Probabilistic Seismic Loss Estimation for Eskisehir, Turkey

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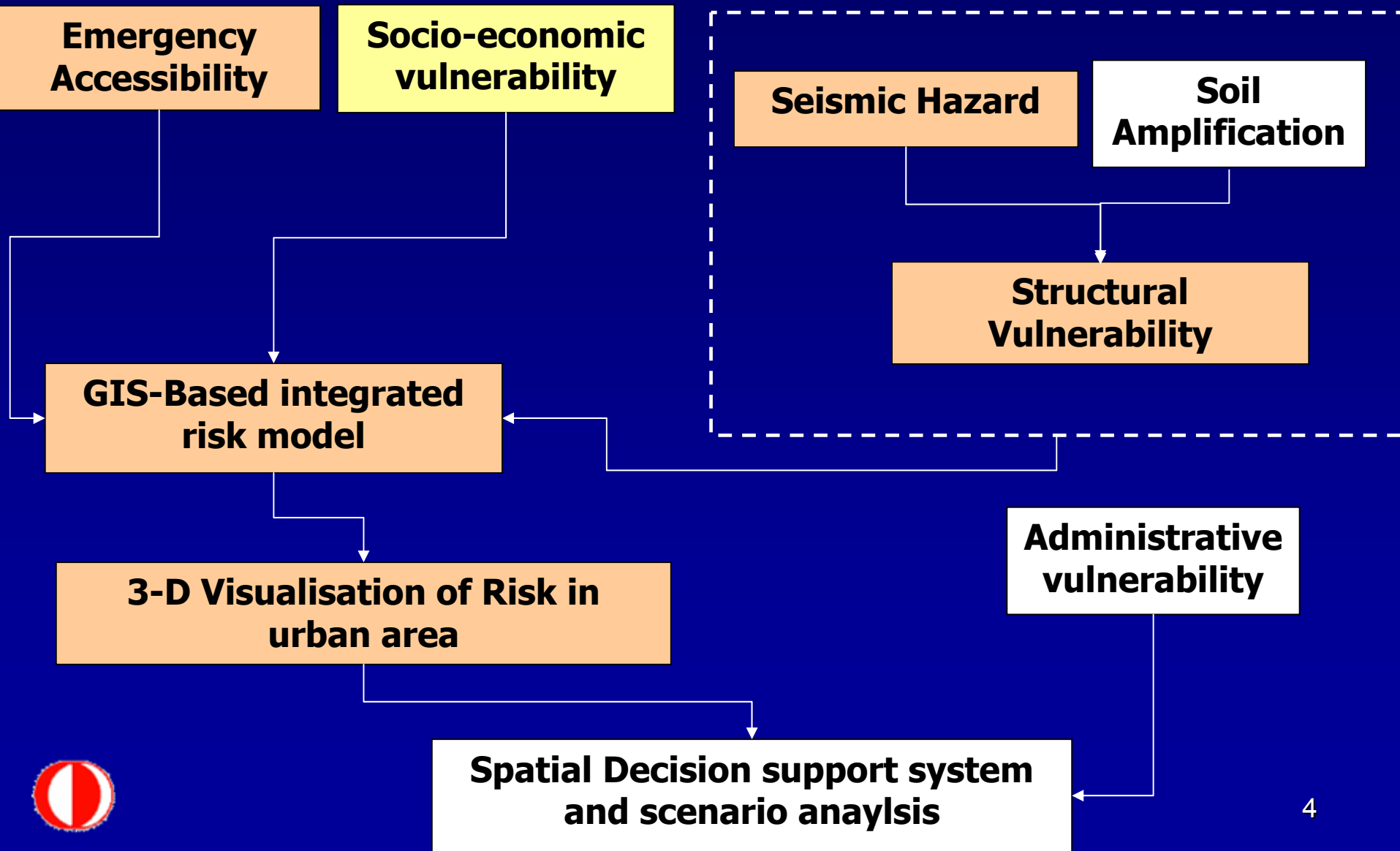
OUTLINE

- Introduction
- Probabilistic seismic hazard analysis
- Seismic hazard mapping
- Building vulnerability analysis

1999 Earthquake in Turkey

An Integrated Natural Disaster Risk Assessment Model for Urban Areas for Sustainable Development: Earthquake Case



AIM

To apply a probabilistic seismic loss estimation methodology for the assessment of potential earthquake losses in a certain municipality of Eskisehir.

