Earthquake scenario

Open source Procedure for Assessment of Loss

abstract

Problem Definition

With the increasing number of global earthquake loss assessment procedures and software, it was decided to develop a decision process for users to undertake earthquake loss estimation. Depending on the location of the earthquake to be modelled, the available exposure, hazard and vulnerability information and the level of detail required, different global earthquake loss estimation packages are needed. It is difficult for interested earthquake modellers to know which software packages to use and when they will be applicable.

What is the OPAL Project?

OPAL or Open source Procedure for Assessment of Loss using Global Earthquake Modelling, is a framework developed to solve the problem above.

> 1. Overview of current **ELE research**

2. Preliminary Global **Software Analysis**

3. Assessment of global ELE software packages and multicriteria software decision making process

4. Loss calculation with chosen existing and new software

It is a detailed 4 step framework including:

- 1) Overview of current and new components of earthquake loss estimation (ELE): vulnerability, hazard, exposure, specific cost and technology;
- 2) Preliminary research, acquisition and familiarisation with all available ELE software packages;
- 3) Assessment of these software packages in order to identify the advantages and disadvantages of the ELE methods used; and
- 4) Loss analysis for any scenario using the most applicable packages from a ranking from multicriteria analysis.

Use of lowly ranked software packages will require much more user experience and possible modification, as well as leading to higher variability in results.

In this study it was decided that a Mw7.2 deterministic scenario for the Zeytinburnu district in Istanbul, Turkey, be used. The highest ranked softwares were DBELA, HAZUS and SELENA. Thus, software coding was needed to produce MDBELA (Matlab-based DBELA) and MHAZUS (Matlab-based HAZUS). SELENA from NORSAR was also used.

Centre for Disaster Management and Risk Reduction Technology Open source Procedure for Assessment

Loss using Global Earthquake Modelling

Mr. James Danie

How does OPAL help researchers?

OPAL provides researchers with the opportunity to learn about the current state-of-art in earthquake loss estimation software. It also allows them to systematically choose applicable software packages for their analysis anywhere around the world and to source those software packages. The OPAL MCA is in the process of being automated for online use but is currently available as a CEDIM research report.

James E. Daniell

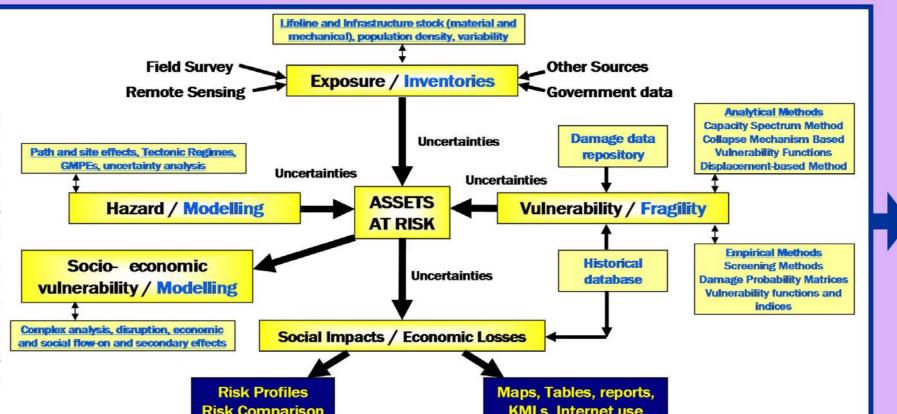
CEDIM, Hertzstrasse 16, Karlsruhe, Germany, 76187. Ph. No. +49 721-608 4609

nho. R., Bommer, J.J. (2004). A Probabilistic Displacement-based Vulnerability Assessment Procedure for Earthquake Loss Estimation. Bulletin of Earthquake Engineering, Vol. 2, No. 2, pp. 173-219 Daniell, J.E. (2010), CATDAT Damaging Earthquakes Database (10600 events), searchable integrated historical global catastrophe database—earthquakes, accessed 04/2010

Overview and Preliminary earthquake loss software

The current state of earthquake loss estimation

many uncertainties and variability within the ELE process. ELE software packages component of ELE and associated global additional software.



