, Director, Research Center for Urban Safety and Security, Kobe University, Kobe, Japan
	"The Statewide Database of California: Creating Public Access to Policy Information" Karin MacDonald, Institute of Governmental Studies, University of California-Berkeley, Berkeley, California, USA
1100-1230	**Panel 2: Technical and Organizational Opportunities**
	"Uses of Remote Sensing in Disaster Environments" James Farley, Director, Center for Advanced Spatial Technologies, University of Arkansas, Fayetteville, Arkansas, USA
	"Organizing Support Networks for Disaster Relief" John Harrald, Director, Center for Disaster, Crisis and Risk Management, George Washington University, Washington, D.C., USA
	"Creating a Geotechnical Knowledge Base for Kobe, Japan" Yasuo Tanaka, Professor, Research Center for Urban Safety and Security, Kobe University, Kobe, Japan
1230-1330	**Luncheon**
1330-1345	**Overview of GDIN** Paul Bourget, U.S. GDIN Team
1345-1415	**Interactive Demonstrations** "RoboCup Rescue: A Global Project to Simulate a Major Earthquake in a Metropolitan Region" Hiroaki Kitano, President, The RoboCup Federation, and ERATO Kitano Project, JST, Tokyo,

	Japan Satoshi Tadokoro, Department of Computer and Systems Engineering, Kobe University and Rescue Engineering Section, Society of Instrumentation and Control Engineers, Kobe, Japan
1415-1430	Interactive chat with H. Kitano and S. Tadokoro, in San Francisco, Workshop participants in Ankara and Virtual Audience, supported by EIIP
1430-1515	"An Interactive, Intelligent, Spatial Information System for Decision Support" Louise Comfort, Principal Investigator, IISIS Project: A Prototype Interactive, Intelligent, Spatial Information System , University of Pittsburgh
1515-1530	Interactive chat with M. Dunn and A. Zagorecki, University of Pittsburgh, Workshop participants in Ankara and Virtual Audience, supported by EIIP
1530-1600	Break
1600-1730	**Recommendations, Critique/Feedback** Discussion of methods, strategies, collaboration needed to build a global network of research on the reduction of seismic risk.

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