REDUCTION OF THE ECONOMIC-FINANCIAL EXPOSURE OF THE STATE AND PROTECTION OF HUMAN LIVES

Models for the prevention and mitigation of damages to people and properties through an insurance coverage

PRESENTATION

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REFERENCE INSTITUTE: National Institute for Earth Physics (NIEP), Magurele, Romania

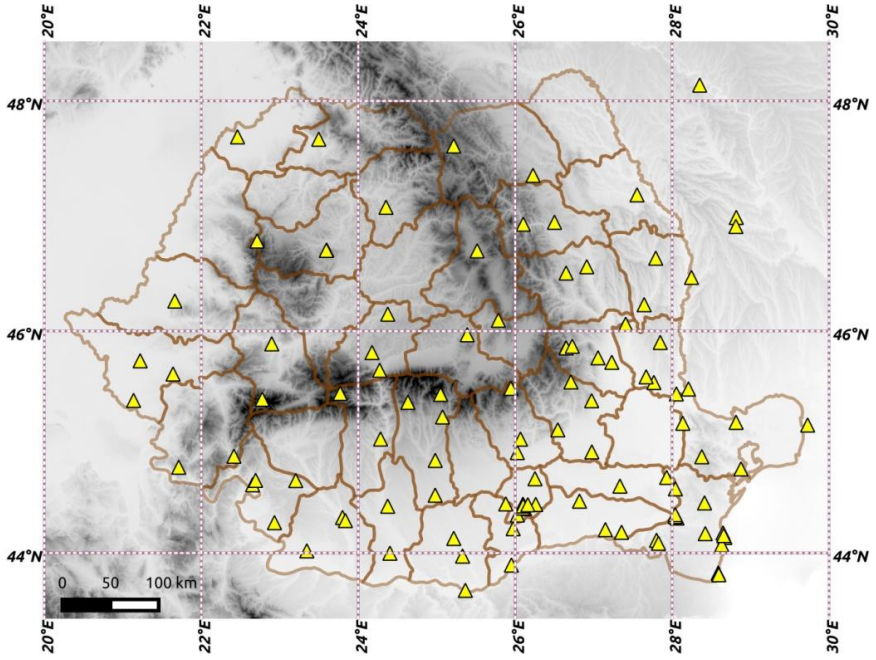
Professional experience

Background: geophysicist (1999), PhD (2009), working at NIEP since 2000

Main building at Magurele, Romania

NIEP major directions of research:

1. Seismic source physics;
2. Seismicity and seismotectonics
3. Lithosphere structure
4. Seismic hazard
5. Engineering seismology



Romanian Seismic Network

1. seismic stations (105) equipped wit both velocity and accelerometer sensors
2. Seismic arrays (2)

Professional experience

1. Site effects;
   - an important role played in understanding the seismic field
   - 8 regions on the Romanian territory having different amplification characteristics -> ShakeMap -> near real-time system for estimating the seismic damage

2. Internal structure of the earth

   - Seismic tomography from ambient noise cross correlations for the Pannonian and Romanian territory
   - Joint inversion of receiver function and surface wave data for imaging the crust structure

3. Seismic wave attenuation
   - Strong frequency-dependent attenuation towards Transylvanian basin -> implications on seismic hazard computations (assessment)

Investigating lithospheric structure using seismic experiments

- A variety of seismologic techniques to investigate the elastic properties of the crust and upper mantle:
  - inversion of P and S wave arrival times
  - reflection and refraction experiments
  - receiver function analysis
  - surface wave analysis
  - ambient noise tomography
- In Romania:
  - Controlled-source seismic experiments:
    - Vrancea99 refraction profile
    - Vrancea01 refraction profile
  - Passive seismic experiments
    - CALIXTO tomography experiment
    - South Carpathian Project