METHODOLOGY

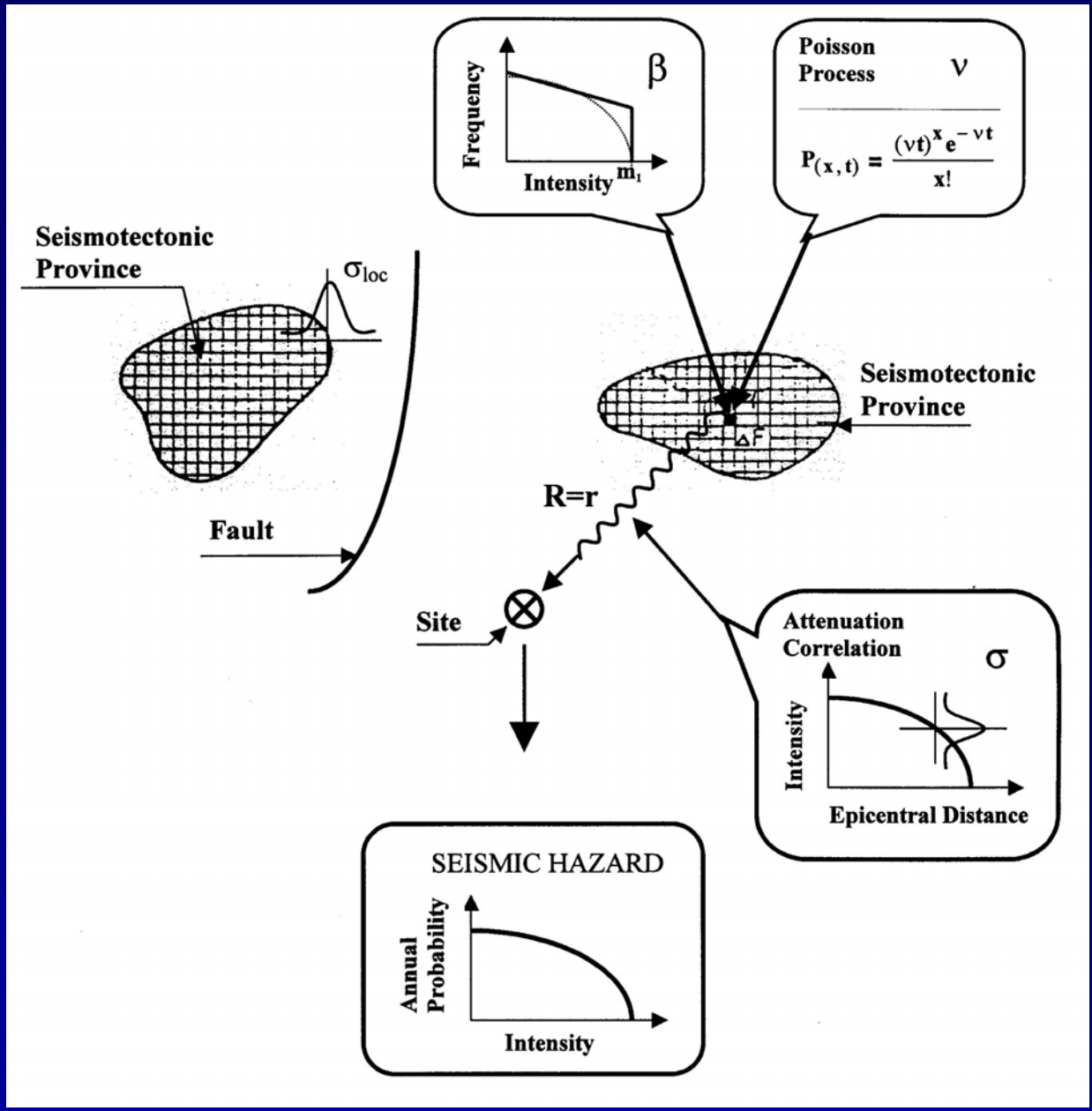
The basic steps are:

