1999 Kocaeli and Düzce, Turkey, Earthquakes

Lessons for Local Governments on Hazard Mitigation Strategies and Human Needs Response Planning

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Street scene in Adapazai following the Kocaeli, Turkey, earthquake

Cover/Credits page photo source – T. Holzer, U.S. Geological Survey
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BACKGROUND

Two massive earthquakes struck Turkey in 1999 – the magnitude 7.4 Kocaeli earthquake of August 17th and the magnitude 7.1 Düzce earthquake of November 12th.

This report resulted from a project to collect data on services provided for human needs following two massive earthquakes that struck Turkey in 1999 – the magnitude 7.4 Kocaeli earthquake on August 17th and the magnitude 7.1 Düzce earthquake on November 12th.

The Kocaeli earthquake resulted in 17,480 deaths, 43,953 injuries, and 66,441 collapsed or heavily damaged housing units. Estimates of losses range from $7 billion to $40 billion. An additional 763 deaths, 4,948 injuries, and 30,389 collapsed or heavily damaged housing units occurred as a result of the Düzce earthquake (Ozmen, 2000).

The principal purpose of our research was to collect and synthesize the data describing the service delivery activities after these earthquakes before the data were lost or the ability to interpret the data was degraded.

Government and non-government organizations faced with meeting the human needs following the Kocaeli earthquake were overwhelmed by the demand for their services. The National Science Foundation funded ABAG and The George Washington University Institute for Crisis, Disaster, and Risk Management (GWU-ICDRM) to collect, assess, and archive data on human needs service delivery for these two earthquakes. In addition, we developed recommendations for ways to collect and archive data in future earthquakes. A report on this effort is available on the web through GWU-ICDRM at –

http://www.seas.gwu.edu/~icdm/Turkey_Report.htm.

Researchers and emergency planners can also access the resulting databases using links from that web site. We believe that these data can provide the basis for developing models to predict the service delivery capability required to meet human needs following future earthquakes. The premise of our research is that analysis of these data will enhance the ability to anticipate the scale of human needs (medical, sheltering, feeding, supplies) following future earthquakes in Turkey, the U.S. and elsewhere, and will support the development of adequate plans, procedures, and service-delivery capabilities. These service-delivery needs are strongly determined by demographic and socio-economic factors in addition to the sustained physical damage. The estimation of demand for human services requires a linked set of modeling activities, data to populate the models, and expert judgment to interpret the quality, meaning, and limitations of available data.

This scenario-based needs estimation is an essential precursor to the development of adequate response and recovery strategies, plans, and organizational structures.

Yet we also uncovered valuable lessons of more immediate use to local governments. This is a summary report of those lessons.

Other findings can have more immediate use, however, to local governments and others concerned with the design and implementation of hazard mitigation strategies, as well as with human needs response planning. This is a summary report of those lessons.

The authors have made no attempt to be comprehensive in identifying these lessons, but rather have tried to identify those lessons that appeared most useful from the interviews of Turkish agencies.

INTRODUCTION

Kocaeli is a modern industrial center in Turkey.

Source – Kocaeli Chamber of Industry

Business was booming. Starting in 1970, the Kocaeli area, just east of Istanbul, grew to become the second largest industrial center in Turkey, accounting for 13% of the country's industrial output. Kocaeli has an educated work force, a central location, and a spectacular location surrounding the Sea of Marmara (roughly the size of San Francisco Bay). Extensive apartment blocks were constructed during the past 30 years to house an exploding population that relocated to serve the rapidly expanding economy. The business community, elected officials, and Chamber of Commerce and Industry are proud of recent awards for promoting "green" industry.

On August 17, 1999, disaster struck.

