EC8-2G

Il nuovo standard europeo per la progettazione sismica

EUCENTRE FOR YOUR SAFETY.

reluis

Sessione 1 – Azioni sismiche di progetto

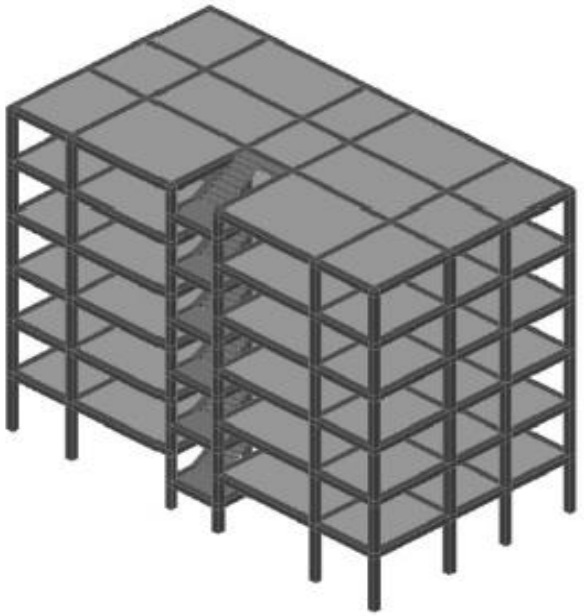
Pericolosità sismica di progetto

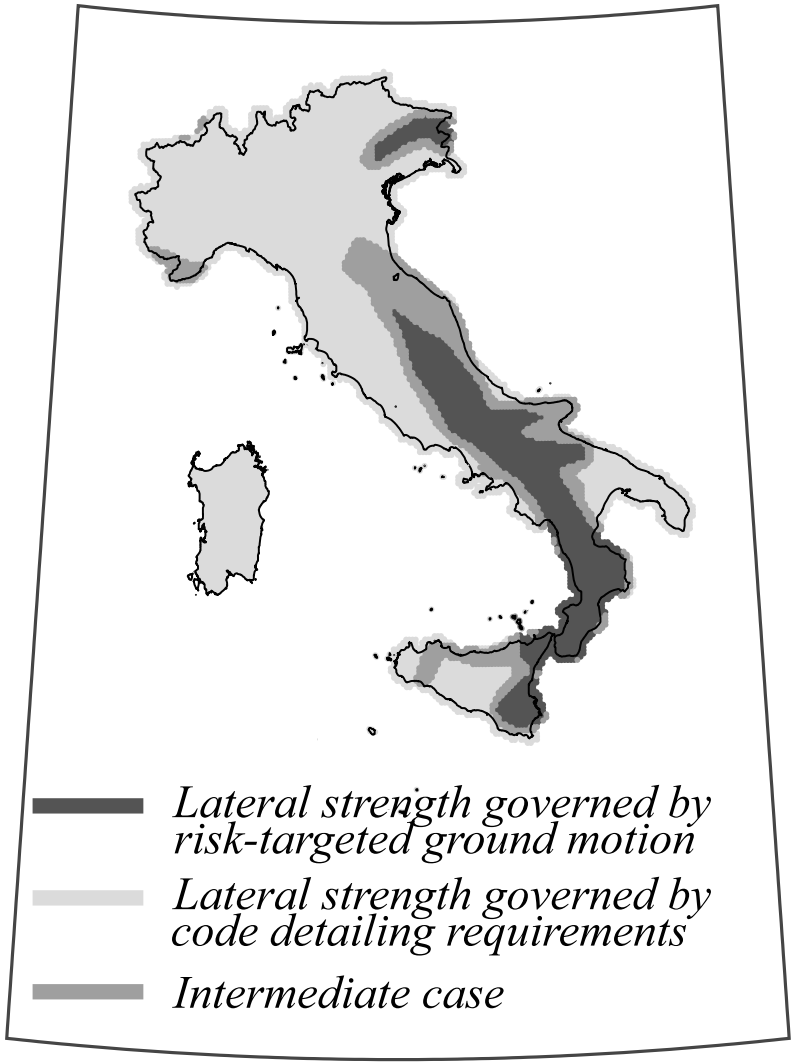
Iunio Iervolino, Università degli Studi di Napoli Federico II, IUSS Pavia

Pavia - 5 Giugno 2025

Introduction and conclusions

Seismic design impacts seismic reliability in the high hazard zones.





Introduction and conclusions

1. For the first time, Eurocode 8 includes seismic hazard maps as informative annex (ESHM20).

2. At least three authoritative seismic hazard models are currently available for Italy: MPS04, MPS19 and ESHM20.

3. Differences across hazard maps in terms, of PGA and Sa(T=1s) can be up to about 40%, in absolute value, at least for T_r from 50 to 2475 years.

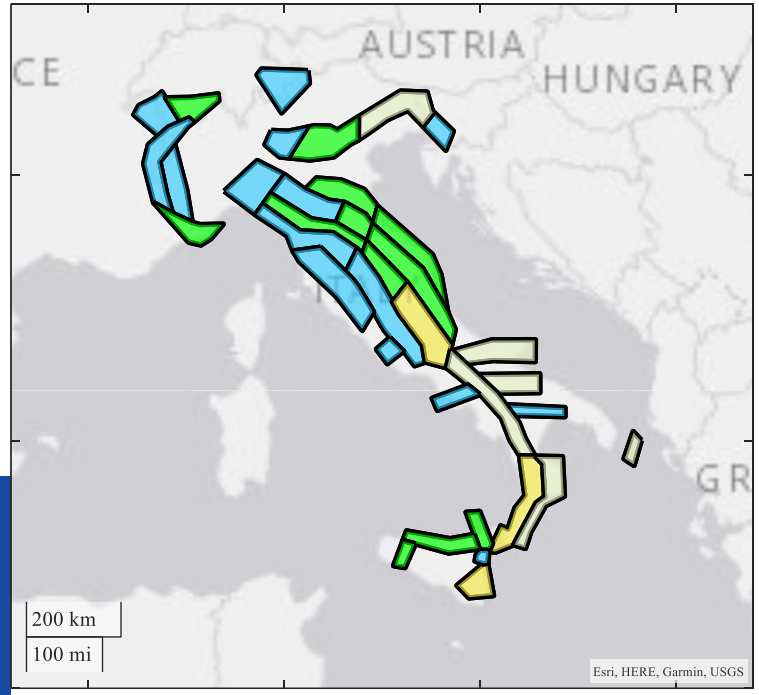
4. Also, hazard maps based on MPS04, MPS19 and ESHM20 are hardly distinguishable in the light of observations, a formal statistical test reveals. They all tend to overestimate the seismic hazard, especially at the low return period.