Investigating lithospheric structure using seismic experiments

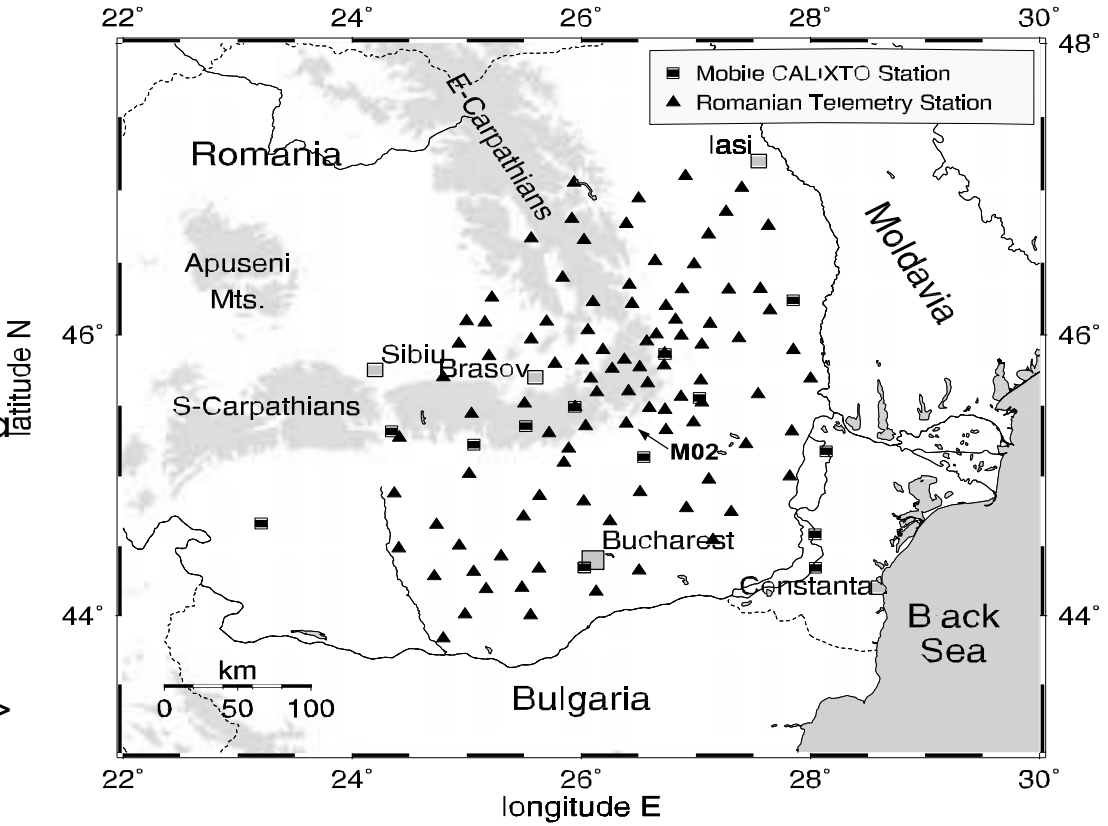
48°

CALIXTO experiment

Dense seismic array installed in Vrancea epicentral area and its surroundings (110 stations)

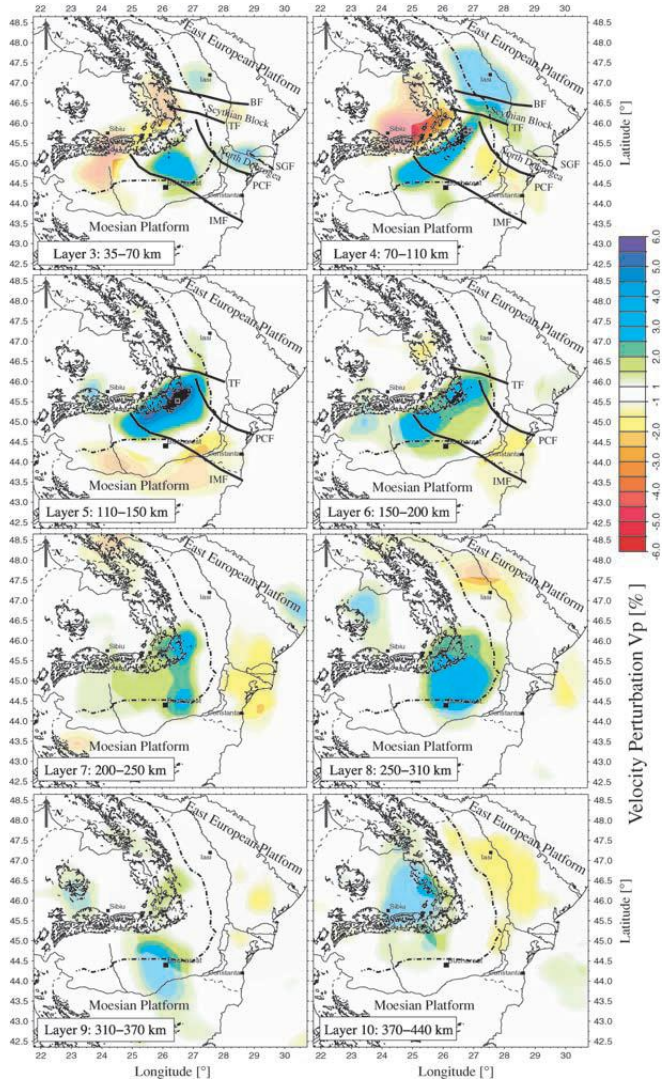
Main objective – detailed investigation of the upper mantle in a unique and interesting region (Vrancea) region

