UPDATED PROBABILISTIC SEISMIC HAZARD MAPS FOR TURKEY


PSHA Workshop
Future directions for probabilistic seismic hazard assessment at a local, national and transnational scale
5 to 7 September 2017, Lenzburg Switzerland
THREE GENERATIONS OF SEISMIC HAZARD MAPPING IN TURKEY

- Earliest maps based on observed damage, updated as earthquakes occurred (1945, 1947, 1963, 1972)
THREE GENERATIONS OF SEISMIC HAZARD MAPPING IN TURKEY

- Second generation based on PSHA, e.g. Erdik et al. (1985), Gülkan et al. (1993), Erdik et al. (1999), Demircioğlu et al. (2007) etc.
THREE GENERATIONS OF SEISMIC HAZARD MAPPING IN TURKEY

- Single tectonic region, except a few more recent ones areal sources only, one or few ground motion prediction models
THREE GENERATIONS OF SEISMIC HAZARD MAPPING IN TURKEY

- Third generation: SHARE, EMME, new Turkish hazard model (several source models, detailed parameterisation)
From SHARE to EMME, from EMME to the Turkey model

Same databases for Turkey, EMME more complete to the east, differences in modeling

Databases compiled by different groups, similar modeling

OPENQUAKE used in hazard computation

The new Turkey model
ACTIVE TECTONIC FEATURES OF THE REGION (FROM EMRE ET AL., 2016)
The homogenized catalogue was declustered using the Gardner and Knopoff (1974) method after testing several alternatives (Eroğlu Azak et al., 2017)
ALL EARTHQUAKES WITH MAGNITUDE LARGER THAN 6.0
FAULT PLANE SOLUTIONS (FROM DUMAN ET AL., 2016)
CATALOGUE

COMPLETENESS
CATALOGUE COMPLETENESS
THE AREA SOURCE MODEL

Full parameterisation in terms of:

- **Mmax** (3 levels, based on maximum observed magnitude and characteristic magnitude from fault segments)
- Depth distribution (based on hypocentral depth and fault depths)
- Rake angle (percentages based on observed earthquake mechanisms and fault data)
- Predominant strike and dip angles (fault database)
- Recurrence (earthquake catalogue and its completeness)

*Sesetyan et al. (2016)*
THE FAULT SOURCE MODEL AND SMOOTHED SEISMICITY IN THE BACKGROUND

Demircioğlu et al. (2017)
FAULT SOURCE PARAMETERIZATION

- Characteristic magnitude (based on segment dimensions and source scaling relations)
- Dip angle (from the fault database)
- Depth distribution (from the fault database)
- Rake angle (from the fault database)
- Slip rate on each segment in a range of min-max
- $b$-value (taken from the corresponding completeness / tectonic region)
- Activity (computed with the above parameters by Youngs and Coppersmith, 1985, truncated exponential model)
- Magnitudes 6 and larger allowed to occur on faults
SMOOTHED SEISMICITY PARAMETERIZATION

- Point sources representing grids of 0.1°
- Buffer zones of 15 km around surface projection of fault sources
- Magnitudes < 6 in the buffer zones occurring on the grid sources
- Magnitudes up to $M_{\text{max}}$ occurring on grid sources outside buffer zones
- All geometric parameters adopted from area sources
- $b$-value taken from the corresponding completeness / tectonic region
- $a$-value computed with a 50 km normal smoothing of the earthquake catalogue
The logic tree

The Area Source Model (0.50)
Active Shallow Crustal Sources
Subduction Interface Sources
Subduction In-Slab Sources

The Fault Source Model (0.50)

Mmax 1 (0.25)
Mmax 2 (0.50)
Mmax 3 (0.25)

Recurrence Parameters

Active Shallow Crustal Sources
Akkar et al. (2014) (0.3)
Akkar and Çağnan (2010) (0.3)
Chiou and Youngs (2008) (0.3)
Zhao et al. (2006) (0.1)

Subduction Interface Sources
Zhao et al. (2006) (0.4)
Youngs et al. (1997) (0.2)
Atkinson and Boore (2003) (0.2)
Lin and Lee (2008) (0.2)

Subduction In-Slab Sources
Zhao et al. (2006) (0.4)
Youngs et al. (1997) (0.2)
Atkinson and Boore (2003) (0.2)
Lin and Lee (2008) (0.2)

Selection criteria of GMPEs presented in Kale et al., (2016)
PARAMETERS DELIVERED

- Mean PGA, PGV, SA (T=0.2 s) and SA (T=1.0 s) corresponding to 43, 72, 475 and 2475 years return periods as requested by the new Turkish earthquake resistant design code

Based on the project results, the Disaster and Emergency Management Authority of Turkey has also designed a web tool for the computation of the design spectra for any selected locality
AREA SOURCE MODEL 475 YEARS PGA
FAULT SOURCE MODEL 475 YEARS PGA
475 years PGA, 0.5 and 0.5 weighted combination of the two source models
475 YEARS PGA, 0.5 AND 0.5 WEIGHTED COMBINATION OF THE TWO SOURCE MODELS

Earthquake zoning map (1996)
The new Turkey model
The project was launched and funded by the Prime Ministry Disaster and Emergency Management Authority (Project Code: UDAP-Ç-13-06), also supported by the Turkish Catastrophe Insurance Pool.

All mentioned articles are now available online in the Bulletin of Earthquake Engineering.
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