5. The slope of the hazard curves, used for a series of applications, varies among the hazard models.

Hazard models for Italy

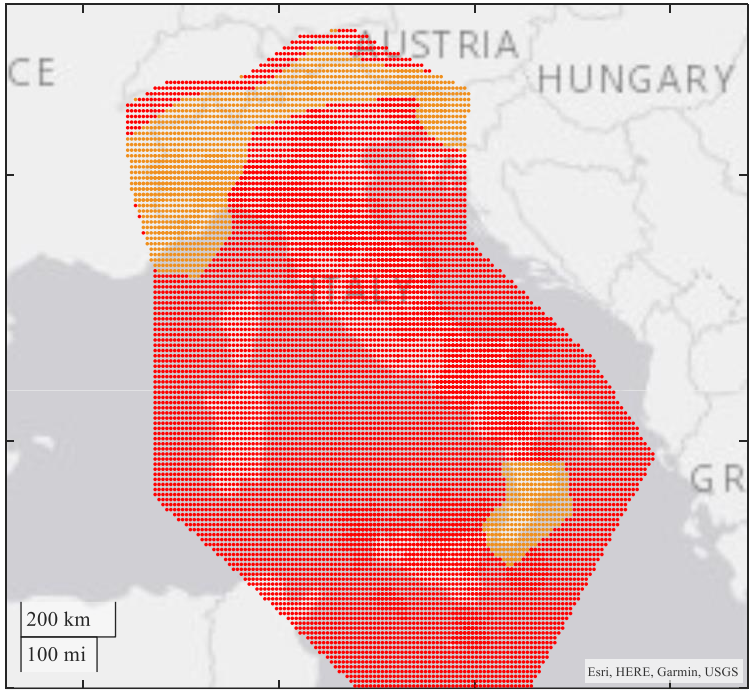
INGV

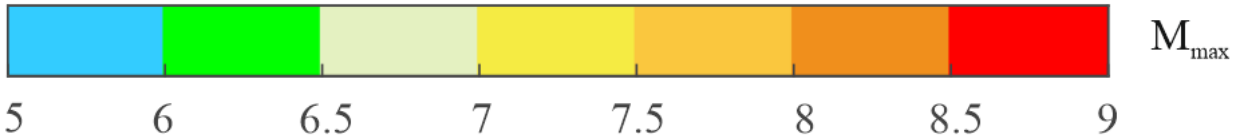
MPS04, M_{min}=4.15



INGV

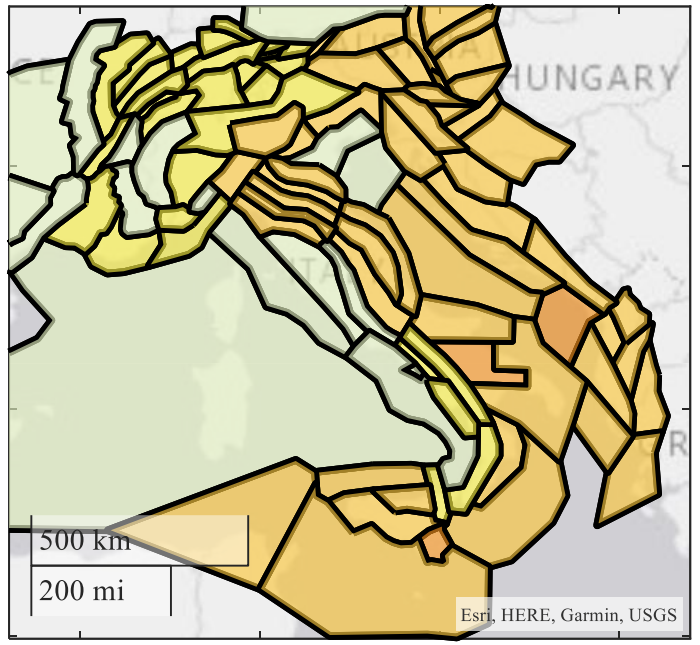
MPS19, M_{min}=4.5



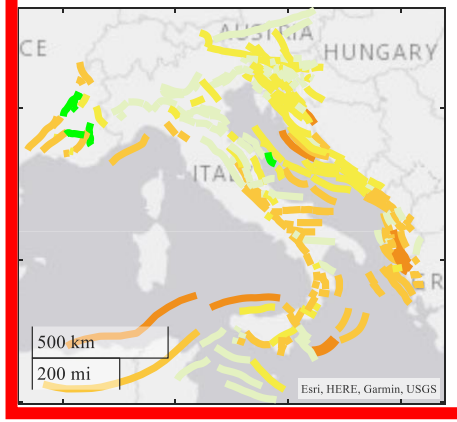


EFEHR EPOS SERA

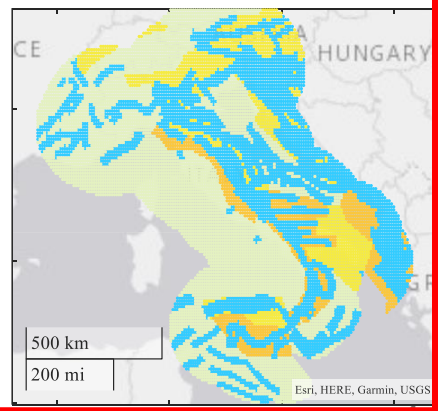
ESHM20 (zones), M_{min}=4.5



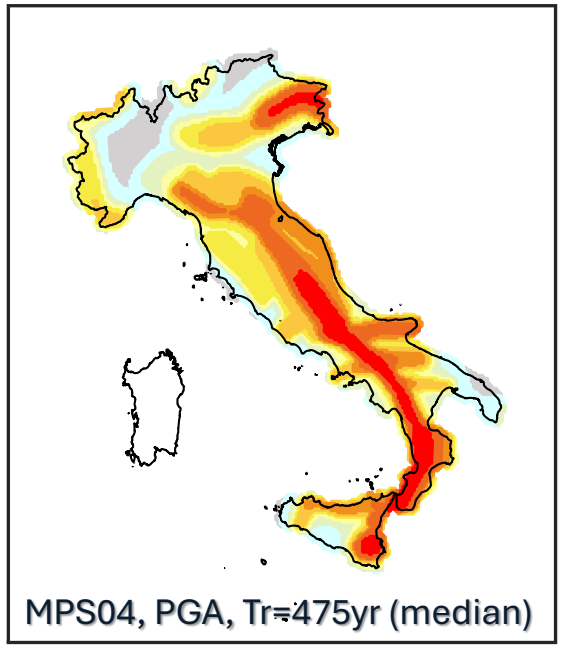
ESHM20 (FAULTS), M_{min}=5.9



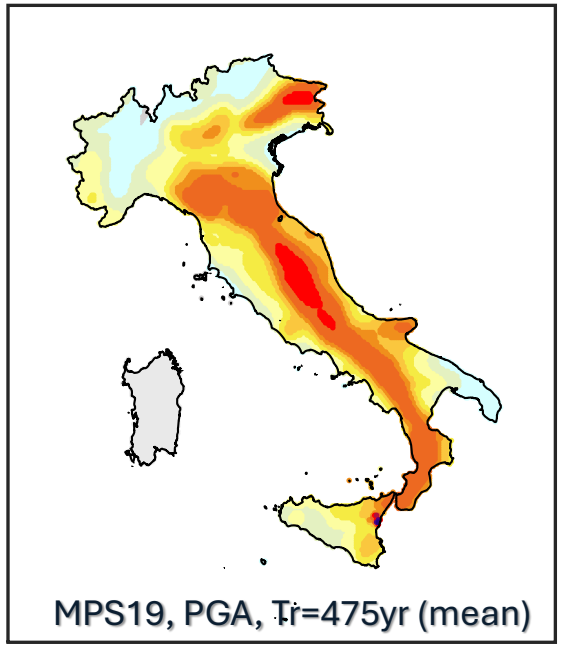
ESHM20 (BS), M_{min}=4.5

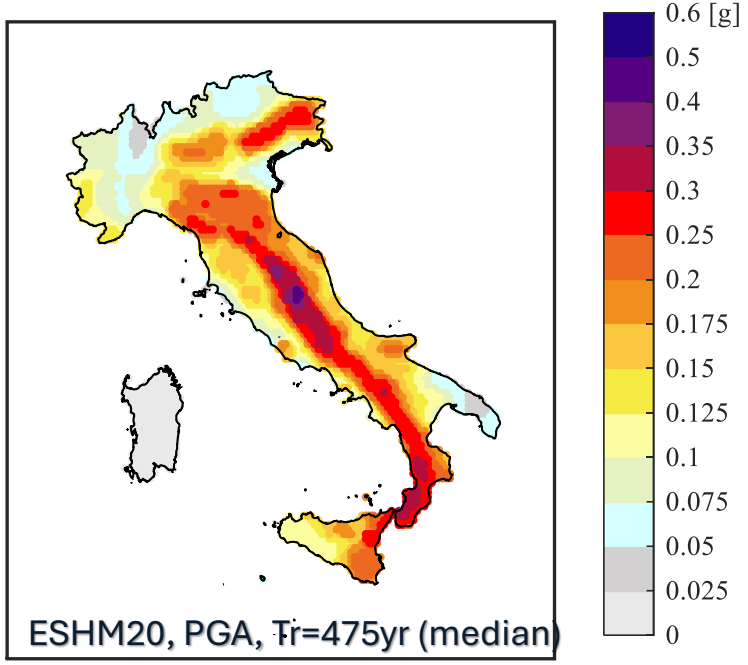


