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COLLECTION, SYNTHESIS AND QUALITY ASSESSMENT OF RESPONSE DATA REGARDING 1999 TURKEY EARTHQUAKES

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Abstract

Two massive earthquakes struck the northwestern part of Turkey in 1999 - the magnitude 7.4 Kocaeli earthquake on August 17th and the magnitude 7.1 Düzce earthquake on November 12th. Both earthquakes resulted in heavy casualties and displaced hundreds of thousands of people from their homes. Government and non-government organizations faced with meeting the human needs following especially the Kocaeli earthquake were overwhelmed by the demand for their services. It was essential that the data describing the service delivery activities of these organizations be collected and synthesized before these data were lost or the ability to interpret data degraded. The analysis of these data will enhance the ability to anticipate the scale of human needs (medical, sheltering, feeding, supplies) following future earthquakes in Turkey and elsewhere. This paper will summarize the process used to collect, synthesize and assess data and some of the findings from the resulted data products. The work described in the paper was funded by The National Science Foundation.

Introduction

Two massive earthquakes struck Turkey in 1999 - the magnitude 7.4 Kocaeli earthquake on August 17th and the magnitude 7.1 Düzce earthquake on November 12th. Both earthquakes were caused from ruptures of the North Anatolian fault, with the Kocaeli earthquake lasting 45 seconds and rupturing 126 km of that fault, while the smaller Düzce earthquake produced a surface fault rupture of only 39 km.

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 26,704 collapsed or heavily damaged housing units occurred as a result of the Düzce earthquake (Ozmen 2000).

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The August 17, 1999 Kocaeli earthquake tragically illustrated the inability to cope with the result of poorly controlled development and rapid population growth in disaster-prone regions. The price of increased vulnerability and inadequate preparedness was the loss of thousands of lives, the displacement of hundreds of thousands of people from their homes, and the economic impact of over $20 billion. Government and non-government organizations faced with meeting the human needs following the Kocaeli earthquake were overwhelmed by the demand for their services.

Research Goals and Objectives

The purpose of this effort was to identify, collect, synthesize and quality assure data describing the response to human needs following the 1999 Turkey earthquakes before these data were lost or the ability to interpret data degraded. The resulting databases have been made available on the Internet for researchers and emergency planners and can provide the basis for developing models capable of predicting the service delivery capability required to meet human needs following future earthquakes in Turkey.

The 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 service-delivery demands 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.

The project had four research objectives:
1. To identify the sources of data necessary for estimating potential damage and for determining the attributes of the potential impacted population for a selected set of future Turkey earthquake scenarios.
2. To build a database describing the medical, feeding, sheltering, material distribution services delivered after the August 17 and November 12 earthquakes.
3. To assess the quality and limitations of this data.
4. To develop a preliminary conceptual model for the estimation of service delivery demands.

Loss prediction models are designed to predict the physical damage to buildings and infrastructure. This damage may then be used to predict the resulting human impacts and service-delivery needs (Perkins et al. 2000). The estimation of response requirements must be based on estimation of service-delivery demands. These demands are determined by human needs. Estimating the conditional probabilities implied by this relationship requires viable data in four distinct areas: housing damage and functionality, infrastructure damage and functionality, human impacts, and service delivery demands. Data describing the impact of 1999 Kocaeli and Izmit earthquakes provide a unique opportunity to provide the basis for populating and calibrating models that may be used to predict the service-delivery needs for future earthquakes in Turkey.

Research Procedure

Activities that responded to human needs were conducted by agencies of the Turkish central government, the provincial government, municipal governments, the Turkish Military, Turkish NGOs, international NGOs, and government teams. The project team cooperated with Turkish scientists, governmental officials, and emergency responders in identifying and collecting those data that were essential for the purposes of this project. During the study period several important

data and information sources have been obtained and were used as a basis for an initial effort to build a comprehensive database.

