DEVELOPING AN EARTHQUAKE LOSS ESTIMATION PROGRAM FOR TURKEY

Muhammed Şahin[1] and Himmet Karaman[1]
Istanbul Technical University

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Abstract

To protect the Turkish society, business sector, buildings and lifelines from the earthquake, Turkey and United States, aim to develop a risk assessment tool. This tool will be based on HAZUS (Hazards US) system which was prepared by FEMA to assess multi hazards. HAZUS is used nationwide to mitigate the long term effects of the natural disasters on human life at social and economic areas. The product of this project will be named as HAZTURK (Hazards Turkey). The designing HAZTURK program will help on natural risk management, program development, development of the current lifelines of Turkey according to the seismic hazards, and designing more stable economy in addition to development and testing of methods for hazard characterization.

The proposed tool will support;

- Decision support for disaster mitigation: the evaluation of alternative scenarios for land use changes, building upgrades, and infrastructure improvements.
- Response, recovery and redeployment following disasters: determining which areas need help more and which areas are the most efficient the help.
- Planning for response and recovery efforts before disasters strike: fire, rescue, and health care needs, resources and lifelines.
- Finding new research areas: characterizing earthquakes, defining building fragilities, and improving data sets.

First of all a demonstration project will completed on a selected municipality of Istanbul to check if the results are consistent. This will help to develop more coherent loss estimation analysis and risk assessment. The aim of this demonstration project is to;

- Provide cost effective and reliable computer and GIS based risk assessment tool that supports risk management.
- Support mitigation efforts at disasters by evaluating alternative land use changes, development of building codes, building upgrades and substructure improvements
- Develop the earthquake knowledge of the community at the regional, provincial, and national levels.

[1] Istanbul Technical University, Civil Engineering Faculty, Geodesy and Photogrammetry Engineering Department, 34469 Maslak-ISTANBUL-TURKEY

Introduction

To support reduction of loss from earthquake hazards affecting millions of people and billions of dollars of infrastructure in Turkey, study the means for creating HAZTURK, a Turkish version of HAZUS, the methodology and software that estimates potential earthquake damage and loss in the U.S. The key objectives for a new Turkish version of HAZUS are to:

- Develop an earthquake hazard characterization model for Turkey based on HAZUS.
- Create a comprehensive Turkish inventory database for loss estimation.
- Develop vulnerability functions for infrastructure at risk to supplement those in HAZUS.
- Develop parameters for casualties, shelter needs and economic loss that reflect conditions in Turkey.
- Provide improved near real time loss assessment capability based on Turkish information resources.
- Provide software that takes full advantage of state-of-the-art GIS platforms and internet capability.
- Provide user-friendly computer interface and support materials suitable for a wide variety of users in Turkey including emergency managers, scientific investigators and decision makers.

To realize these objectives, a feasibility study is required to determine the steps to developing loss estimation methods and software applicable Turkey, the potential for technology sharing with HAZUS, and approaches to potential distribution. The feasibility study is intended to be used to seek funding for HAZTURK development from sources such as the World Bank, the United Nations and others (Sahin and Karaman, 2005).

Local officials and planners will use these tools to assess national and local risks, and prioritize loss reduction activities. The new tools will pinpoint vulnerable areas that would benefit from special land-use provisions or building codes, or compare damage and loss assessments of buildings, key facilities, and infrastructure before and after applying different prevention or intervention options.

The project will begin with an assessment of the models, tools, research and data that is available in Turkey and for Turkey. The first step in the project is to identify a proposed area of study based on needs, vulnerabilities, local interest, willingness to participate and the availability of data and other resources. Input will be sought from government officials, regional and local emergency managers to assist with conducting the demonstration, university personnel to assist with conducting the demonstration, collecting data and developing demonstration methods.

Once a study area is selected, a group of users will be identified to participate in the project. Turkish risk management resources will be assessed including identifying and assessing local and regional emergency management capability, participants and stakeholders.

Data Storage

The necessary data will be described and a plan prepared for gathering it. This includes boundary maps, geological surveys, seismic risk studies, census and other data, building data, building types unique to Turkey, and applicable building codes. Where gaps in the data exist, a number of international databases have been identified that can be potentially used to build the default database including but not limited to:

- LandScan population data

- World Agency of Planetary Monitoring and Earthquake Risk Reduction's building inventory data derived from satellite imagery
- National Center for Earth Resources Observation and Science data
- UN Department of Economic and Social Affairs (DESA) Development Policy and Planning Office data
- UN Environmental Programme Division of Early Warning and Assessment Global Resource Information Database

Following data collection, a database model will be designed, populated and tested (Sahin and Karaman, 2005).