Global ELE software packages

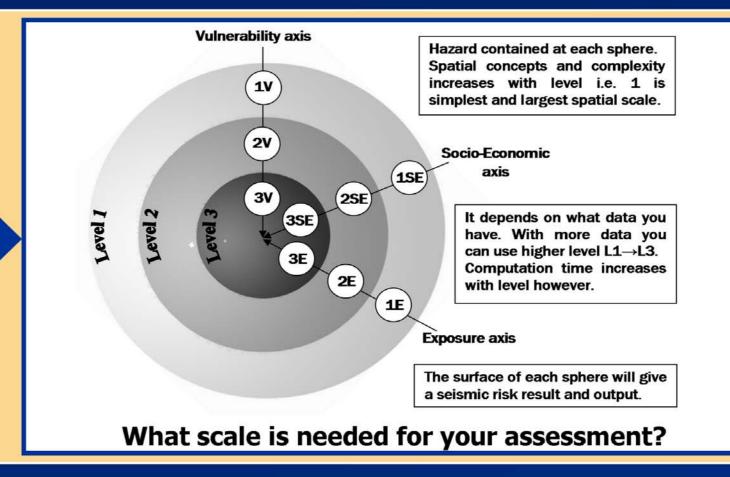


based. The red dot shows the location of Zeytinburnu.

Assessment and decision process

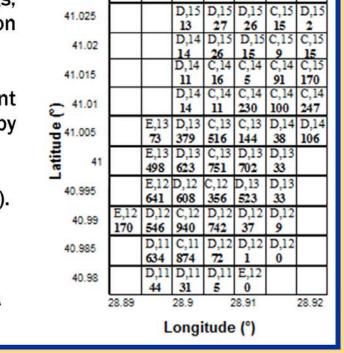
Assessed parameters for each ELE software Multicriteria analysis was undertaken using a comparison of key ELE parameters for each software. The methodology was derived from Stafford et al. (2007) with many additions

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TECHNICAL ASPECTS	HAZARD/DEMAND MODULE	VULNERABILITY AND EXPOSURE	RAPID RESPONSE AND
OCLOSED OR OPEN SOURCE? OCLOSED OR OPEN SOURCE? AVAILABLE? CONTACT. METHOD DOCUMENTATION	HAZARDS CONSIDERED 1. GROUND SHAKING, 2. FAULT RUPTURE, 3. LIQUEFACTION, 4. TSUNAMI/SEICHE, 5. LANDSLIDE, 6. FIRE	INVENTORY ELEMENTS CONSUMPRISO • GENERAL BUILDING STOCK • LARGE LOSS POTENTIAL • CRITICAL,	TECHNOLOGY USED
• UPDATED SINCE 2007? • AGE, DEVELOPMENT STATUS AS OF APRIL 2010.	ANALYSIS MODELS POSSIBLE 1-2. USER SPECIFIED EQ / EVENT (DP) 3-4. HISTORICAL GMs / AUTOMATED REAL TIME GMs (DO) 5-6. POISSONIAN/TIME DEPENDENT (P) Refer in ELE table above for acronyms.	TRANSPORTATION UTILITY 1. USE, 2. OCCUPANCY RATE STRUCTURAL—3. BASIC, 4.	 Is rapid response capability present? And complexity—are the results simplified? Onsite details—do the software provide updating and management systems?
AND SOFT- SOURCE CODE SOFTWARE	PARAMETERS • INTENSITY—DETAILS, TYPE. • RESPONSE SPECTRUM-DETAIL, TYPE	REVIEWED BEHAVIOUR, 5. COMPLEX FAILURE FEATURES OUALITY-6.AGE, CLASSES,	3. Is a GIS output available?4. Is remote sensing integrated into the software?
REGIONAL PLICABILITY • LICENSED SOFTWARE NEEDED • APPLICABLE REGIONS • SPATIAL LEVEL (see below)	SPATIAL DIST. GROUND MO- TION TYPE • 1. OBSERVED, 2. THEORETICAL, 3. EMPIRICAL—DETAILS • ARE GMs UPDATED? MAPS?	7. VARIABILITY CONSIDERED VULN. METHOD USED	5. Shake and loss map use?6. How useable are the results?7. Are they integrated into government or
TEST REGIONS USED (see map)	SITE EFFECTS • SITE CLASSIFICATION SCHEME • CORRECTION FACTOR, DETAIL	METHOD AND NO. OF DAMAGE CLASSES TYPE AND BASIS	policy solutions in respective countries?