The most useful documents were the damage statistics published by the General Directorate of Disaster Affairs of the Ministry of Public Works and Resettlement (Ozmen/GDDA 2000), the Prime Ministry's Crisis Management Center's daily situation reports describing the daily progress of the response and provision of mass-care and a summary report on the damage statistics, casualties and the service delivery (Prime Ministry 2000), the International Federation of Red Cross/Red Crescent daily situation reports, and Results of a survey on the statistics of the displaced population conducted by the State Institute for Statistics (SIS 1999). Data were retrieved from the original sources and were extracted and entered into databases. The complete products of this research have been posted on a web site maintained by The George Washington University Institute for Crisis, Disaster, and Risk Management. The URL for the project web site is www.seas.gwu.edu/~icdm/turkey

Findings and Conclusions

Although detailed analysis of the data collected was not the primary purpose of this project, several observations were made using only basic descriptive analysis techniques:

- As illustrated on Figures 1, 2 and 3, time-phased displays of data describing damage and displaced persons illustrated that information describing the impact after the Kocaeli earthquake was initially very incomplete. Early estimates were inaccurate; in some cases it took a significant period of time (weeks and months) to obtain an accurate measure of the disaster's impact.

Figure 1: Reported Death Figures by Day – Kocaeli Earthquake
(Source: Turkish Prime Ministry's Crisis Management Center, 1999.)

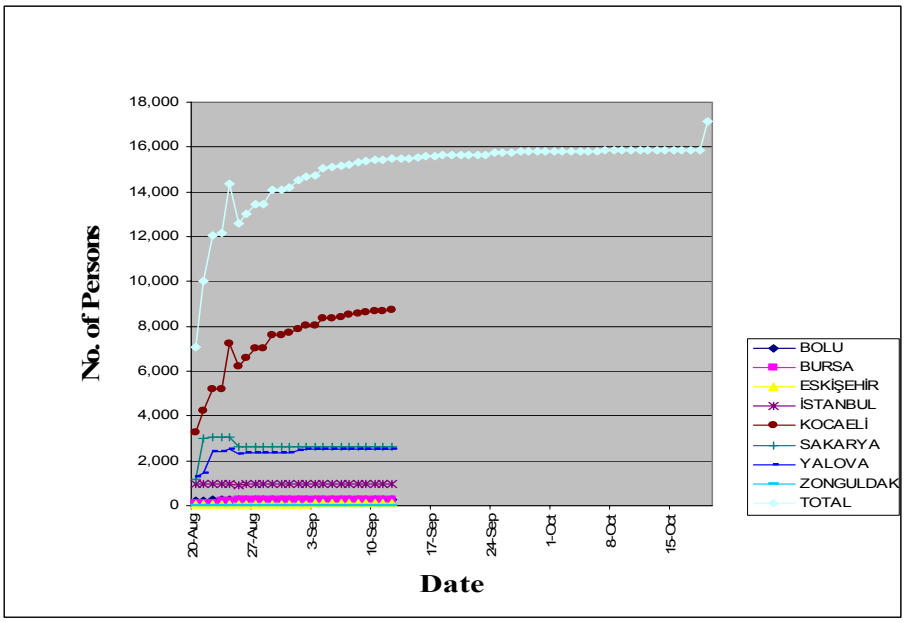


Figure 2: Reported Injury Figures by Day – Kocaeli Earthquake
(Source: Turkish Prime Ministry's Crisis Management Center, 1999.)