Hazard models for Italy



median hazard curves and maps, UHS, disaggregation)



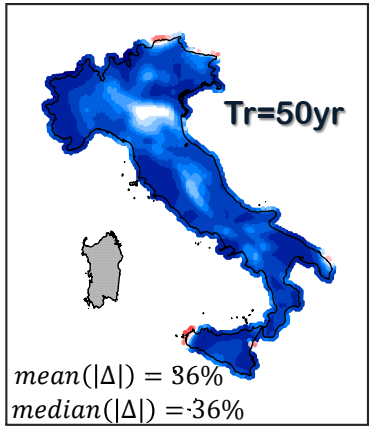


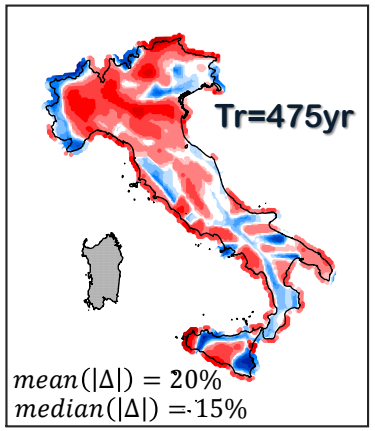
Mean and median hazard curves and maps, UHS)

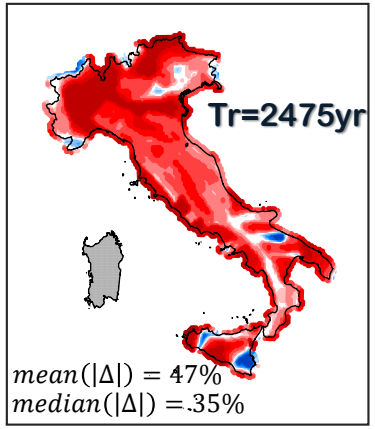
Hazard models for Italy

PGA

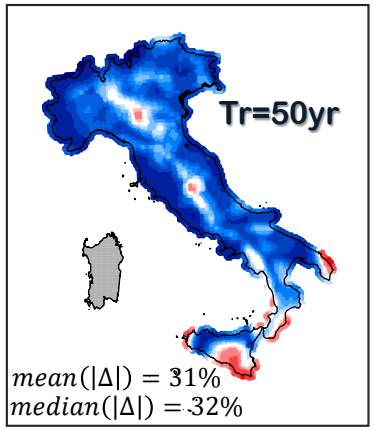
$$\Delta = \frac{PGA_{MPS19} - PGA_{MPS04}}{PGA_{MPS04}}$$

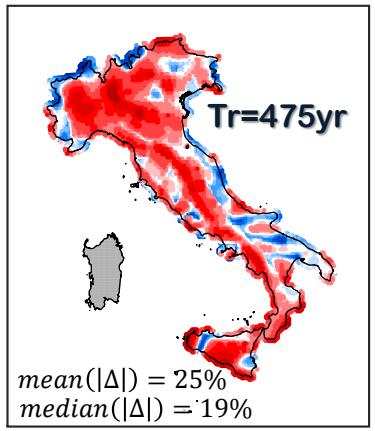


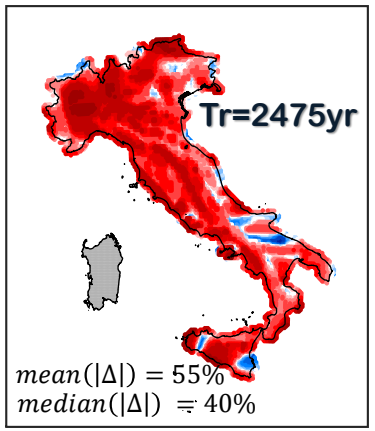




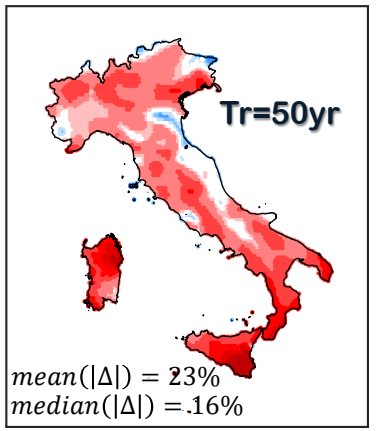
$$\Delta = \frac{PGA_{ESHM20,median} - PGA_{MPS04}}{PGA_{MPS04}}$$