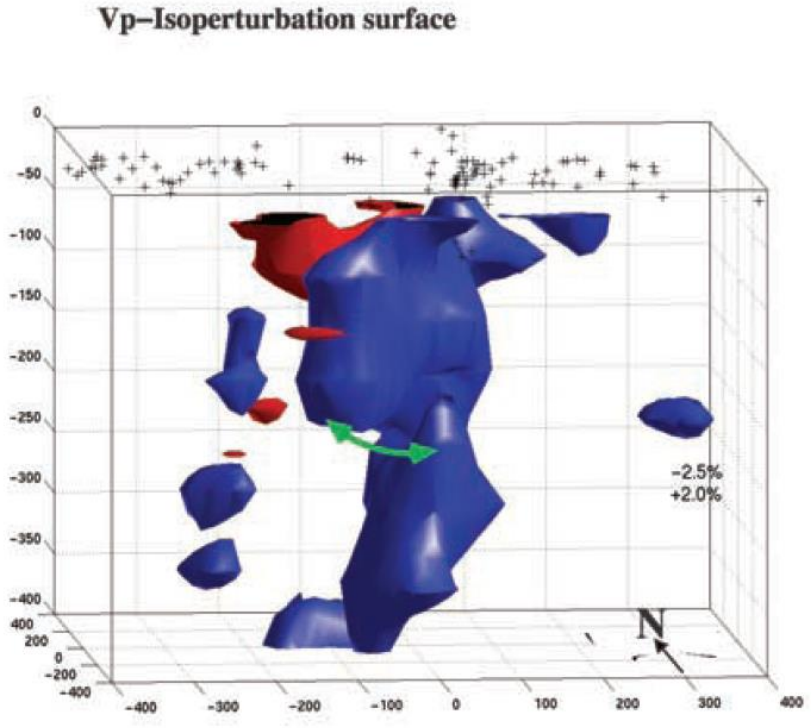
Teleseismic body wave tomography (more than 190 teleseismic events) -> more than 12000 relative P-wave travel time residuals



Location of the 110 CALIXTO stations used for the tomographic inversion (after Martin et al., 2006)

Investigating lithospheric structure using seismic experiments





3D model resulted from high-resolution seismic tomography (view from SSW , after Martin et al., 2006)