Methodology and Software Development Process

A prototype tool for assessing residential building damage will be developed including modules and damage functions for unique Turkish buildings. The prototype damage and loss model will include the database, a building classification system based on local and regional building stock and construction practices, the methods suited for hazard characterization and damage and loss calculations for use in the study area.

In addition, a prototype software tool for mitigation analysis for residential building will be developed.

The prototype software will be used to conduct a sample analysis in the demonstration study area. This will include a building damage and loss assessment, and a sample mitigation analysis. The new methodology will be testing and validated with local data.

Architecture of HAZUS

The HAZUS software consists of a three-tier system architecture that utilizes a relational database management system for storing and retrieving inventory data, model parameters and analysis results. This configuration provides HAZUS with the means to utilize data interchangeably from a variety of sources, to communicate with other emergency management tools. The user interface, GIS functionality and report generation is packaged in the *Presentation Layer*. The study region management module and engineering analysis (hazard characterization, damage and loss) modules are packaged into the *Application Logic Layer*. Data access is implemented in the *Data Access Layer*. MSDE (Microsoft Database Engine) serves as the database engine in this layer. The three-tiered approach for HAZUS allows for changes to be made to a single layer without having to modify the other layers. The inter-communication between the different layers is done via interfaces *(*in simple terms, these are protocols of communication), and as long as the interfaces remain the same, the internal workings can be modified without affecting the rest of the system. (NIBS, 2005)

HAZUS Hazard Characterization

The methodology generates estimates of the consequences to a city or region of a "scenario earthquake" -- that is, an earthquake with a specified magnitude and location. For these events, the probabilistic ground motion data is provided by USGS. Earthquake faults are developed from data supplied by the U.S. Geological Survey in Golden, CO with enhancements by the state agencies of California and Nevada. Historical earthquake epicenters are compiled from several catalog and databases: the ANSS Worldwide Earthquake Catalog, the National Earthquake Information Center (NEIC) database, and the Earthquake Seismicity Catalog Volume 1 (NOAA/USGS). Also, USGS shakemaps, that describe shaking immediately following an earthquake in California, can be imported in geodatabase format. As an example, for estimating the building damage due to ground

shaking, GBS data is combined with the following damage functions: (1) fragility curves that describe the probability of reaching or exceeding different states of damage given peak building response, and (2) building capacity (push-over) curves that are used (with damping-modified demand spectra) to determine peak building response. The extent and severity of damage to structural and nonstructural components of a building is described by one of five damage states: None, Slight, Moderate, Extensive, and Complete. (Schneider and Schauer, 2005)

HAZUS Analysis Procedures

A HAZUS analysis consists of three basic steps:

a. Study region creation
b. Hazard characterization
c. Damage and loss analysis

HAZUS results can be mapped and are displayed in detailed browser tables, summary reports, a global summary report that provides a 19 page document on a scenario earthquake for a region, and a quick assessment report for use in response and recovery situations according to the HAZUS Earthquake Model (Figure 1). (Schneider and Schauer, 2005)