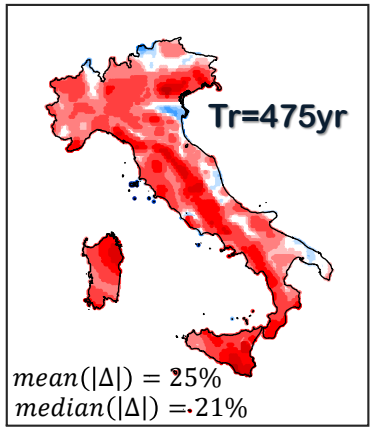


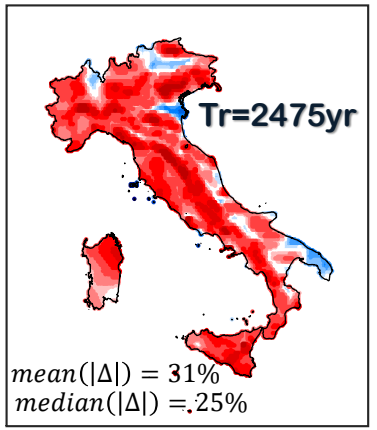


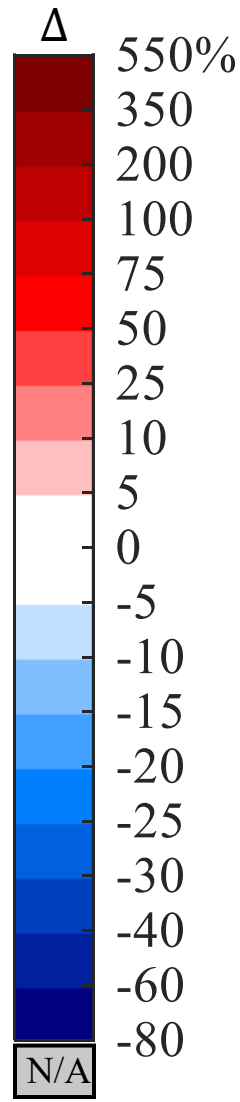


$$\Delta = \frac{PGA_{ESHM20,mean} - PGA_{MPS19}}{PGA_{MPS19}}$$





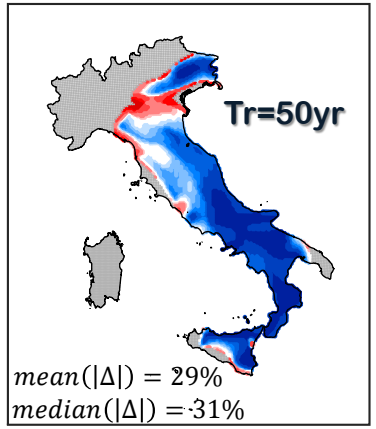


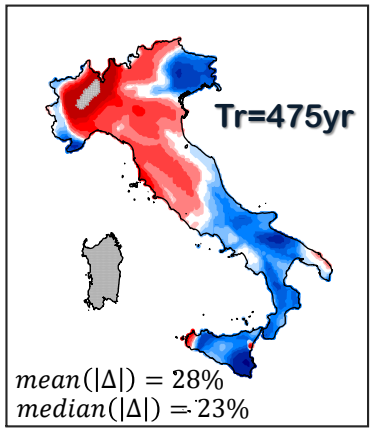


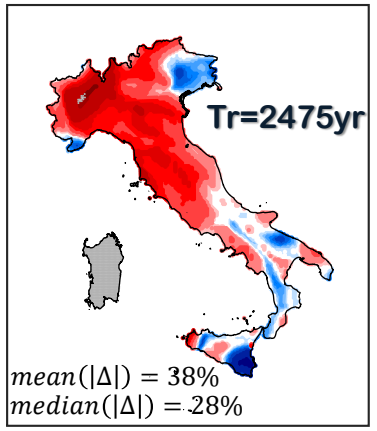
Hazard models for Italy

Sa(T=1s)

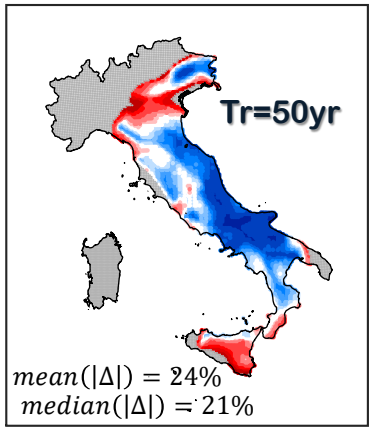
$$\Delta = \frac{PGA_{MPS19} - PGA_{MPS04}}{PGA_{MPS04}}$$

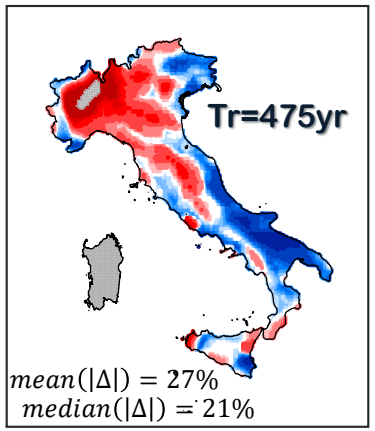


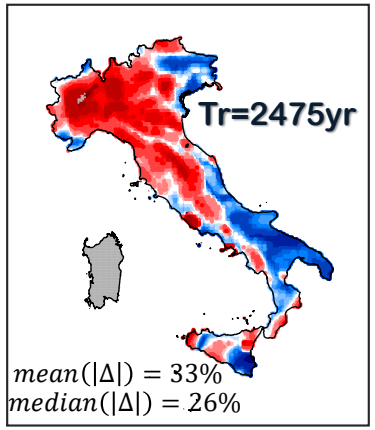




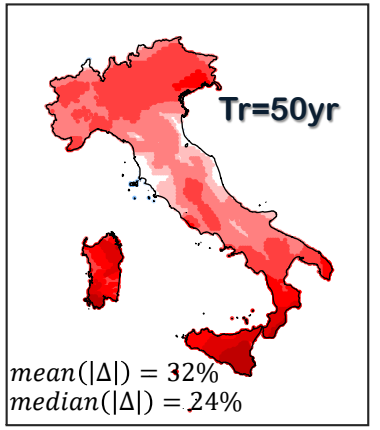
$$\Delta = \frac{PGA_{ESHM20,median} - PGA_{MPS04}}{PGA_{MPS04}}$$

