Seismic hazard modeling
for Bulgaria

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Bulgarian seismic network and foreign stations used in epicenter location
Sismicity in Bulgaria and surroundings \((M\geq 4.0)\)
Epicentral map for Bulgaria and surroundings (after 1980, all recorded quakes)
First building code - 1957
SEISMIC SOURCES

SEISMIC ZONING MAP – 1987, return period 1000 years
PROBABILISTIC SEISMIC HZARD ASSESSMENT

The probability that a ground motion parameter, $Z$, at a given site, will exceed a specified level, $z$, during a given time period, $t$, is given by the expression:

$$P(Z \geq z \mid t) = 1 - e^{-\nu(z)t \leq \nu(z)t}$$

where $\nu(z)$ is the average frequency during time period $t$ at which the level of ground motion parameter $Z$ exceeds $z$ at the site, resulting from earthquakes in all sources in the region.

The frequency of exceedance, $\nu(z)$, is calculated by:

$$\nu(z) = \sum_n \alpha^n (m^0) \int \int f(m) f(r \mid m) P(Z \geq z \mid m, r) dr dm$$

$\alpha^n (m^0)$ is the frequency of earthquakes on source $n$ above a $m^0$ (min. mag. of ing. Importance);
$f(m)$ is the PDF for events between $m^0$ and maximal event for the source $m^u$;
$f(r \mid m)$ is the PDF for distance to the earthquake rupture;
$P(Z \geq z \mid m, r)$ is the probability that for a given magnitude $m$ earthquake at a distance $r$ from the site, the ground motion exceeds level $z$. 
A seismic source model is developed for PSHA for the territory of Bulgaria. The model is based on complex geodetic, geological, geophysical and seismological data and is presented in Fig. For each source are defined the all parameters describing the seismicity in the source. Two cases are considered:

1. All sources are areal sources – earthquakes are randomly distributed in the corresponding source
2. Smaller earthquakes are randomly distributed in the source while stronger earthquakes are happened only on the faults defined in the source.

The final result is a mean of the two considered cases. The hazard was evaluated for a grid with cell size 0.05°x0.05°.
COMPLEX GEOLOGO-GEOPHYSICAL AND SEISMOLOGICAL MAP
Influence of intermediate Vrancea earthquakes

Seismic hazard (475 years return period)

National Institute of Geophysics, Geodesy and Geography - BAS
DEAGGREGATION OF THE 475 YEARS HAZARD – Northern cities
DEAGGREGATION OF THE 475 YEARS HAZARD – Southern cities
DEAGGREGATION OF THE 475 YEARS HAZARD – South-Eastern part
DETERMINISTIC HAZARD ASSESSMENT


Active faults
5% -Damped Pseudo-Absolute Acceleration Response Spectrum

Bourgas,
Fault length=64 km, M=7.2, distance=31km

Varna,
M=8, distance=39km
THANK YOU FOR ATTENTION