OPAL Multicriteria Analysis for Zeytinburnu

- Global Location: Zeytinburnu, Turkey.
- Building class data: detailed—3E. Site class, buildings, seismological information, cost data all present on geocell level—Level 3.
- Level wanted: District—split into geocells—Level 3
- Best result given vulnerability: Using displacement based (3V), followed by HAZUS (2-3V) and followed by intensity (1-3V). i.e. analytical and then empirical.
- **Hazard wanted:** Use of response spectrum.
- Coding wanted: major—to achieve best result (complex). Socio-economic analysis wanted: both complex (3SE).
- Software tools in order of MCA results:
- 1. MAEviz, 2. DBELA, 3. SP-BELA, 4. ELER, 5. SELENA
- 6. HAZUS, 7. EORM, 8. StrucLoss, 9. EOSIM, 10. CAPRA MAEviz had already done a Zeytinburnu case study.



Site Class, Source Dist.

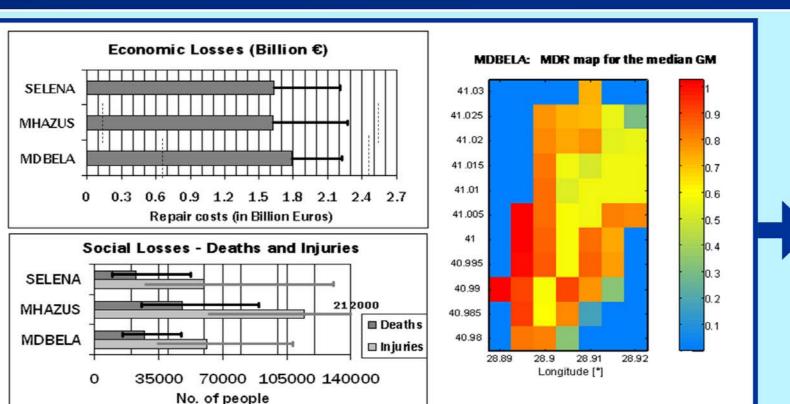
Loss assessment for zeytinburnu & future directions

MDBELA Methodology SHA CHOSEN used Hazard, Exposure and Fault Modelling The impact of a Mw7.2 buildings using classes into 5. fragility for buildings, deterministic COMPUTED nd D BELA process and HAZUS process. HAZUS Process earthquake in the Marmara Sea on the - Built area in m2 damage district of Zeytinburnu, Istanbul, Turkey, has GIS, mean damage ratio for each cell and been modelled using statistics using 201 damage models three chosen upancy rates for day and night used Population-time data with Spence (2007) injury/death rates software packages. social losses for each cell and full statistics. type and total social losses mean, variance and % COMPARISON AND LOGIC TREE ELEASSESSMENT

Results for Zeytinburnu

LOSSES - COMPLEXITY RATING

- All methods show the destructive capability of such a scenario earthquake in a vulnerable district like Zeytinburnu. It can be seen that the three software packages gave reasonably similar results.
- By running 100 ground motion scenarios (i.e. accounting for epistemic uncertainty and aleatory variability) as well as spatial and temporal correlation, MDBELA showed the least variability
- A minimum run of 150 million Euros damage was returned from MHAZUS. and a minimum of 670 million Euros damage was returned from MDBELA.
- The maximum run was around 2.5 billion Euros damage.
- A median 1.6-1.7 billion Euros loss expected.
- Median 27,000 deaths and 60,000 injuries, with much variation depending on
- SELENA was easily modified and showed the value of the OPAL process.



Future directions for **OPAL**

The procedure has been used by a number of scientists around the world to decide appropriate software and the next steps are as follows:

- Online MCA tool setup using the OPAL procedure to allow global use.
- A 2010 version of the OPAL report is proposed and continued
- Integration with CATDAT Damaging Earthquakes database to provide historic earthquake information for any user test region. MDBELA and MHAZUS to be released online.

OPAL aims to provide an open source framework to help researchers select appropriate software for their studies into regional earthquake loss estimation.