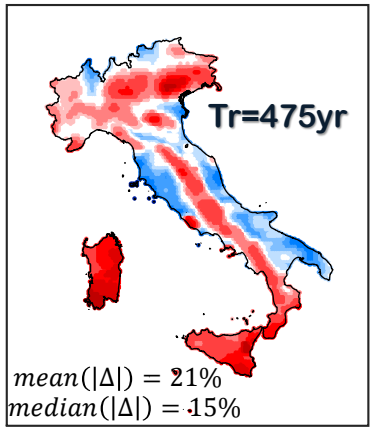


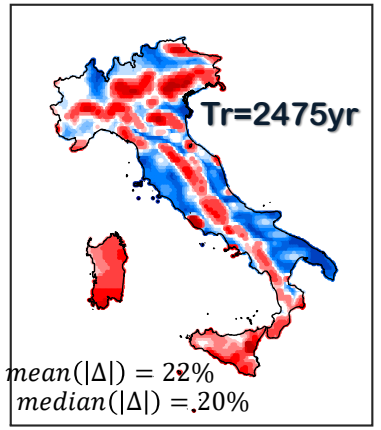


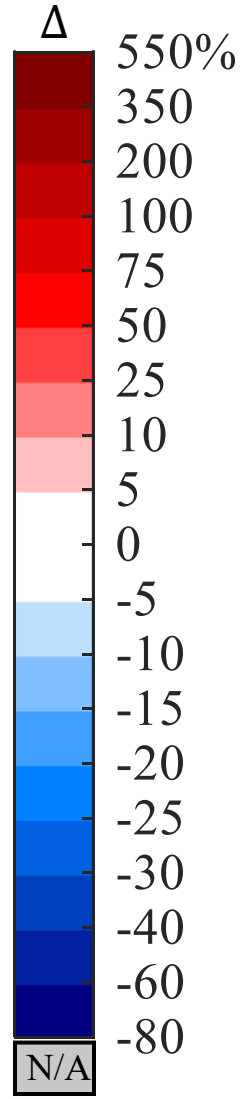


$$\Delta = \frac{PGA_{ESHM20,mean} - PGA_{MPS19}}{PGA_{MPS19}}$$



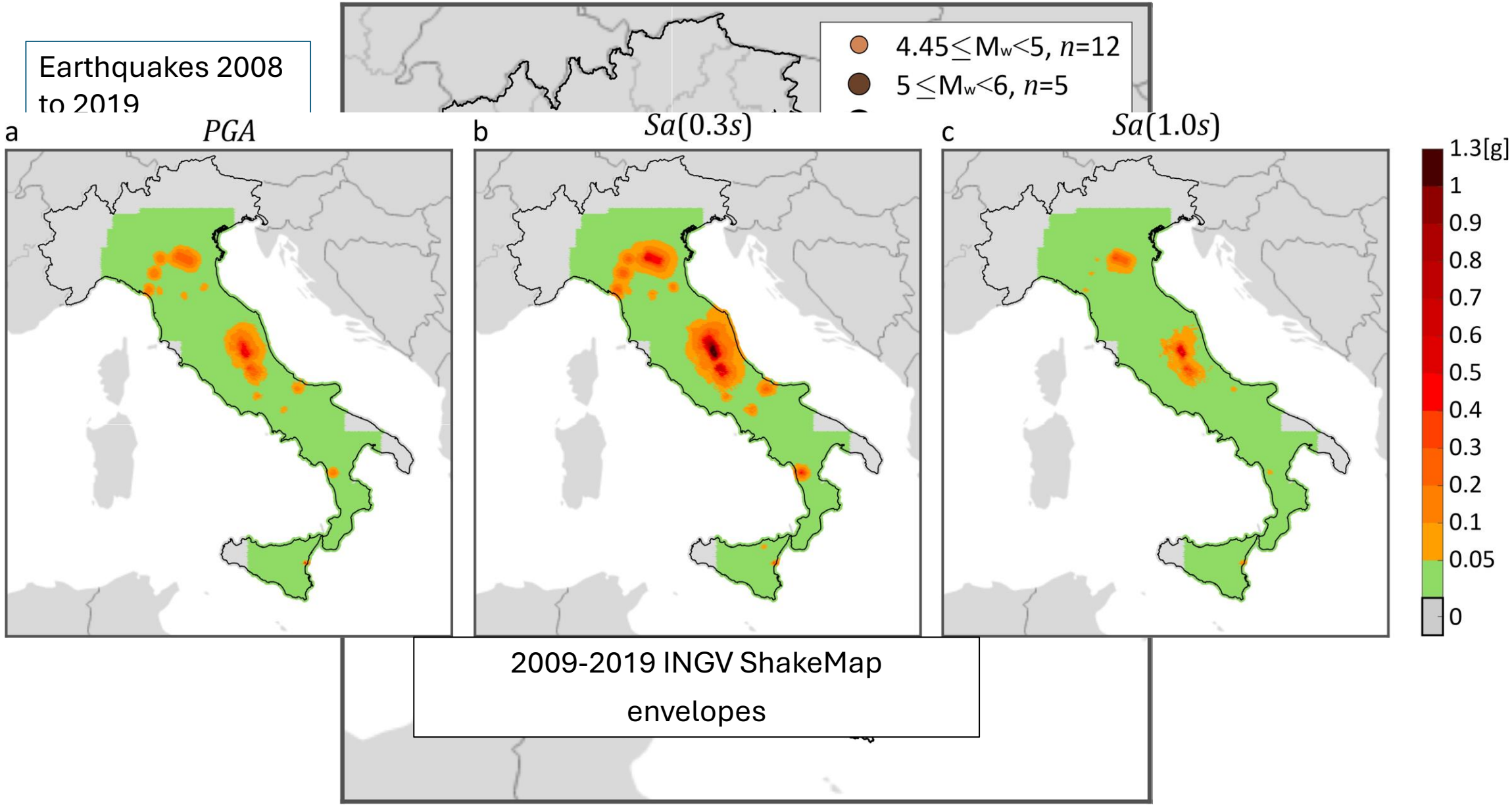






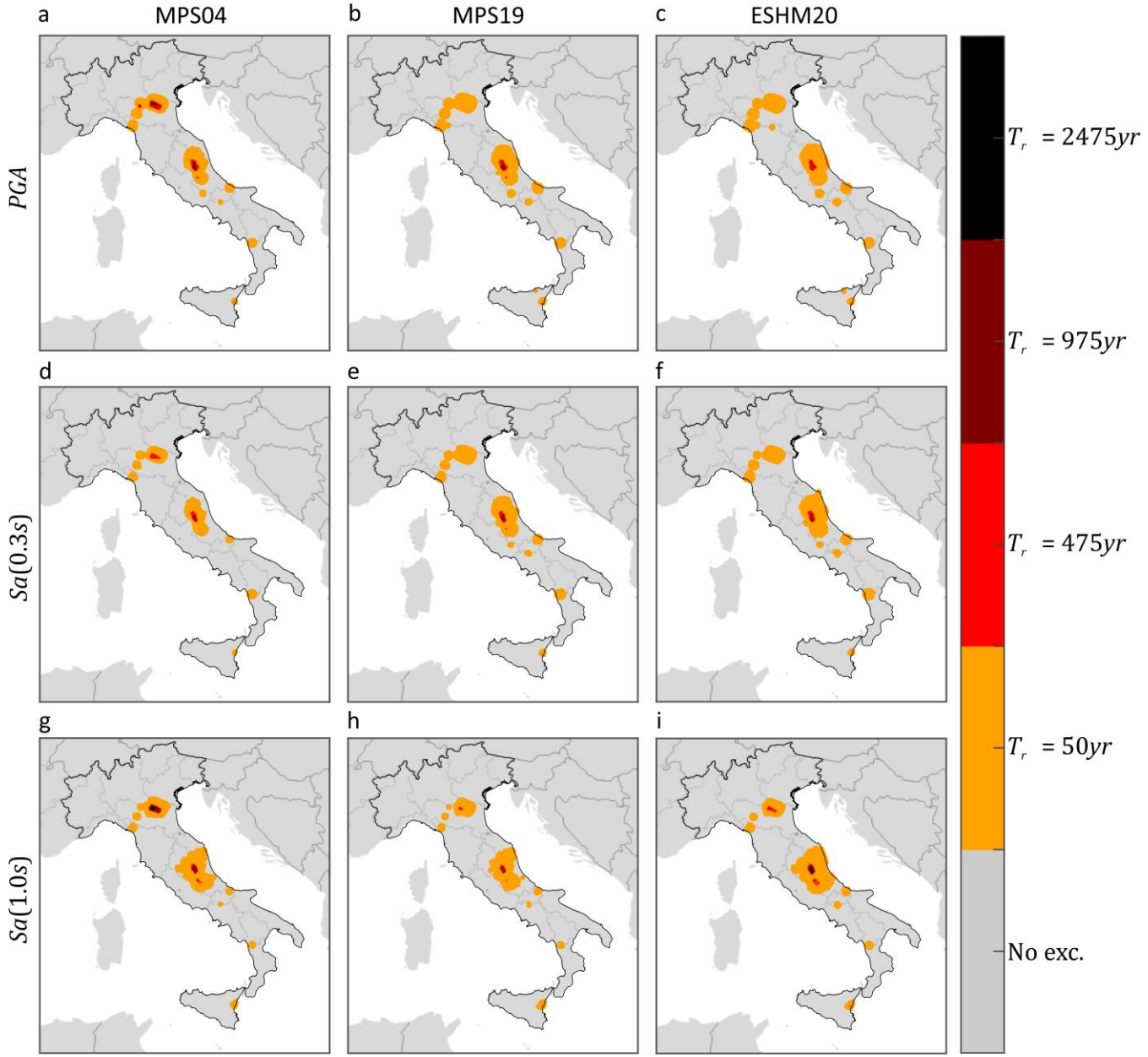
Hazard vs observations: Territorial exceedance area

Earthquakes 2008 to 2019



2009-2019 INGV ShakeMap envelopes

Hazard vs observations: Territorial exceedance area



