Seismic hazard data for the new, Italian building code based on European standard

V. Montaldo (1), C. Meletti (1), M. Stucchi (1), E. Faccioli (2), G. Calvi (3), E. Boschi (4), G. Di Pasquale (5), and A. Gomez Capera (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Milano; (2) Politecnico di Milano, Dipartimento di Ingegneria Strutturale; (3) Università di Pavia, Dipartimento di Meccanica Strutturale; (4) Istituto Nazionale di Geofisica e Vulcanologia; (5) DPC, Ufficio Servizio Sismico Nazionale - ITALY

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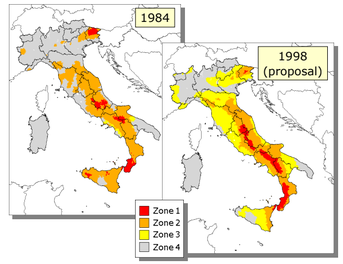
1 – The seismic provisions in Italy prior to 2003

Prior to 2003 the Italian building code, established in 1974, was mostly based on working stress design. The zonation that guided its application was made up in 1981 using a semi-quantitative, mainly seismological approach; it was enforced in 1984 and left about 2/3 of the territory without seismic provisions.
In 1998 a new zonation was proposed but never adopted.
The 2002 Mw5.7 earthquake in Molise (Southern Italy) caused the collapse of a school and the death of 26 children. The school was built in an area where seismic provisions were not applied, although the zonation proposed in 1998 assigned it to the second zone.
The earthquake triggered a process that led in a few months to a new set of seismic provisions.



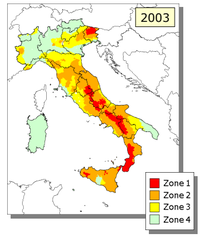
CHRONOLOGY OF EVENTS

October 31, 2002	Molise earthquake (Southern Italy), Mw5.8
December 2002	A panel of experts, known as "Commissione Letta", is appointed the task of updating and upgrading the national building code following EC8 prescriptions
March 20, 2003	The new seismic provisions are released through the Prime Minister Ordinance "Ordinanza PCM n.3274"
May 2003	The Prime Minister Ordinance is officially enforced in the Country

2 – The new seismic provisions

The new provisions, inspired by EuroCode8 (CEN, 2004), are the result of the interaction between seismologists and engineers, which addressed many topics:

1. the general criteria supporting the definition of the seismic zones;
2. the ground-motion description in each zone in probabilistic terms and the definition of smoothed elastic and design response spectra;
3. the definition of site amplification effects by means of code coefficients;
4. the definition of advanced design rules for the assessment and rehabilitation of existing structures and for the use of innovative technologies in seismic design, e.g. the seismic isolation.



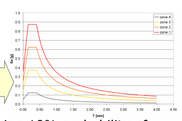
A preliminary zonation to support the new provisions was based on the "forgotten" 1998 map.
This 2003 zonation introduced a major difference: the areas not considered seismic in 1998 were put in a seismic zone of lower (but not null) seismic hazard. The whole territory now belongs to a seismic zone.

However, to accomplish the full transition to the new seismic provisions, a new seismic hazard map compiled in terms of PGA was required.

It was then decided that the reference seismic hazard map must be computed as follows:

- ✓ employ recent, widely used methods;
- ✓ employ updated input data;
- ✓ employ transparent procedures: input data must be made available to public;
- ✓ results to be checked through peer review.

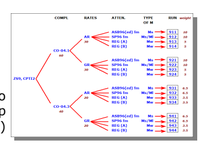
PGA, 10% prob. in 50 years [a_g/g]	zone	Anchor values of the elastic response spectrum [a_g/g]
> 0.25	1	0.35
0.15 – 0.25	2	0.25
0.05 – 0.15	3	0.15
< 0.05	4	0.05



The seismic zoning is governed by the values of PGA having 10% probability of exceedance in 50 years, computed on hard ground condition (Vs_{30}>800m/sec).

3 - Seismic hazard map of Italy

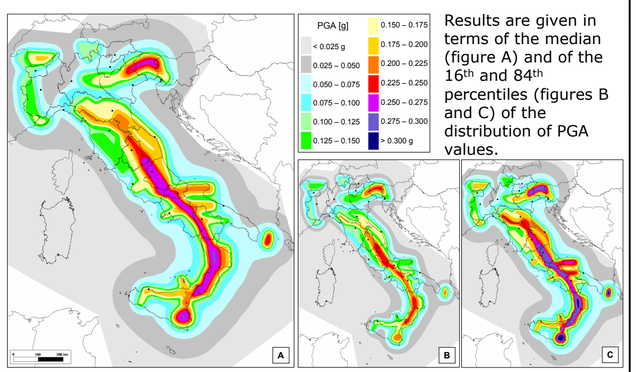
A first release of the reference seismic hazard map of Italy was issued in April 2004.



The logic tree followed to compute the seismic hazard map (Gruppo di Lavoro MPS, 2004)

CHRONOLOGY OF EVENTS

July 2003	Working Group is formed, web site is opened and the preliminary technical reports are posted
November 2003	A draft map and report are submitted for peer review
December 2003	Reviewers formulate comments on the preliminary results
January 2004	The Working Group meets the reviewers
April 2004	The final seismic hazard map and technical report are officially approved



Results are given in terms of the median (figure A) and of the 16th and 84th percentiles (figures B and C) of the distribution of PGA values.