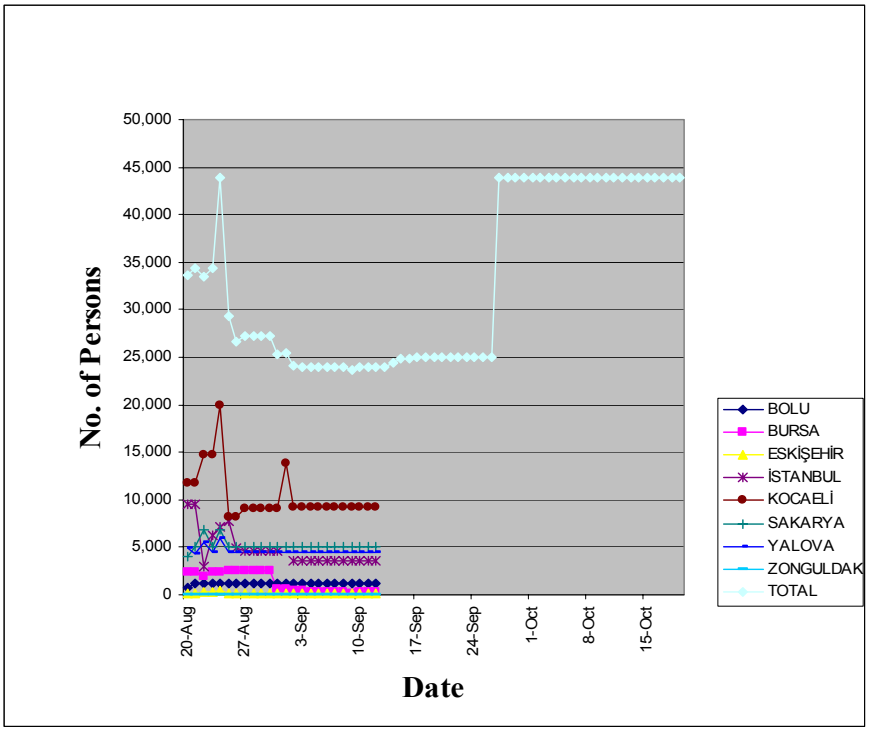
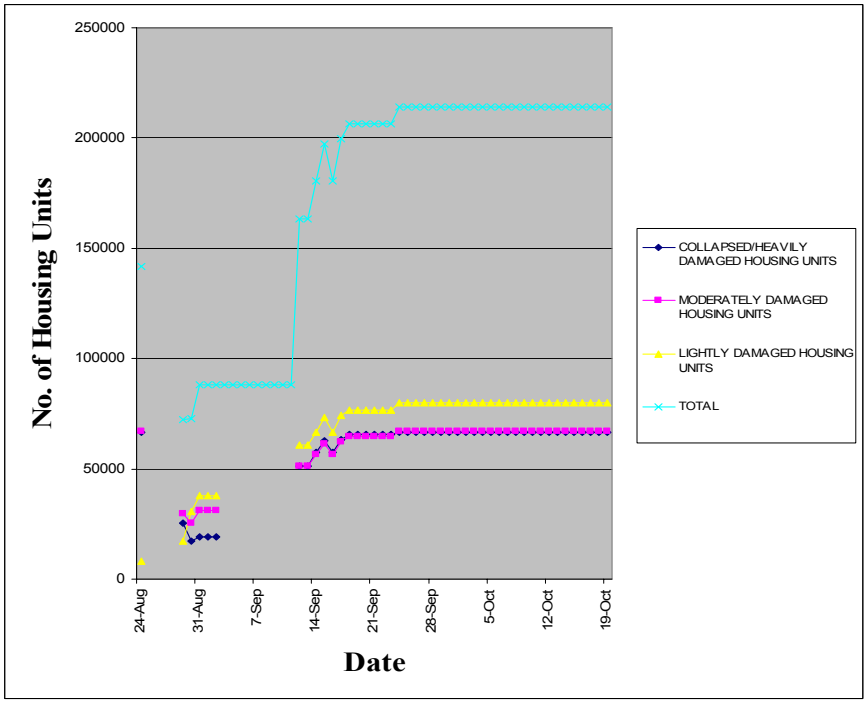


Figure 3: Reported Housing Damage Figures by Day – Kocaeli Earthquake
(Source: Turkish Prime Ministry's Crisis Management Center, 1999.)



- Time-phased data figures as depicted on Figures 4 and 5, also show that mass-care response to the Kocaeli earthquake (provision of tents and feeding) was slow but that the response to the November earthquake was more rapid and better documented.

Figure 4: Reported (Cumulative) Number of Tents in the Disaster Region by Day – Kocaeli Earthquake

(Source: Turkish Prime Ministry's Crisis Management Center, 1999.)