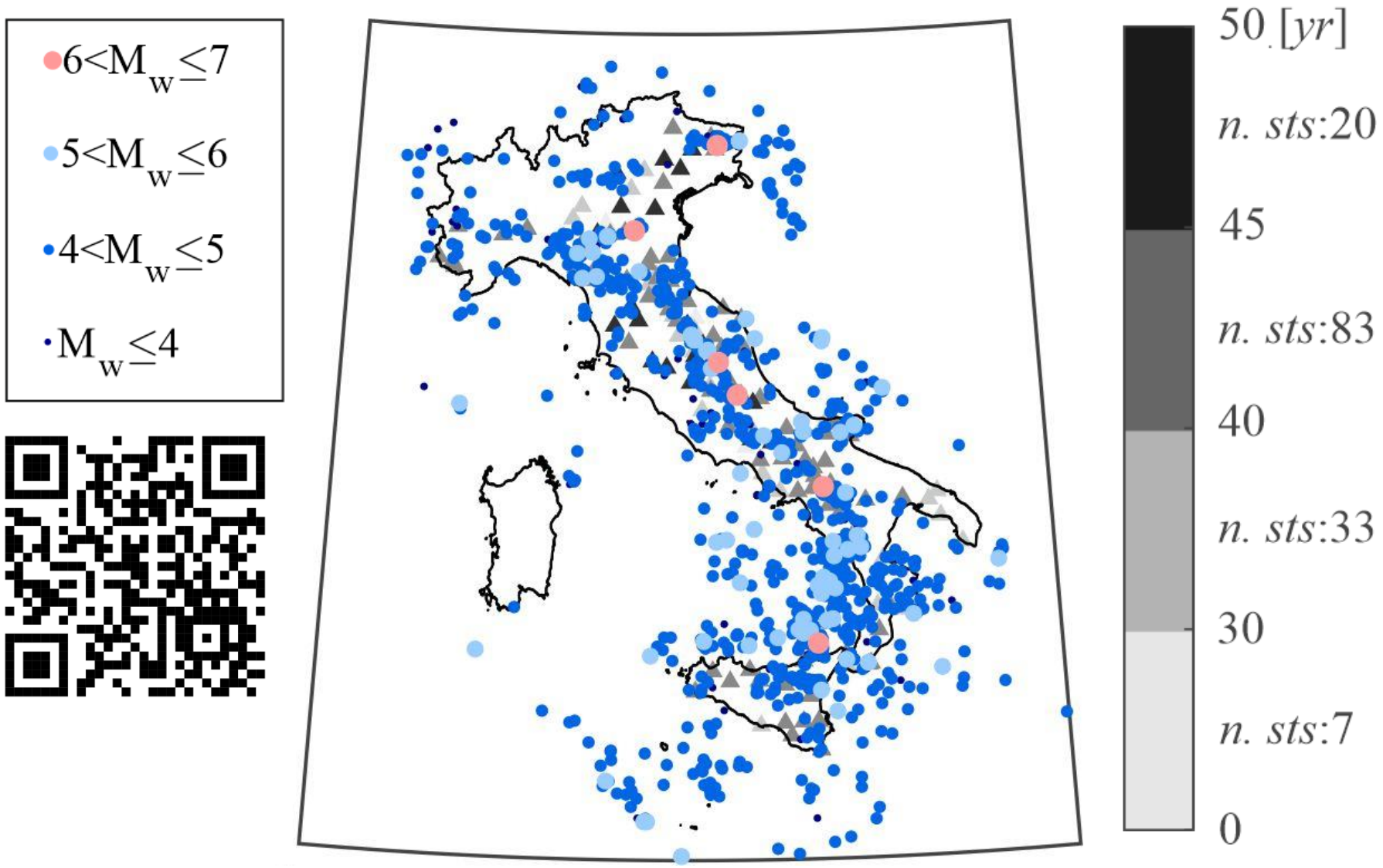
T_r [yr]		50	475	2475
Expected		21.3%	2.5%	0.5%
MPS04	PGA	4.42%	0.90%	0.01%
	Sa(0.3s)	3.40%	0.48%	0
	Sa(1.0s)	5.11%	0.79%	0.09%
MPS19	PGA	6.00%	0.39%	0.01%
	Sa(0.3s)	5.40%	0.32%	0
	Sa(1.0s)	4.36%	0.29%	0
ESHM20	PGA	6.29%	0.34%	0.01%
	Sa(0.3s)	5.67%	0.33%	0
	Sa(1.0s)	6.33%	0.64%	0.08%

The exceedance area is similar among the models and lower than what expected.