- Probabilistic seismic hazard analysis
- Vulnerability analysis
- Loss estimation

ELEMENTS OF PROBABILISTIC SEISMIC HAZARD ANALYSIS

The implementation of the classical probabilistic seismic hazard analysis consists of six major steps as listed below:

1. Preparation of a seismic database
2. Subdivision of the region to be studied into discrete seismic sources in the form of lines and areas.
3. Construction of a seismotectonic map
4. Development or selection of a ground motion estimation (attenuation) equation.
5. Preparation of a computational algorithm which will aggregate the seismic threat nucleating from different sources, yielding the probability distribution for the specified earthquake severity or ground-motion parameter at a specified location or at a number of locations
6. Consideration of different sources of uncertainties (aleotory and epistemic) by conducting sensitivity studies and employing logic tree or similar statistical methods.



Schematic procedure for determining the seismic hazard at a site

The Database for Eskisehir

A comprehensive seismic data base, which contains earthquakes that have occurred within 250 kms of the city center in the last century is compiled. The catalogs used are:

- Earthquake Research Department of General Directorate of Disaster Affairs of Turkey (GDDA-ERD),
- Kandilli Observatory and Earthquake Research Institute of the Bogazici University (KOERI),
- International Seismological Centre (ISC),
- United States Geological Survey (USGS).

Modifications in the Database for Eskisehir

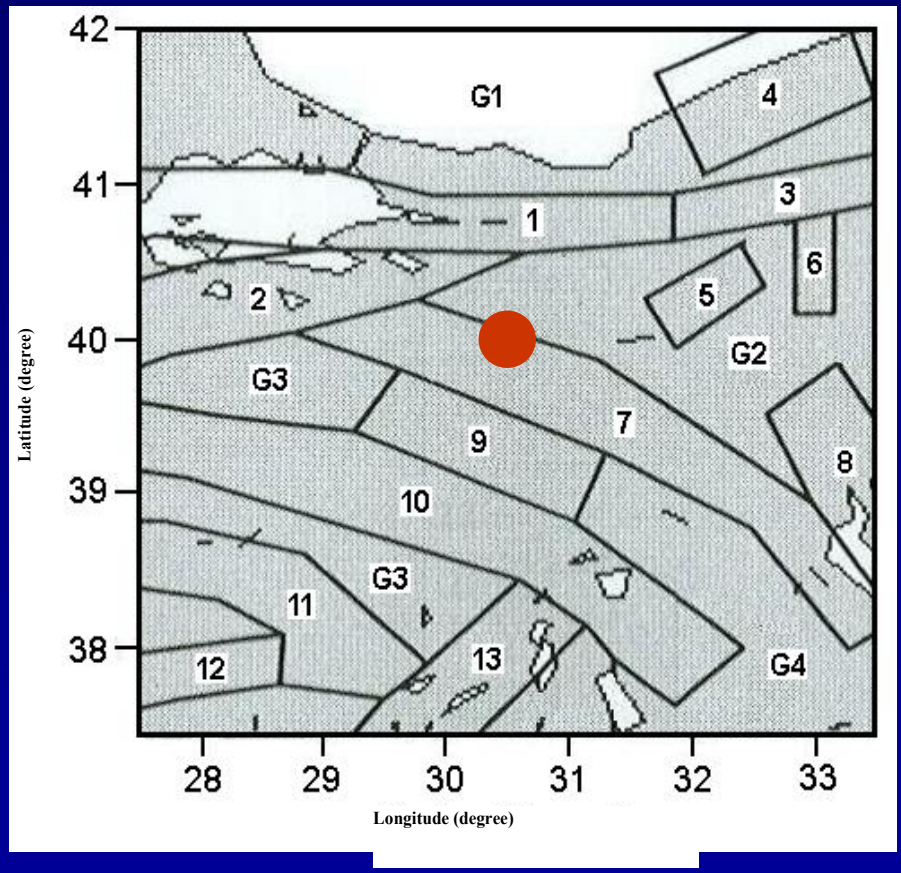
- All the magnitude scales used in the seismic data base are homogenized and converted to the moment magnitude scale (M_W) by using the empirical equations that were developed by Deniz (2006).
- These equations were obtained by applying the orthogonal regression procedure to earthquakes that have occurred in the last 100 years in Turkey.