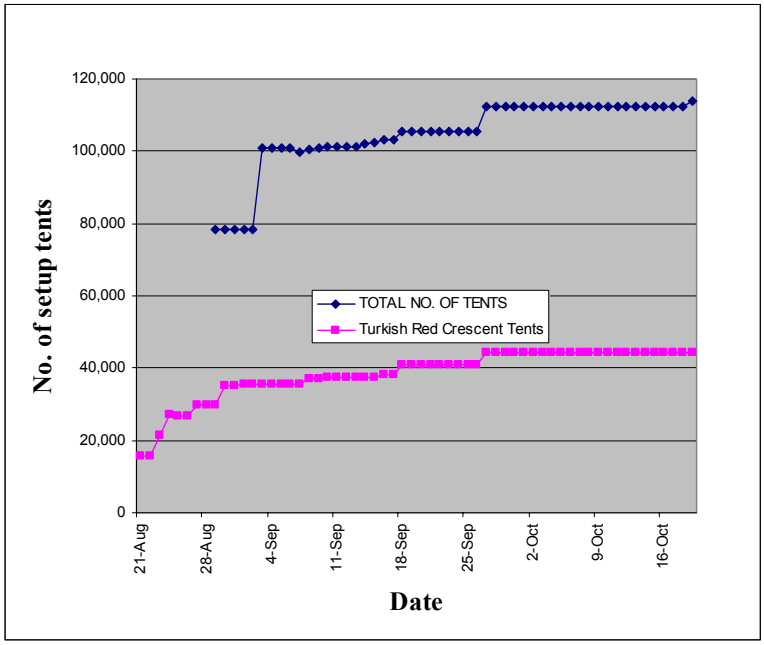
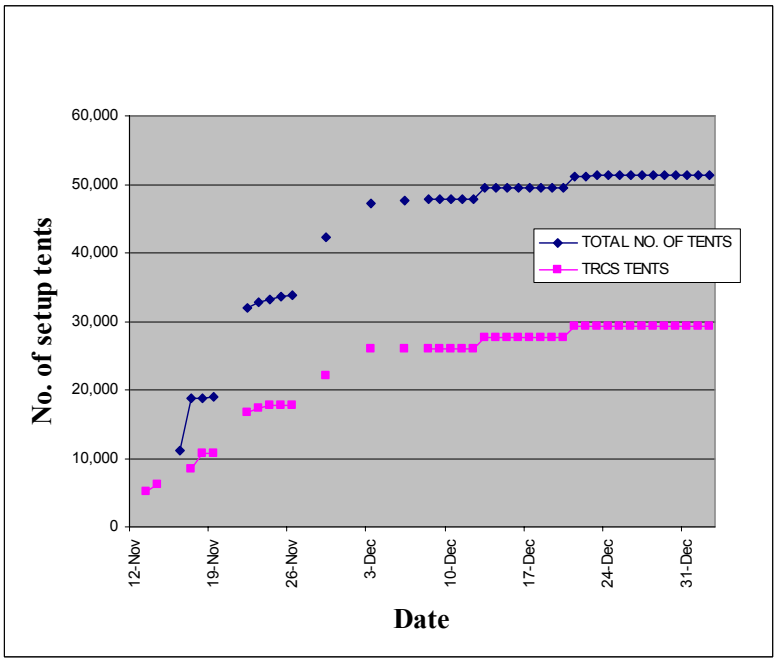


Figure 5: Reported (Cumulative) Number of Tents in the Disaster Region by Day – Düzce Earthquake

(Source: Turkish Prime Ministry's Crisis Management Center, 1999.)