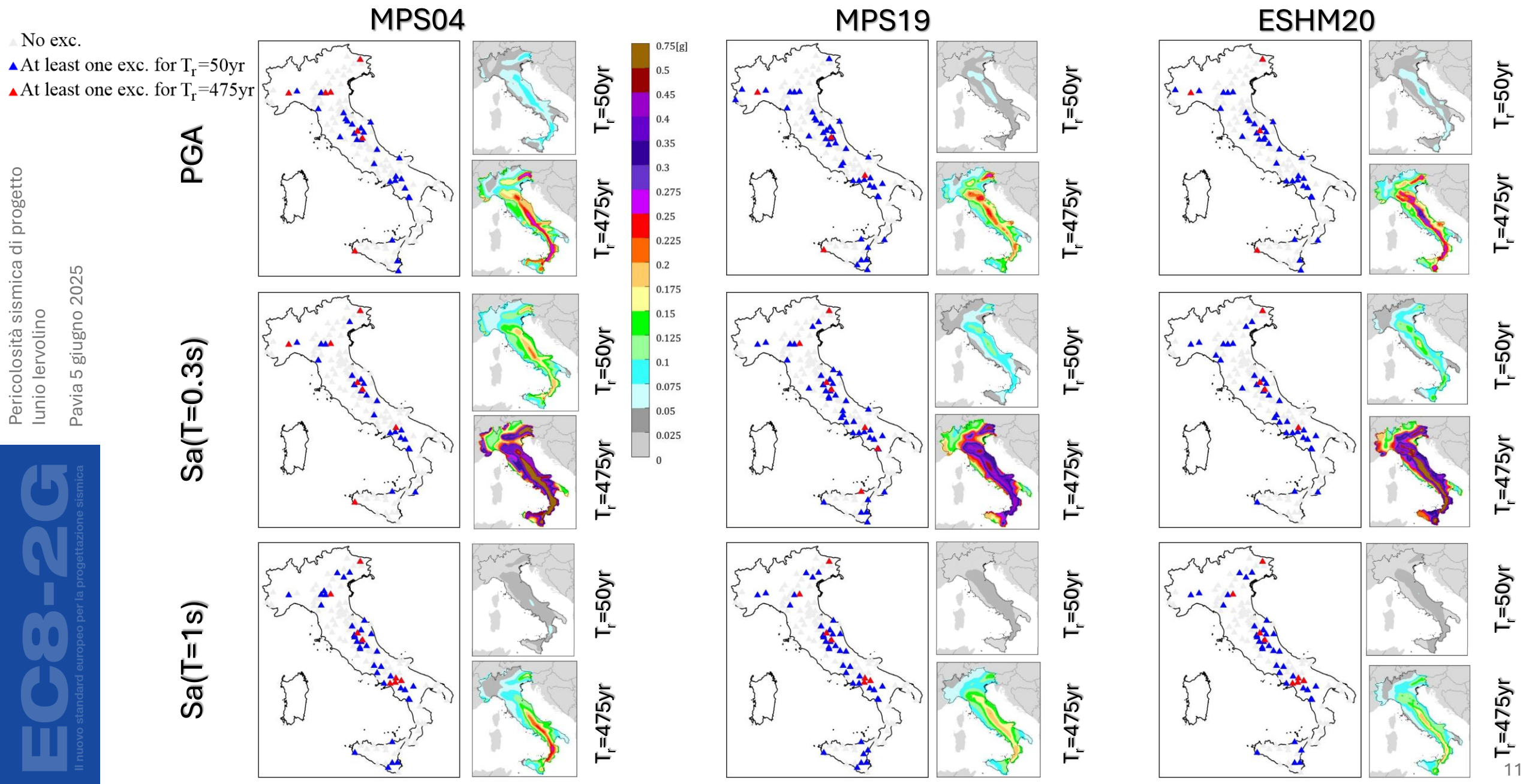
Hazard vs observations: Counting exceedances

143 stations operating from 1973 to 2019

Mainshocks from 1973 to 2019



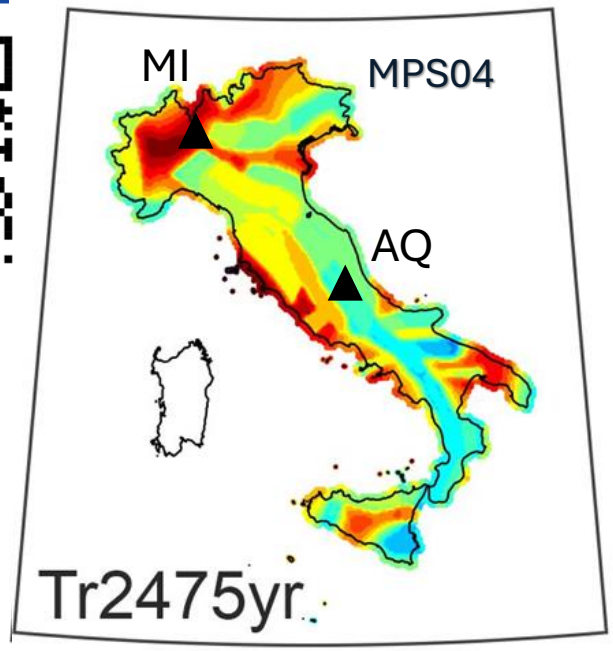
Hazard vs observations: Counting exceedances

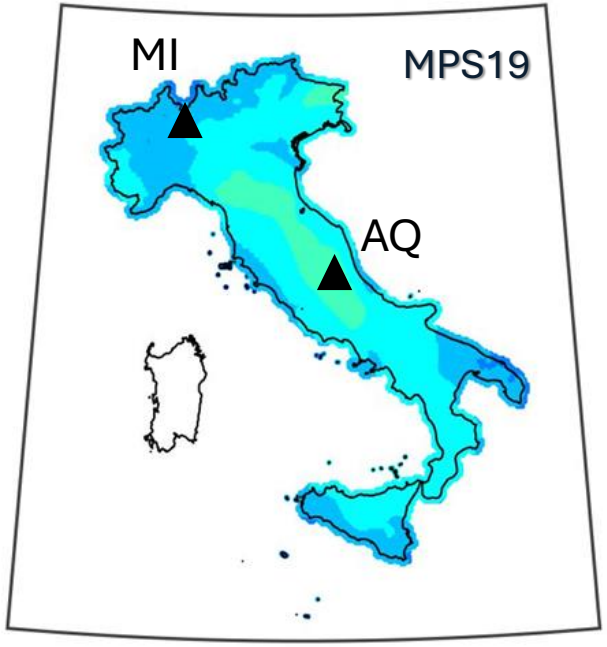


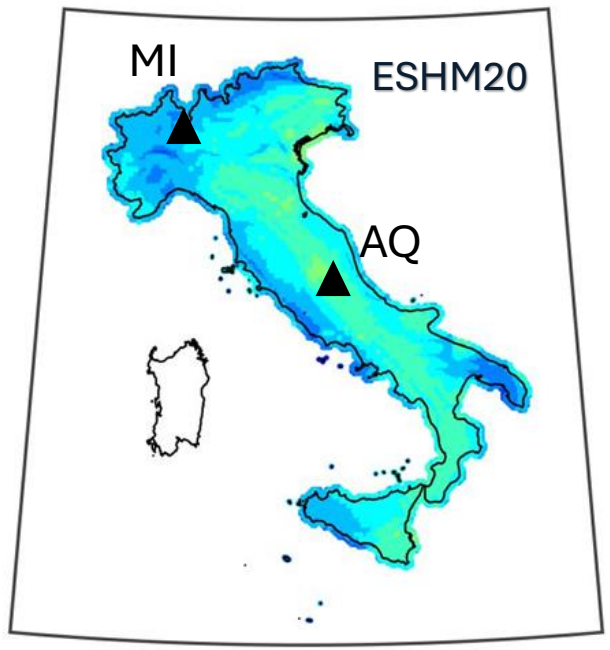
Hazard vs observations: Couting exceedances