Modifications in the Database for Eskisehir

- Elimination of earthquake clusters and identification of dependent events (fore and after shocks) by by using the space and time windows specified by Deniz (2006).
- Analysis of incompleteness in the earthquake catalogs by using artificially completed rates (i.e. complete number of events over a particular time period) based on the method proposed by Stepp (1973).

Delineation of the Seismic Source Zones

- The configuration given by **Bommer, et al. (2002)** is adopted with some local modifications (**Kocyigit, 2005**) to take into account the recent findings.
- For the earthquakes that can not be related to any of the 13 seismogenic provinces, **background seismicity** regions are defined.



GROUND MOTION PREDICTION EQUATIONS

For the peak ground acceleration the ground motion prediction equations given by

- Gulkan and Kalkan (2002) and
- Boore, et al. (1997)

for rock sites are adopted.

For intensity attenuation, the equation proposed by Musson (2000) is used.

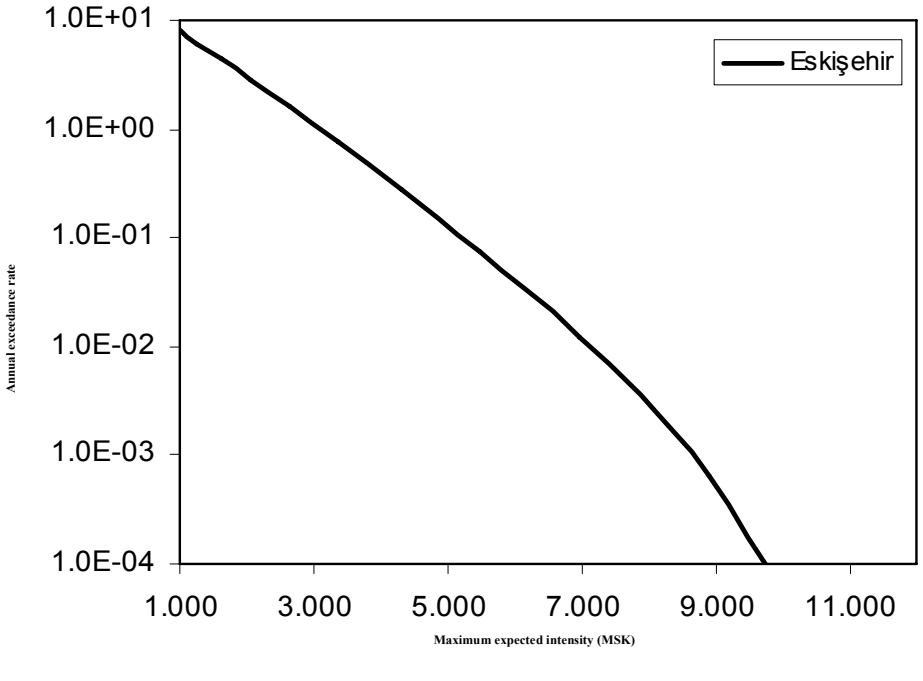
Best Estimate of Seismic Hazard for Eskisehir