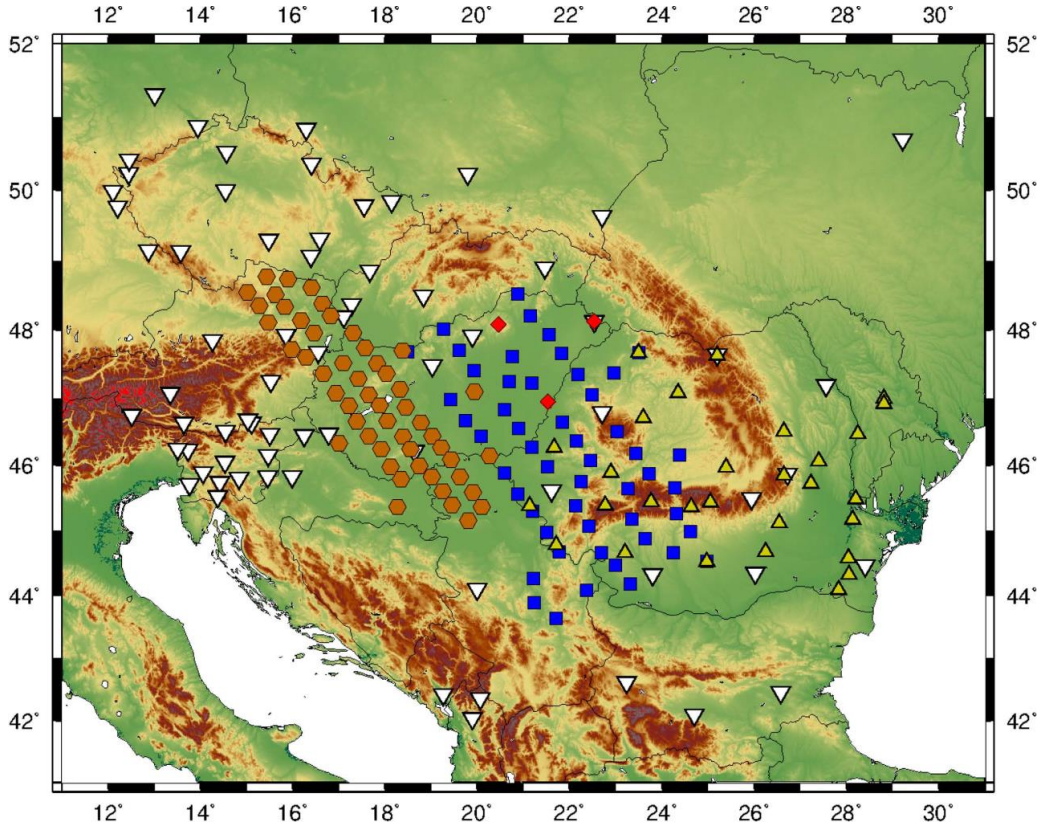
Upper mantle relative *P-wave velocity structure as the result of the inversion with the CALIXTO data set (after Martin e al. 2006)*

Investigating lithospheric structure using seismic experiments

Ambient noise tomography
powerful in imaging the Earth's crust and uppermost mantle at both regional and global scale beneath dense seismic arrays

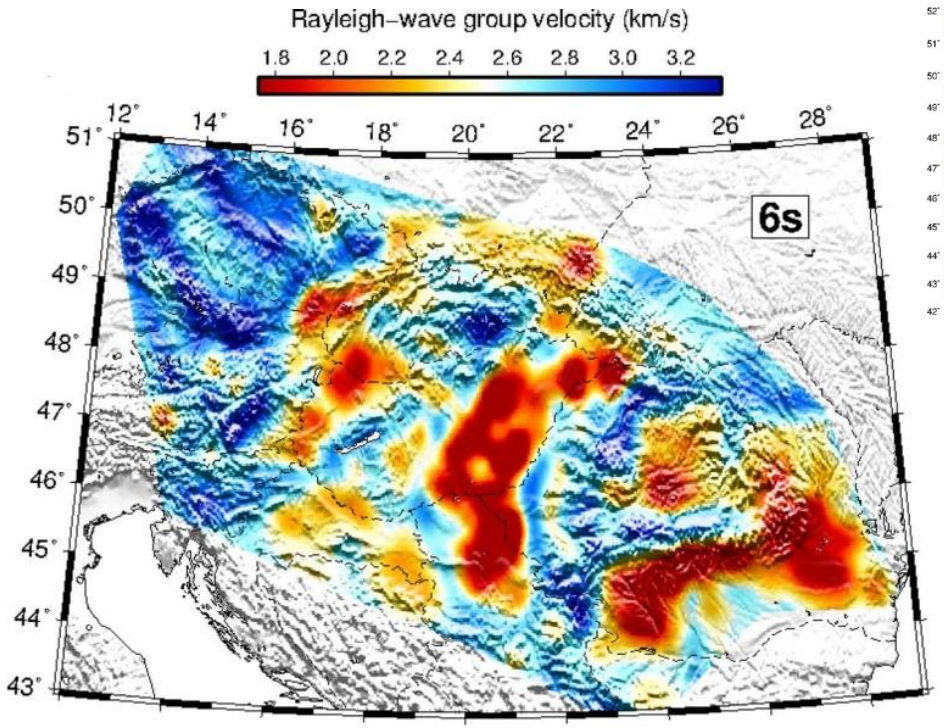
- temporary network of 54 stations deployed during the South Carpathian Project (SCP) (2009–2011)
- 56 temporary stations deployed in the Carpathian Basins Project (CBP) (2005–2007)
- 100 permanent and regional broad-band stations