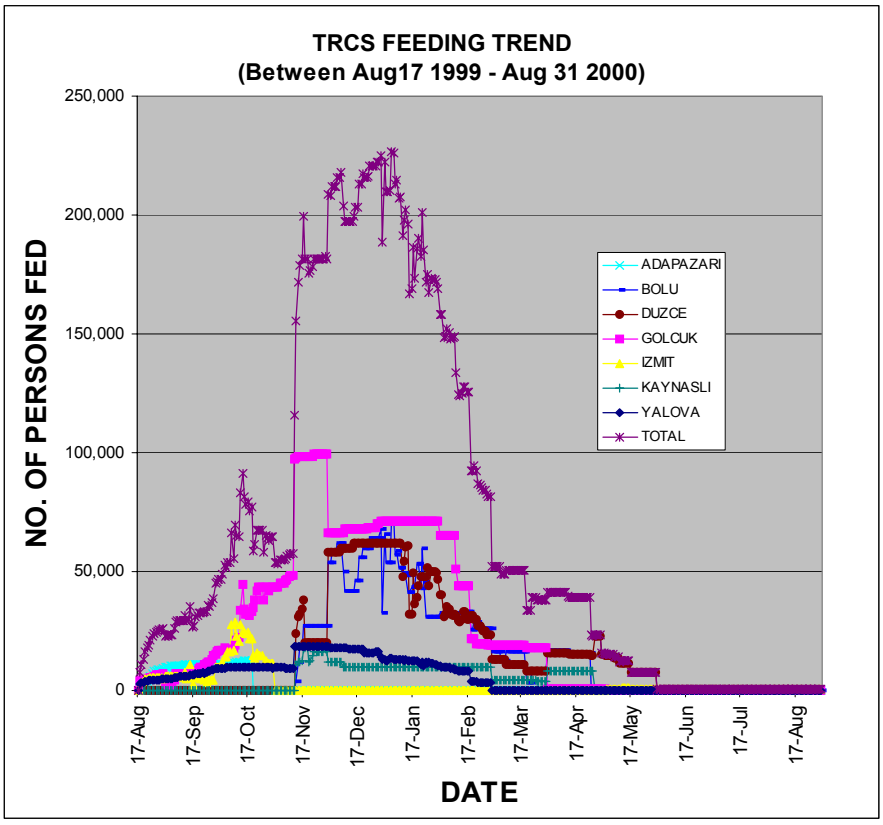


- The data describing the distribution of damage and the distribution of services provided should be analyzed for relationships and anomalies. Descriptive analysis provides some indication of these relationships.
- Not all the data needed for needs analysis are available. The extent of the distribution of bulk food supplies by the Turkish Armed Forces and civilian sources during the early days of the relief effort is not clear from the data collected. There is no way to ensure that the efforts of all non-governmental organizations that participated in the relief effort are captured in the statistics of the Turkish government, the IFRC, and the TRCS.

"Numbers change over time"

One way that numbers change over time is that the number of people needing care (feeding, shelter, etc.) 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 shows 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. (See Figure 6 below).

Figure 6: TRCS Feeding Trend
(Source: Turkish Red Crescent, 2000.)



Another reason numbers can change over time is 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 provide insight into 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. Figures 4 through 8 show the temporal evolution of selected aspects of the response effort. Tents were still being erected and basic relief supplies such as blankets, sleeping bags, and stoves were still being distributed a month after both the August and November earthquakes. In the United States, peak shelter populations are typically experienced 3-7 days after a major earthquake (Perkins et al., 2000). It is apparent that peak populations of temporary shelter populations were experienced in tent cities months, not days, after the earthquakes in Turkey.

Assessment of form and completeness of data

The original data drawn upon in this project was collected and stored by organizations that were responding to an unexpected catastrophic event. In the aftermath of any significant natural disaster, attention is focused on providing essential rescue, medical, and mass-care services to victims. Government and non-governmental organizations do the best they can with what they have until adequate response resources can be mobilized. Keeping track of who is providing what service is clearly of lower priority than responding to critical needs. This means that if the responsibility and mechanism for collecting data are not in place prior to the event, that data will be collected in a haphazard manner and that the data collection will be driven by the motivations of hundreds of unique organizations. It is not surprising that the data available on the initial response to a catastrophic event may be incomplete and inaccurate. In the case of the Turkey earthquakes, the completeness of the data describing the response to human needs were affected by the following:

- Original data were collected/stored by an individual organization. Efforts to integrate and reconcile data from different sources were made after a significant time delay. Integrated data that has been reconciled and aggregated are typically available only in paper form.
- Data were collected by different organizations using different selection criteria (e.g. per person, per family, per unit of service delivered) and by differing geographic levels of decomposition (provincial, district, municipal)
- Data definitions were determined by organizations collecting data and it is difficult to determine if definitions are compatible between sources.