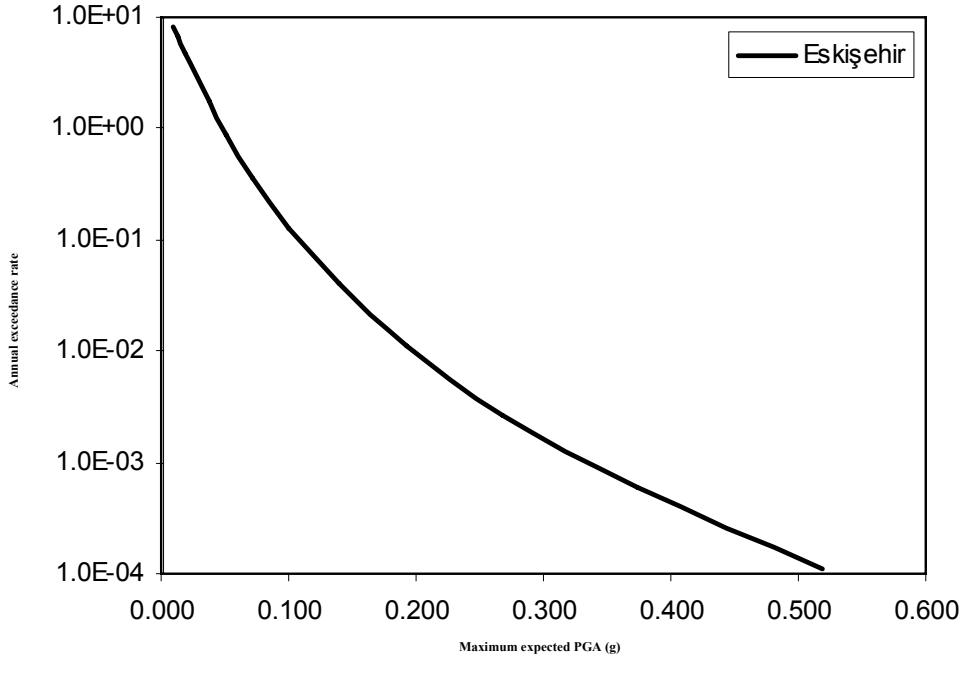
- In order to reflect the influence of various assumptions discussed above and to account for the epistemic uncertainties in the values of seismicity parameters, the logic tree procedure is applied.
- The alternative assumptions are listed in Table 2, together with the subjective probabilities assigned to them.

Table 2. Alternative assumptions and corresponding subjective probabilities

Alternative assumptions		Subjective probability
All earthquakes		0.5
Main shocks only		0.5
Incomplete catalogs		0.4
Artificially completed catalogs		0.6
Standard least squares regression in the computation of the recurrence relationships		0.4
Maximum likelihood method in the computation of the recurrence relationships		0.6
If PGA is used	Attenuation relationship of Gulkan and Kalkan (2002)	0.6
	Attenuation relationship of Boore, et al. (1997)	0.4
	Attenuation uncertainty, $\sigma_{\ln Y} = 0.447$	0.1
	Attenuation uncertainty $\sigma_{\ln Y}$ is equal to the reported value	0.6
	Attenuation uncertainty, $\sigma_{\ln Y} = 0.707$	0.3
If intensity (MSK) is used	Attenuation relationship of Musson (2000) in its original form	0.5
	Attenuation relationship of Musson (2000) converted to M_w scale	0.5
	Attenuation uncertainty, $\sigma_{\ln I} = 0.01$	0.15
	Attenuation uncertainty, $\sigma_{\ln I} = 0.06$	0.60
	Attenuation uncertainty, $\sigma_{\ln I} = 0.10$	0.25