On August 17, 1999, roughly 10 years after our Loma Prieta earthquake, disaster struck. Over 75 miles of the North Anatolian fault ruptured, generating a magnitude 7.4 earthquake and 45 seconds of violent ground shaking at 3:02 a.m. In comparison, the magnitude 6.9 Loma Prieta earthquake in 1989 ruptured a fault 25 miles long, with approximately 20 seconds of violent shaking. Those 45 seconds of terror resulted in 17,480 deaths, largely in relatively new apartments, and 133,000 uninhabitable housing units (Ozmen, 2000; EERI, 2000; USGS, 2000). These numbers are huge relative to the 62 deaths and 16,000 uninhabitable housing units resulting from the Loma Prieta earthquake. The central and municipal governments in Turkey became overwhelmed. Kizilay (the Turkish Red Crescent/Red Cross) struggled to meet the basic feeding needs of the displaced, having only planned for a disaster one-fifth as large.

What went wrong? What lessons are there for cities and counties as we work to reduce the damage from future earthquakes through hazard mitigation and human needs response planning?

There is no such thing as a "natural" disaster. Hazards are natural, but the damage that results is the result of human activities.

Zenaida Delica
Director, Training and Education
Asia Disaster Preparedness Center

LESSON 1 - Mitigation Guidelines May Be Developed Centrally, But Implementation of Building Codes and Land Use Planning for New Construction Are the Responsibility of Local Governments

Blaming the building damage associated with casualties on shaking or other hazards does not explain what went wrong in terms that can be corrected to reduce future damage.

Most of the deaths and injuries in the Kocaeli earthquake were due to severe ground shaking causing the collapse of residential housing units, typically in 3-to-6-story reinforced concrete buildings with masonry infill walls.

Yet the Turkish building code is similar to that used in California and the country has extensive mapping of hazards. ***What went wrong?***

Although most building damage was due to severe ground shaking, additional damage documented by EERI (2000) was due to:

- fault rupture (causing the partial or total collapse of approximately 100 concrete frame buildings),
- liquefaction (when granular or sandy materials saturated with water can behave like a liquid, instead of like solid ground),
- coastal failures (including the failure at Degirmendere, where a large coastal slide carried a hotel into the bay, killing several people), and
- a small tsunami.

Both liquefaction and ground shaking particularly hit Sakarya Province, with a population of 731,800, and its capital, Adapazari, with a population of 183,000. A total of 5,078 buildings (27% of the total building stock of the city) were either severely damaged or destroyed. 19,043 housing units collapsed or were heavily damaged in Sakarya Province. 3,891 people were killed in the Province (EERI, 2000).

Yet these hazards were broadly recognized. ***What went wrong?***

Local governments were in charge of implementation of building codes without adequate training or education.

As in California, local governments in Turkey are in charge of implementation of building code standards. Yet the employees of these agencies are typically less well paid than their counterparts in the central government, leading to less well-qualified employees working for local governments. At the same time, little attention has been paid to ensuring that these employees receive adequate continuing education and training to allow them to enforce increasingly complex codes.

California building inspectors are currently required to have continuing education credits. Local governments should continue to support these requirements and ensure that their employees are adequately trained to understand and enforce building codes.

Passage of codes for <u>new</u> construction does not address <u>existing</u> buildings.

It was not until 1998 that Turkish building codes "caught up" to California codes. Yet, as in California, inadequate attention has been paid to development of mitigation and retrofitting programs for particularly hazardous buildings built prior to the establishment of stringent codes.

Some hazards are more appropriately addressed by land use restrictions.

Although shaking hazards are most effectively addressed with building codes, other earthquake hazards, including fault rupture and coastal sliding, are often best mitigated through land use controls, such as requirements for detailed identification of fault locations and coastal sliding areas followed by set-back restrictions. Again, local governments rarely institute the requirements, but almost always will be asked to implement them. As with code enforcement, land use implementation recommendations should be coupled with adequate continuing education and training for the local government employees who will be enforcing increasingly complex regulations.

Example of liquefaction damage in the 1999 Kocaeli, Turkey Earthquake

Source – T. Holzer, U.S. Geological Survey

LESSON 2 - Human Needs Services Are Delivered in the Context of Other Damage

Services are delivered in the context of the disaster.