Over 7500 Rayleigh wave empirical Green's functions

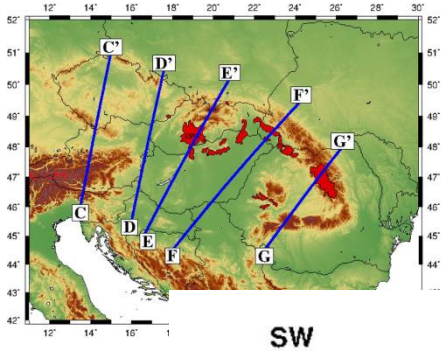


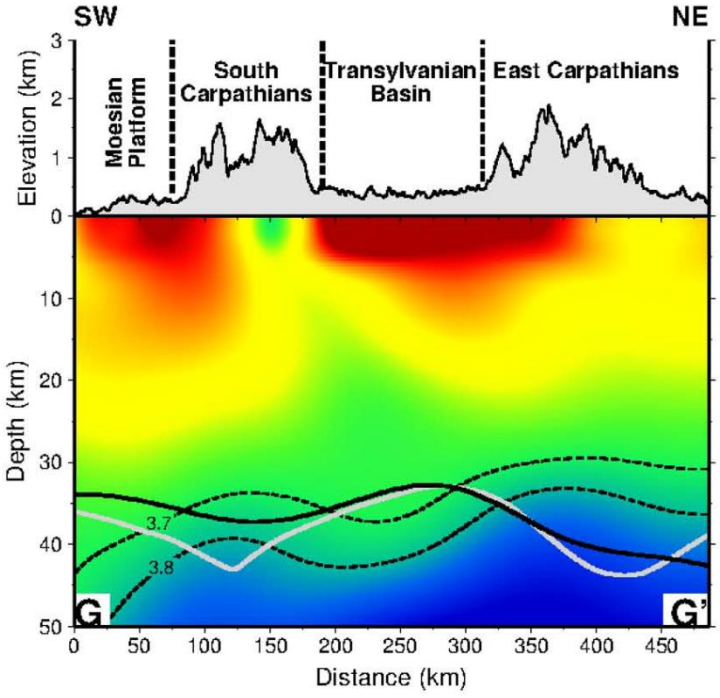
Distribution of broad-band stations used for ambient noise tomography; brown hexagons - stations from CBP project, blue squares – stations from SCP project, white inverted triangles - permanent broad-band stations; yellow triangles – broad-band stations from the Romanian Seismic Network (after Ren et al., 2013)

Investigating lithospheric structure using seismic experiments



Rayleigh-wave group velocity map at T = 6s (after Ren et al., 2013)





Vertical sections through the 3-D shear wave velocity model (G–G'); dashed lines iso-velocities of *Vs = 3.7 and 3.8 km/s; grey and black continuous lines correspond to Moho depths from* Tesauro *et al. (2008) and Grad et al. (2009)* (Ren et al., 2013)