"Services are not delivered in a vacuum"

Recovery occurs within the context of the economic and social fabric of the region affected. In the U.S. it has been observed that when industrial operations are 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 Turkish earthquakes, major manufacturing facilities survived and resumed operation relatively quickly. Thus, the need for sheltering was greater than it would have been if more damage to industrial facilities had occurred.

Why are data currently collected?

Local governments collected data on structural damage to make decisions on safety related to occupying or reoccupying those structures. Various non-governmental organizations (NGOs) collected data on the number of meals served or tents erected and compiling macro-data for use in fund raising. Although many structural engineers focused their efforts on case studies, other researchers collected statistical data on structural damage that will be of use to those modeling future damage potential. Similar techniques need to be employed by those doing research on human needs.

What should be collected and by who?

Two organizations in Turkey appear to have both the organizational authority and responsibility to establish a coherent information management capability that would include standardizing data definitions, geographical boundaries, and collection procedures: the Turkish Emergency Management Agency (TEMAD) and the Turkish Red Crescent Society (Kizilay). Kizilay, like the American Red Cross, has functioning units throughout the country that will be on scene for any earthquake or other major disaster. Supported by the American Red Cross, the IFRC and other national societies, Kizilay is upgrading its ability to collect and manage information during major disaster operations. A coordinated TEMAD/Kizilay effort to ensure that data describing the response to human needs is collected after future earthquakes will significantly improve the development of response and recovery plans and capabilities. The database created in this project provides guidance on the type of data that could be collected in a coordinated effort.

What opportunities exist for using these data?

The data collected in the aftermath of earthquakes like these will enhance earthquake preparedness and planning and will improve the risk and vulnerability modeling capability in Turkey, the United States and elsewhere.

Figure 7 shows the types of data that are needed to populate damage models (Perkins, 1995, Perkins et al., 1996, Perkins et al., 2000). Building inventory data, data describing actual ground shaking and liquefaction, and structural damage data for the two Turkish earthquakes has been collected by the Turkish government agencies and universities. The focus of this project was on the perishable event specific data shown in Figure 8. The estimation of response requirements must be based on estimation of service delivery demands. These demands are determined by human needs and modeling this relationship requires viable data in four distinct areas: housing damage and functionality, infrastructure damage and functionality, human impacts, and service delivery demands. The most immediate challenge for future analysis is to investigate whether or not the data available are adequate to support this type of modeling. Where data are not adequate, methods of obtaining and utilizing expert judgment may be another promising approach.