Basic human needs had to be met after these earthquakes. People needed to be rescued from collapsed buildings and to receive emergency medical care. They needed safe drinking water, food, and shelter. Later, they needed help being reunited with their families and in moving forward with their lives.

Yet provision of these services had to occur in highly disrupted areas. Roads were closed and jammed with traffic. Some utilities, particularly water distribution lines, were not functional and frantic family members hoping to get through to their relatives jammed the phone system. Given the magnitude of these disasters, the efforts of the service deliverers to collect data on what they were doing are to be commended.

Surface transportation and response

Response was limited somewhat by highway, road, and rail line damage. Although significant disruptions occurred, the transportation system was not crippled. EERI (2000) reconnaissance team members noted that the Istanbul-Ankara highway (E80, or Trans-European Motorway) was closed at several locations by surface fault rupture causing buckling of the road surface, and, in one instance, collapse of an overpass near Arifiye. The bridge was removed and the highway reopened after three days. Landsliding in inland areas caused many secondary roads to require clearing, and damaged the highway north of Lake Sapanca. Shaking damage closed a bridge on a local road near Arifiye.

Arifiye overpass collapse following the 1999 Kocaeli, Turkey Earthquake

Source – T. Holzer, U.S. Geological Survey

The larger concern was the massive traffic jam for the first 24 hours after the Kocaeli earthquake that extended from Istanbul to the impacted area. The traffic was due, in large part, to people who decided to drive to the impacted area when the phone system was not operational. As a result, the Governor of Kocaeli placed immediate restrictions on travel into the impacted area following the Düzce earthquake (personal communication, 2001).

Similarly, fault rupture closed the rail lines between Izmit Bay and Arifiye. Although one of the lines was repaired enough to allow limited rail traffic the following day, and the second line was partially repaired after five days, the rail lines did not return to normal for several weeks (EERI, 2000).

Water transportation and response

Damage to the Port of Derince, as well as ground failure and surface fault rupture damage to the military port at Gölcük, limited the role of these major facilities during response and recovery (EERI, 2000).

Air transportation and response

The Atatürk International Airport in Istanbul was the closest major airport to the earthquake. It was undamaged and handled extensive additional traffic in the week following the earthquake due to international relief efforts (EERI, 2000).

Water supply damage and response

Water storage dams experienced few problems, in part because the earthquake occurred in late summer when the reservoirs were relatively low. Water treatment facilities also experienced minimal difficulties.

The Izmit Water Project services the municipalities along the northern and western shores of the Bay of Izmit. The main water transmission pipe (2.2m diameter) survived over 3 meters of fault offset without rupturing. The leak in one kink of the pipeline was repaired approximately one month after the earthquake. The water system remained operational, although demand increased, probably due to leaks (EERI, 2000).

The strong shaking and liquefaction failures in the Adapazari area contributed to significant damage to 70% of the pipelines in the area, with the remaining 30% having some leaks. The extensive damage led to the decision to completely replace the entire pipeline system. While lack of water impacted delivery of services for human needs, building demolition and construction activities delayed water pipeline replacement (EERI, 2000).

The Yalova-Gölcük system serves the municipalities on the southern shore of the Bay of Izmit. Damage to the transmission line led to as many as one million people being without water for up to three weeks. In addition, severe damage to the water distribution system occurred in Gölcük, with 45% of the system being destroyed and another 25% damaged (EERI, 2000).

Gas and electric power disruptions and response

Natural gas pipelines service only a portion of the Izmit area. This system, installed in the late 1990s, experienced minimal problems.

Most of the electric power distribution system was restored within 11 hours of the Kocaeli earthquake, with all repairs being completed within two weeks. However, as might be expected, the most heavily impacted areas were without power for over a week (EERI, 2000).