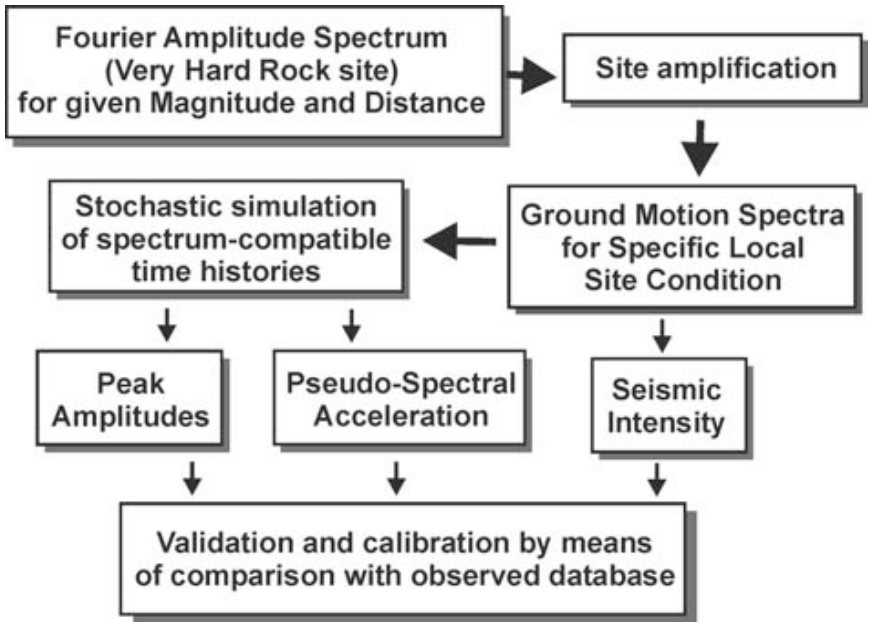
Ground shaking caused by earthquakes

PGA defined for bedrock conditions -> ground motion amplifications -> ground motion at surface

Estimation of ground motion:

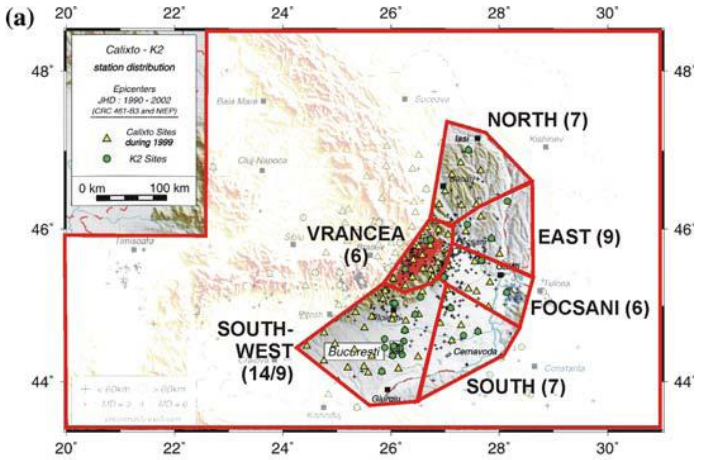
1. strong motion simulations (hybrid waveform modeling method – combination of the modal summation technique with finite differences technique; Cioflan et al. (2004) reproduced the recorded ground motion in Bucharest at a satisfactory level for seismic engineering)
2. attenuation relationships based on earthquake data

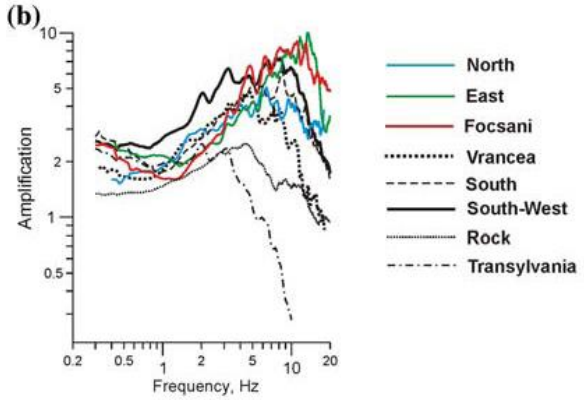
Sokolov et al. (2008) – regional GMPE for PGA, PGV, PSA, intensity (MSK scale) for the Vrancea intermediate depth earthquakes and territory of Romania



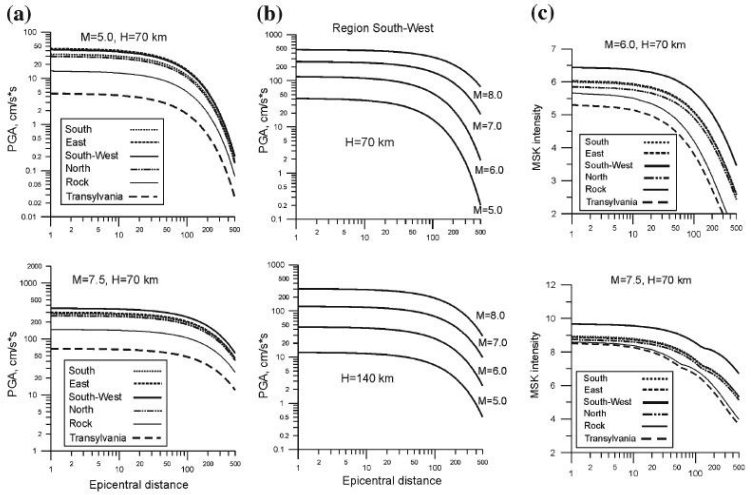
Scheme of evaluation of the ground-motion attenuation relationships based on the Fourier amplitude spectra (after Sokolov et al., 2008)