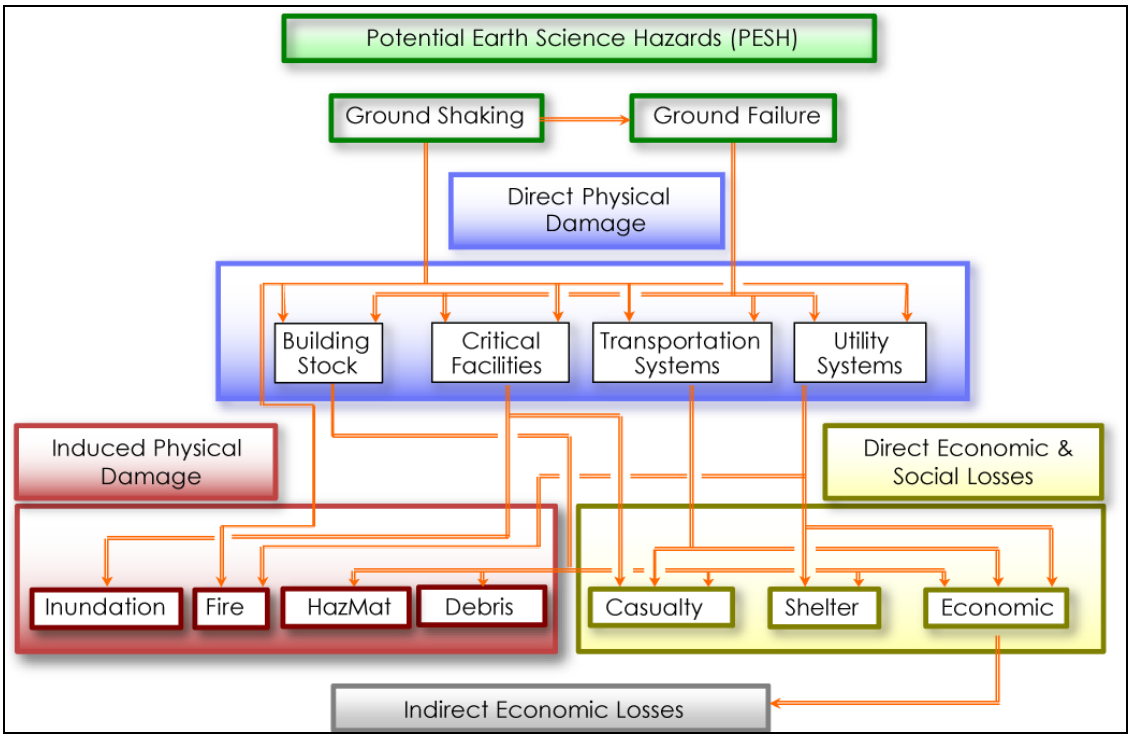

Figure 1. HAZUS Earthquake Model Components

Conclusion

This study is a start of a project that will conduct the disaster management and hazard mitigation works firstly for a region of the city of Istanbul and then the Istanbul city and finally the whole Country of Turkish Republic. The reason for not using the HAZUS program for Turkey as itself is not readily transferable for use in Turkey. National and provincial boundaries, characterization of the earthquake hazard, data used in HAZUS and its method of storage are applicable only in the U.S. That is why the loss estimation program of HAZTURK must be build from the beginning. For the U.S. it has taken approximately 7 years to have a fully usable and nationally applicable loss estimation program. For Turkey, we hope to shorten this period with the experience and the help of the team that desing and develop

HAZUS for the U.S. This work as itself has some deficiencies, like has no other disaster types other then earthquakes, but as in the HAZUS example, those missing parts will be added after the first working version of HAZTURK hasbeen released. Firstly, it is important to have a working software for loss estimation of earthquakes. Then the improvements on the earthquake model will be done, and then the other disaster models will be added to the system. Like, flood.

References

National Institute of Building Science, 2005. HAZUS-MH MR1 Earthquake Model Technical Manual, Prepared for the Federal Emergency Management Agency, Washington, D.C.

Sahin, M., Karaman, H.,, 2005. Development of GIS Based Loss Estimation Program For Turkey, International Symposium on Modern Technologies, Education and Professional Practise in Geodesy and Related Fields, pp: 570-576, November, 3-4, 2005, Sofia, Bulgaria.

Schneider, P.J., Schauer, B.A., 2005. Overview of HAZUS® Earthquake Model Technology and Applications, HAZTURK-2005, Strategies for An Earthquake Loss Estimation Program for Turkey, pp: 8-25, I.T.U. Surveying Technique Division, V,158 s., Istanbul.

Author Biography

Muhammed Şahin is a professor of Surveying in the Faculty of Civil Engineering, Istanbul Technical University. He has been the head of Surveying Technique Division since September 2004. He was born in Pazar, a town of Rize where he finished his primary, secondary and high schools. He graduated from the Department of Geodesy & Photogrammetry, Istanbul Technical University in 1987. He received MSc & PhD from University College London and University of Newcastle Upon Tyne, UK, respectively. He become an assistant professor in 1994, an associate professor in 1996 and professor in 2002. His research interests include satellite positioning techniques, monitoring of earth crust using GPS, emergency management, disaster information systems, GIS based on emergency management.

Himmet Karaman is a geodesy and photogrammetry engineer and has his Master of Science degree on 2003 from ITU Science and Technology Institute on database systems on disaster management. He is a PhD candidate since 2004. He is a research assistant in Istanbul Technical University, Civil Engineering Faculty, Surveying Technique Division, since 2001.