Figure 7: Pre-Disaster Data Required For Loss Estimation

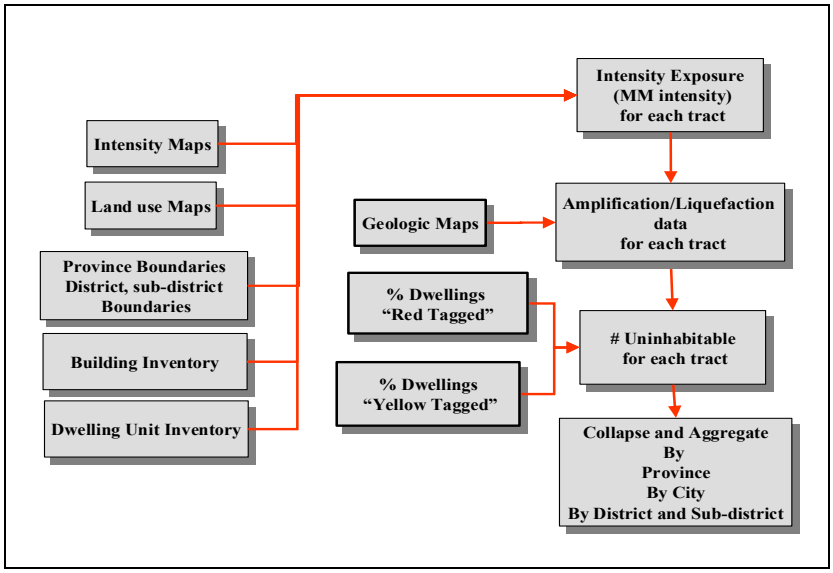
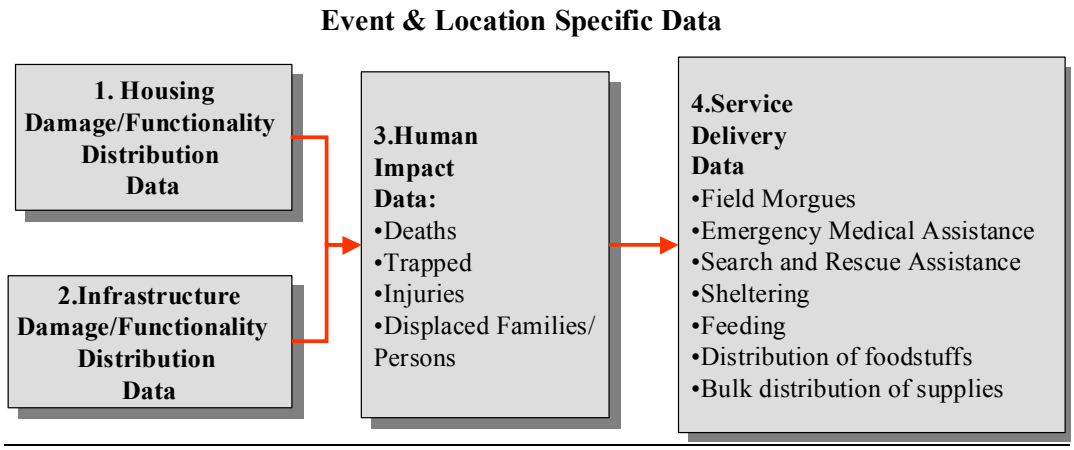


Figure 8: Scenario-Specific Data for Determination of Human Needs and Service Delivery Demands



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Note: This article was based on the authors' report, Quick Response Report "The Collection, Synthesis, and Quality Assessment of Data Describing the Response to Human Needs Following the 1999 Turkey Earthquakes", completed with a grant from the National Science Foundation.

Author Biographies

Irmak Renda-Tanali is a Research Associate at the George Washington University, Institute for Crisis, Disaster, and Risk Management. She has conducted basic and applied research for various organizations in the fields of emergency, disaster and risk management and organizational management since 1998. Ms. Tanali holds a B.S and an M.S. degree in Civil Engineering and an M.B.A. Her interests include Engineering Economy, Project Management and Disaster and Risk Management. She is a Doctoral Degree Candidate at the Department of Engineering Management and Systems Engineering of The George Washington University. Ms. Tanali is currently working on her Doctoral Dissertation entitled "*Life Cycle Cost Analysis of Water Systems as Critical Lifelines"*.

John R. Harrald is the Director of the George Washington University Institute for Crisis, Disaster, and Risk Management and is President of TIEMS. Dr. Harrald is a Professor of Engineering Management and Systems Engineering. He received his B.S. degree from the United States Coast Guard Academy, his M.S. from M.I.T., and his M.B.A. and Ph.D. from Rensselaer Polytechnic Institute.

Jeanne B. Perkins is the Earthquake Program Manager of the Association of Bay Area Governments in Oakland, CA. She is the manager of ABAG's award winning Internet site focusing on providing clear information on types of earthquake hazards and mitigation options (www.abag.ca.gov), and is author of numerous earthquake related reports and papers.