Ground shaking caused by earthquakes

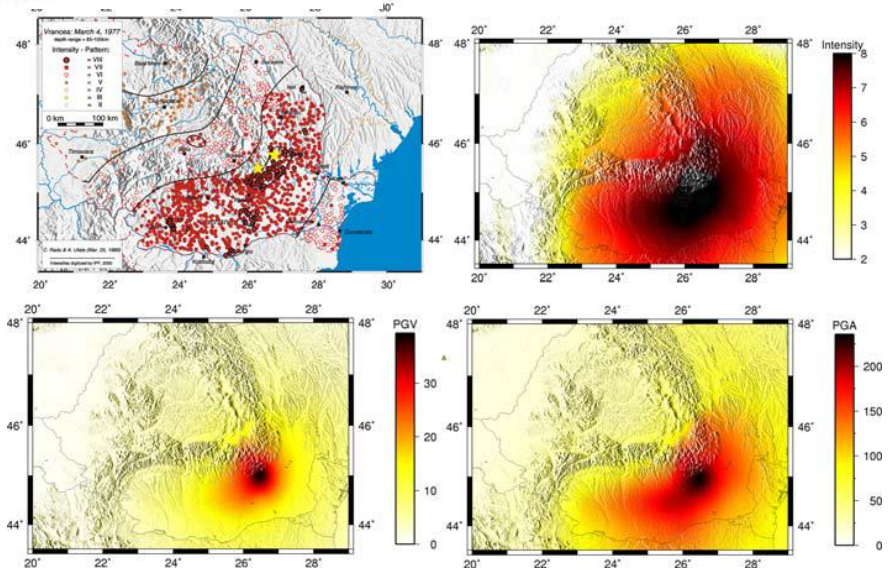




Scheme of the characteristic regions and location and the generalised region-dependent site amplifications (mean amplitude values) including amplification for the generalised "rock" category (after Sokolov et al., 2008)