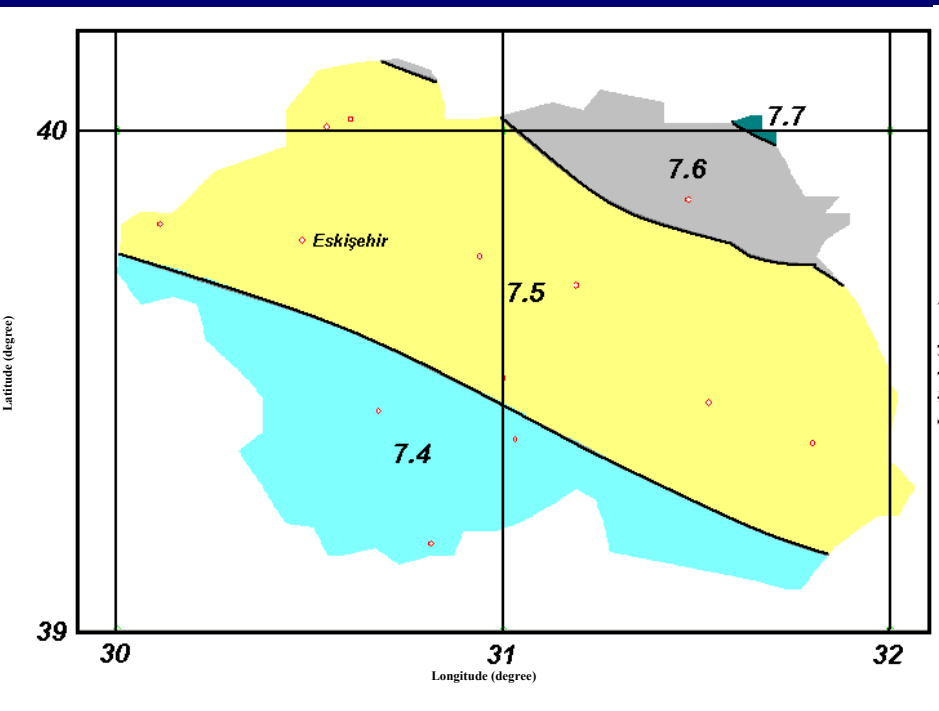
Best estimate seismic hazard curve for Eskisehir/City Center **in** terms of (a) intensity (MSK) and (b) peak ground acceleration (g)

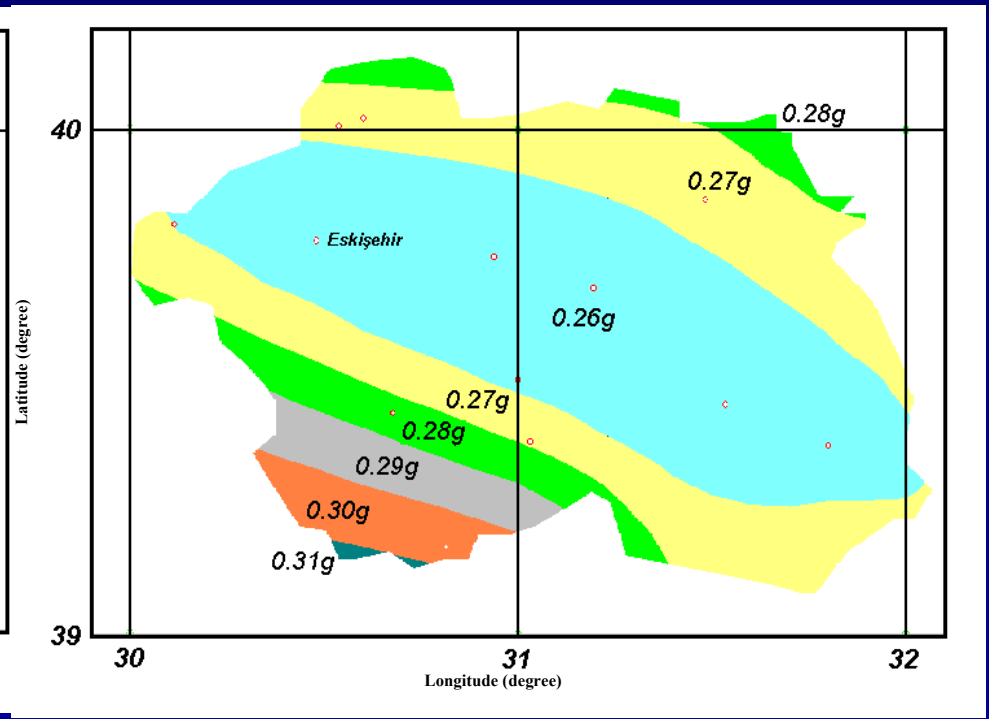




- (a)
- (b)