Raw input data and the PGA values having 10% probability of exceedance in 50 years can be downloaded from http://zonesismiche.mi.ingv.it

4 – Ongoing activity

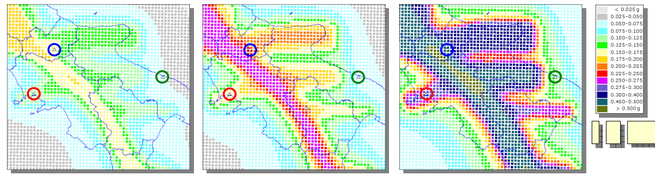
The new building code implies a substantial change of many professional practices. For this reason a period of overlapping between old and new regulations is foreseen, to allow both the discussion of the rules and the immediate change in seismic protection for those who wanted to use the new code.

At this stage seismologists and engineers are re-evaluating some main issues such as:

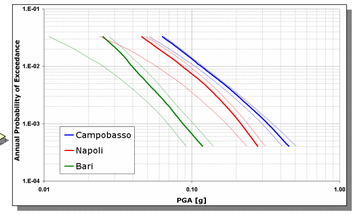
1. The reliability of the anchor values of the elastic response spectrum.

As these values are greater than the maximum PGA shown by the seismic hazard map, seismologists and engineers are currently debating if they should be reviewed.

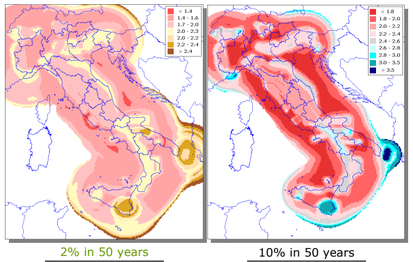
However, the engineering community is in favour of a direct use of the probabilistic value of PGA at the site of interest.

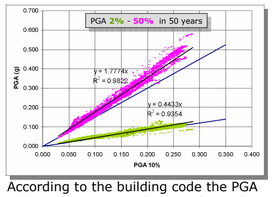


Seismic hazard curves at each grid point can be generated from these maps.



2. The introduction of seismological constraints on the response spectra for the ultimate limit states and for the damage limitation states.



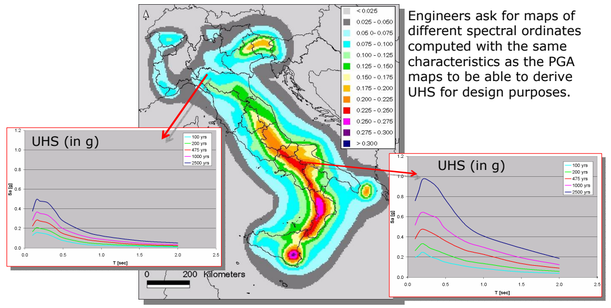


According to the building code the PGA 10% in 50 years can be transformed in PGA 2% in 50 years or PGA 50% in 50 years multiplying respectively by 1.5 and 0.4 (blue lines).
The actual seismic data point to different values: 0.44 and 1.78.

These data may serve as an input to define priorities for seismic intervention on strategic buildings and relevant structures.

3. Maps of spectral ordinates.

Engineers ask for maps of different spectral ordinates computed with the same characteristics as the PGA maps to be able to derive UHS for design purposes.

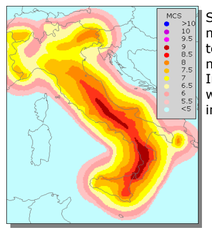


SA 1 sec, 10% p.e. in 50 years

5 – What next?

Due to its long historical record and the early start of the macroseismic investigation, Italy has a wealth of intensity data which can be used as an independent set for calibration purposes.

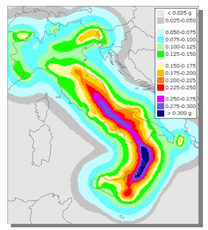
In this view, the seismic hazard has been assessed in terms of intensity values for varied probabilities of exceedance in 50 years, using part of the input data already employed in the PGA assessment and intensity attenuation relations (Gomez Capera, 2005).



Seismic hazard map of Italy in terms of macroseismic Intensity (MCS) with 10% p.e. in 50 years.

As a first hand calibration, such values have been transformed in PGA by means of I/PGA relationships found in the literature.

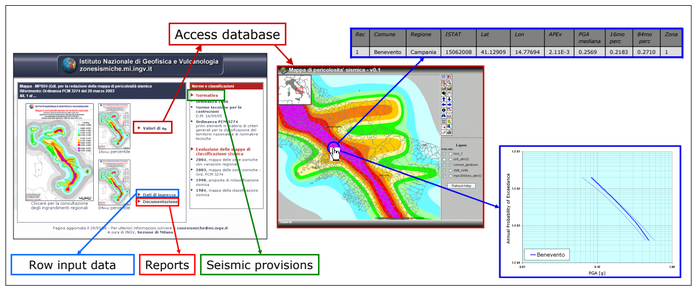
The converted map shows the same range of PGA values as the map directly computed from PGA attenuation relationships, although the shape of the areas is different because intensities decay less rapidly with distance compared to PGA.



Seismic hazard map of Italy in terms of PGA converted from macroseismic Intensity (MCS) with 10% p.e. in 50 years.

The activities described above are apt to provide useful feedback to seismologists, engineers and end-users in general.
Seismic hazard data will be made available to public in a comprehensive seismic hazard database, accessible via internet through a WebGIS interface (Locati et al., 2006).
The database will offer at each grid point:

- ✓ values of PGA, SA, and macroseismic intensity for different exceedance probabilities;
- ✓ the corresponding values of the 16th and 84th percentiles, used as a measure of the variability of the results;
- ✓ deaggregation values;
- ✓ UHS;
- ✓ hazard curves.



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Locati M., Meletti C., Rovida A., Rubbia G., Ercoleni E., Meroni F. (2006). A WebGIS tool for dissemination of earthquake data. Geophys. Res. Abs., Vol. 8, 09097.