Telecommunications disruptions and response

The telecommunication system was functional within three hours to three days. Most disruption was due to interruptions in the power supply and lack of, or failure of, backup power (EERI, 2000).

The larger economic picture and recovery

Finally, recovery is occurring within the context of the economic and social fabric of the region affected. To the extent that industrial operations were lightly impacted, employees of those companies are more likely to remain and require shelter for longer periods. On the other hand, if companies go out of business, the employees no longer have jobs and are thus more likely to leave the area. In the case of these earthquakes, manufacturing facilities appeared to be built to higher construction standards than the housing stock. Thus, the need for sheltering has been greater than it would have been if more damage to industrial facilities had occurred.

LESSON 3 - Local Governments Are First to Respond to Disasters, NOT Social Service Agencies or the Central Government

Local governments are the first responders.

Local municipalities were on the front end of responding to this disaster. Yet local governments can be unprepared for disasters due to the perception that service agencies or the central (or federal) government will respond. At the same time, the central government may fail to provide funding and training for local governments due to the mistaken belief that they will not be at the "front line."

Local government is at the action level, and earthquakes do provide action!

James McCarty
Former City of Oakland
Public Works Director
(1987)

Environmental and other regulations are not suspended during the emergency.

Pressures may exist for waiving environmental regulations during an emergency. For example, debris was pushed into the Sea of Marmara for two days until those responsible were stopped and fined. The remaining debris (about 90 - 95% of the total) was crushed and recycled using both local and international equipment.

Local governments need to ensure that their employees have training in emergency response.

As is the case with training on building code enforcement, local governments should ensure that appropriate employees are adequately trained to respond to the disaster, not only in basic search and rescue, emergency medical services, and fire suppression, but also in traffic control and enforcement of regulations in emergencies.

Rescue effort in Avcilar following the 1999 Kocaeli, Turkey Earthquake

Source – T. Holzer
U.S. Geological Survey

LESSON 4 - Local Governments Need to Plan to Distribute Data Initially After the Disaster, as Well as for Weeks and Months as Data Are Compiled

Local governments are often the lead in providing data on casualties and losses.

These two Turkish earthquakes were just two of numerous examples of the role that local governments need to play as a source of reliable information. That information was passed up to the central government, and outward to the public, to relief organizations and others responding to the disaster, and to the media.

This role remains for weeks, or even months, not just for hours or days.

But the local government role as information source does not disappear after a few hours or days. The principal reason for the on-going role of local governments as data provider is that the numbers change over time.

Numbers change over time because the number of people needing care varies.

One way that numbers change over time is that the number of people needing care (feeding, shelter, medical, and family services) can vary from day to day. For example, the Turkish Red Crescent set up their mobile kitchens one day after the August earthquake and increased their capacity as more victims populated the tent cities and temporary shelters. The feeding activity reached its initial peak (91,000 persons/day) 2 months after the August earthquake. It then declined until the November 12 earthquake strikes, at which time the trend showed an increase with the highest peak attained (226,000 persons served meals/day) approximately 5 months after the August 17 earthquake and 2 months after the November 12 earthquake.

Numbers also change over time because the accuracy of data improves over time.

Another reason numbers can change over time is that the quality and accuracy of data improves. For example, the Turkish Prime Minister's Crisis Management Center web site's press releases about the situation assessment and their response efforts convey a sense of revelation about the scope of the difficulties faced by response organizations in mobilizing their resources, especially during the initial stages of the disasters. In particular, the press releases document information on changing estimates of housing damage and casualty figures, search and rescue efforts, the mass care efforts (number of persons that were sheltered and fed), and the medical services provided to the victims of the disaster. All of this information was subject to update and revision as more information became available.

CONCLUSIONS

Several themes emerge from the lessons of the 1999 Turkey earthquakes.

- Training of local government employees is essential.
- Local governments are the first to respond and must lead recovery.
- The key local government role, and the need for leadership of local elected officials, is not unique to earthquakes, as the recent tragedies on September 11, 2001, illustrated.

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