Seismic hazard map, in terms of intensity (MSK) and peak ground acceleration (g), corresponding to a return period of 475 years (10 % Probability of exceedance in 50 years) obtained based on the combination of the most likely assumptions

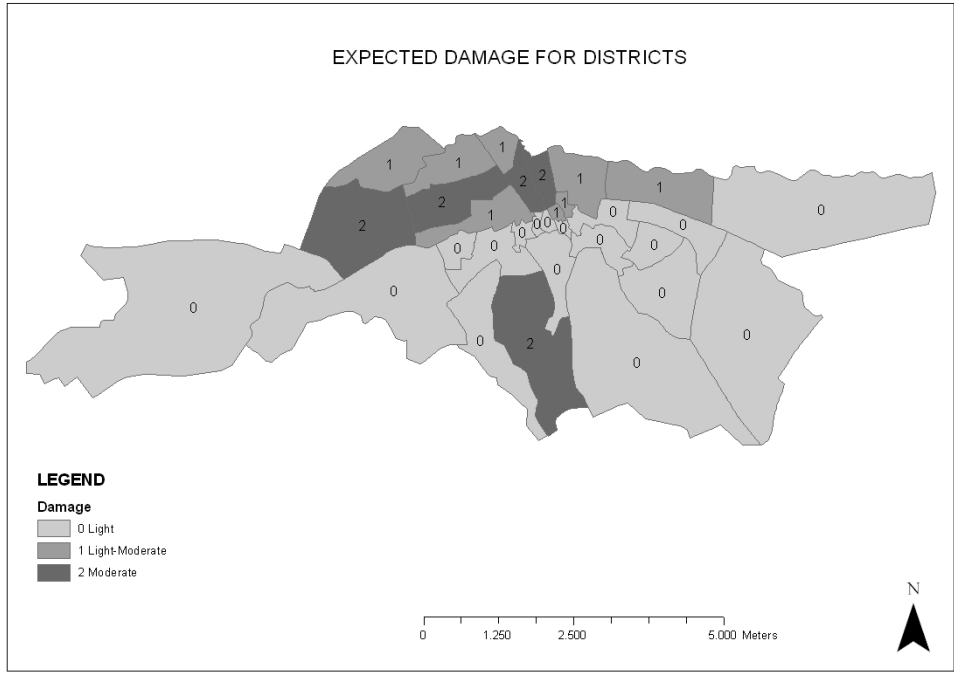




VULNERABILITY ANALYSIS FOR ODUNPAZARI

Servi (2004), has compiled a data base for the 27904 buildings located in the 31 districts of the Odunpazari municipality. This data base contains information on:

- Location (longitude and latitude)
- Number of floors
- Soil classification (Z1, Z2, Z3, Z4)
- Condition (very bad, bad, moderate, good)
- Ttype (reinforced concrete, masonry, wooden) buildings.



CONCLUDING COMMENTS

- It was not possible to apply the renewal model for the temporal distribution of earthquakes together with the characteristic earthquake model for the magnitude distribution as alternatives and check the sensitivity of results to these assumptions
- This is due to the fact that available earthquake catalogues for Turkey fail to report the last characteristic earthquake of each seismic source zone as they only cover a century. Studies on the long-term seismological slip rates are also quite recent for Turkey. Hence, the data requirements of the renewal and characteristic earthquake models can not go further than being assumptions.