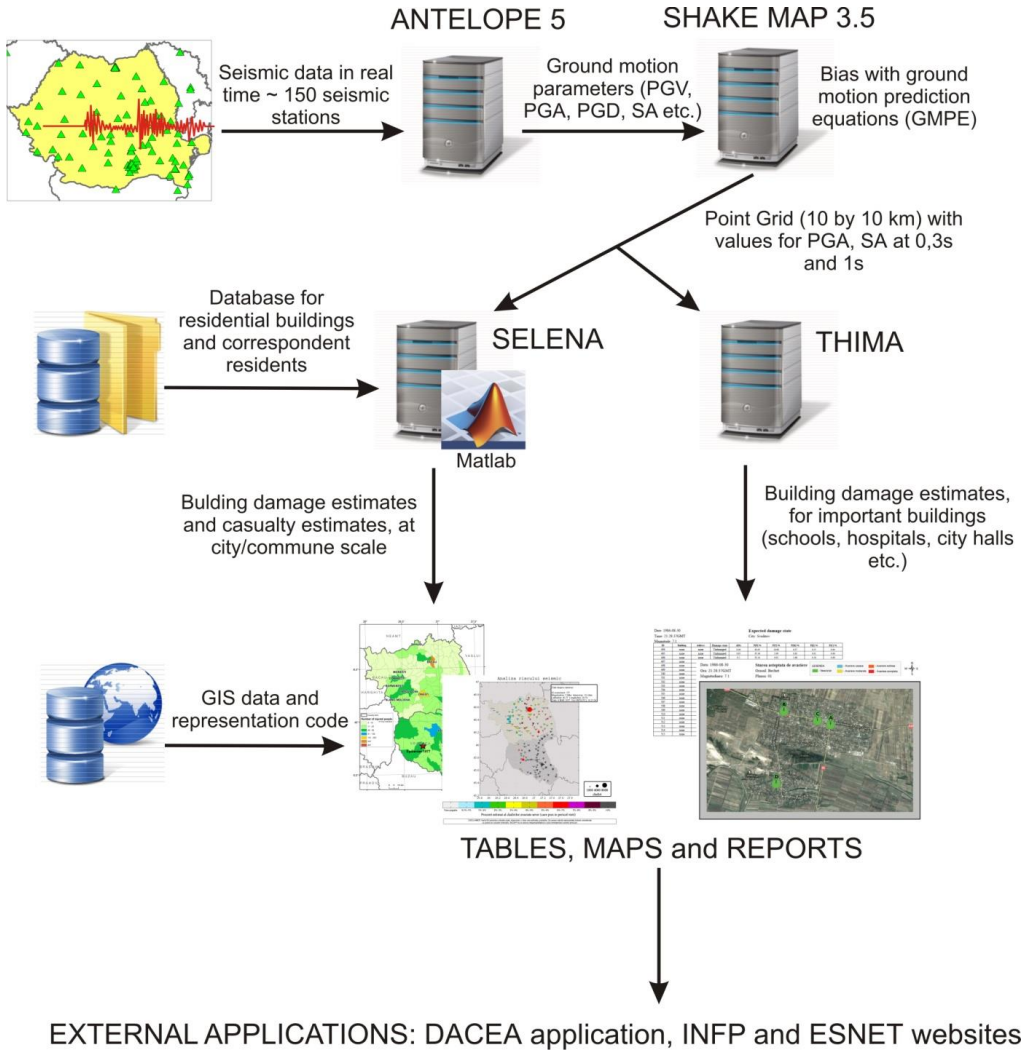


Comparison of the modelled PGA andMSK intensity curves for various zones, magnitudes (M), depth (H), and epicentral distances.



The observed macroseismic maps and the modeled distribution of ground motion parameters (MSK intensity, PGA and PGV) for the earthquake of March 4, 1977 (MW 7.4, depth 95 km)

Ground shaking caused by earthquakes



Flow chart of the near real-time system for estimating the seismic damage running at NIEP and developed within the project Cross-border System for Earthquake Alert (DACEA) implemented in the framework of the Cross-border Cooperation Programme Romania-Bulgaria 2007-2013, cofinanced by the *European Fund for Regional Development*, the *Bulgarian and Romanian Governments* and the *5 partners* of the project.

SELENA (SEimic Loss EstimatioN using a logic tree Approach, ©NORSAR) is based on the HAZUS methodology that has been developed as a multi-hazard risk assessment tool for the US (FEMA, 2004), adapting it to the European conditions (specific GMPE's), adding new methods (MADRS, I-DCM) and replacing ESRI ArcGIS dependencies.

THIMA is a loss estimation software created by the Technical University of Civil Engineering, Bucharest, that uses the near real-time methodology of SELENA used at NIEP, to analyze the behavior of important individual buildings (like emergency centers, schools, hospitals, city halls) in case of an earthquake.

Importance and validity of project

- Importance of project
  - Italy has a high seismic risk (high seismic hazard, high vulnerability and high exposure) -> mitigation of the risk of building collapse and reduction of casualties
  - challenging objectives, such as: characterization of the seismogenic structures (blind faults), promoting seismic hazard estimation by 2 aspects: time-independent and time-dependent modeling of earthquake occurrence and the deformation distribution in time and space based on kinematic computations;
  - from seismological point of view it will provide new refined information related to the structure and geodynamics of the studied area (Calabria)
- Validity
  - The project is based on a large multidisciplinary data (seismological, geodetic, geological, vulnerability data)
  - The proposed methodology is appropriate and links well all the procedures involved in different domains (seismic hazard, vulnerability)

Originality and innovative aspects

- New approach for a refined characterization of seismic sources
- Interpretation and integration of new multidisciplinary data (airborne geophysical exploration, passive seismic experiments, GPS and InSAR data)
- New aspects related to time and space behavior of the seismic activity through numerical simulation