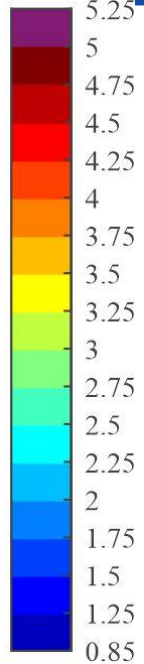
	$T_r = 50yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	$46 \notin [76–140]$	$55 \notin [75–165]$	$48 \notin [76–163]$
Sa(0.3s)	$36 \notin [71–145]$	$59 \notin [67–174]$	$45 \notin [74–164]$
Sa(1.0s)	$52 \notin [55–165]$	$54 \in [45–201]$	$51 \notin [61–179]$
	$T_r = 475yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	$8 \in [4–19]$	$4 \in [4–22]$	$4 \notin [5–21]$
Sa(0.3s)	$7 \in [4–20]$	$7 \in [3–25]$	$4 \in [4–21]$
Sa(1.0s)	$8 \in [2–23]$	$7 \in [0–29]$	$8 \in [3–23]$
	$T_r = 2475yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	$2 \in [0–5]$	$0 \in [0–6]$	$0 \in [0–5]$
Sa(0.3s)	$1 \in [0–5]$	$1 \in [0–6]$	$0 \in [0–5]$
Sa(1.0s)	$2 \in [0–6]$	$1 \in [0–7]$	$1 \in [0–6]$

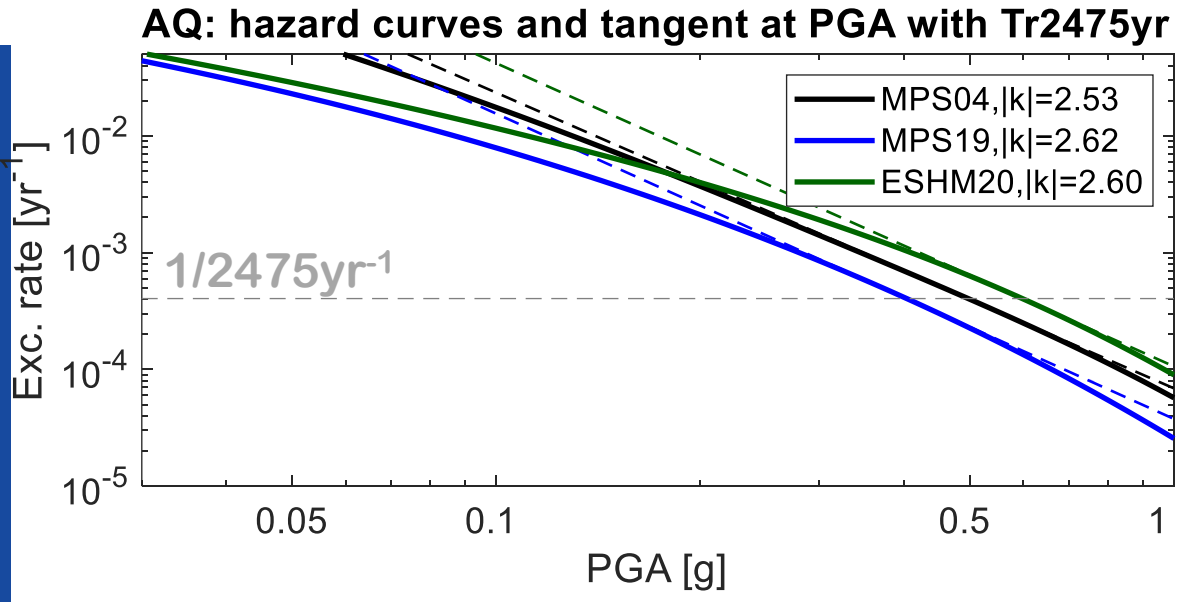
Slope of the hazard curve (k)

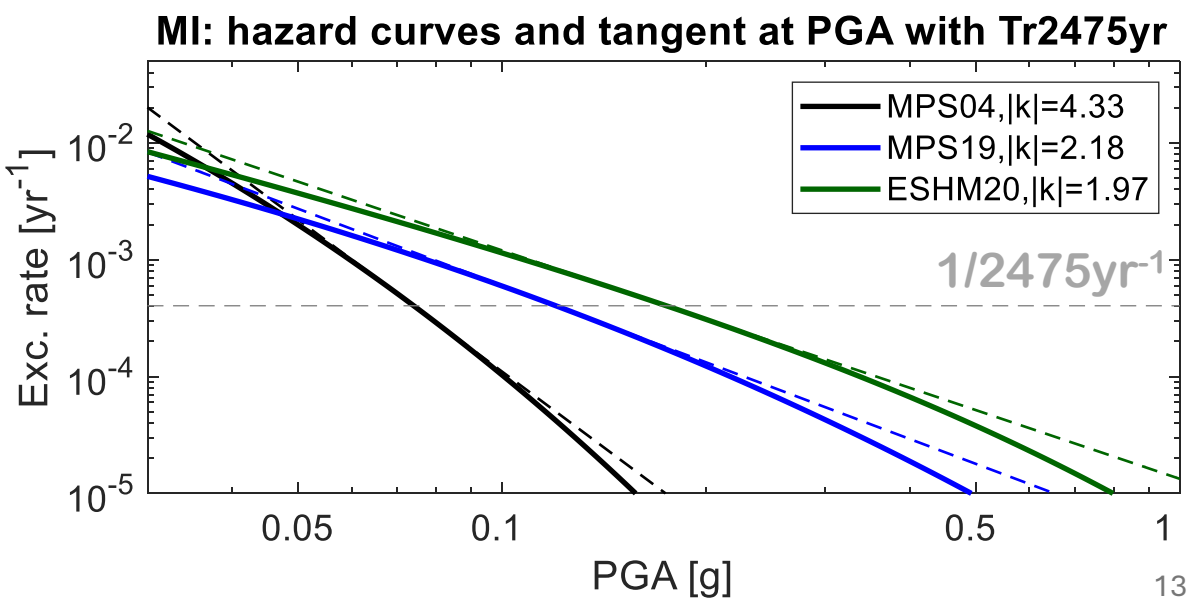












Slope of the hazard curve (k)

Example 1/2: definition of seismicity level for Milan following EC8-2g

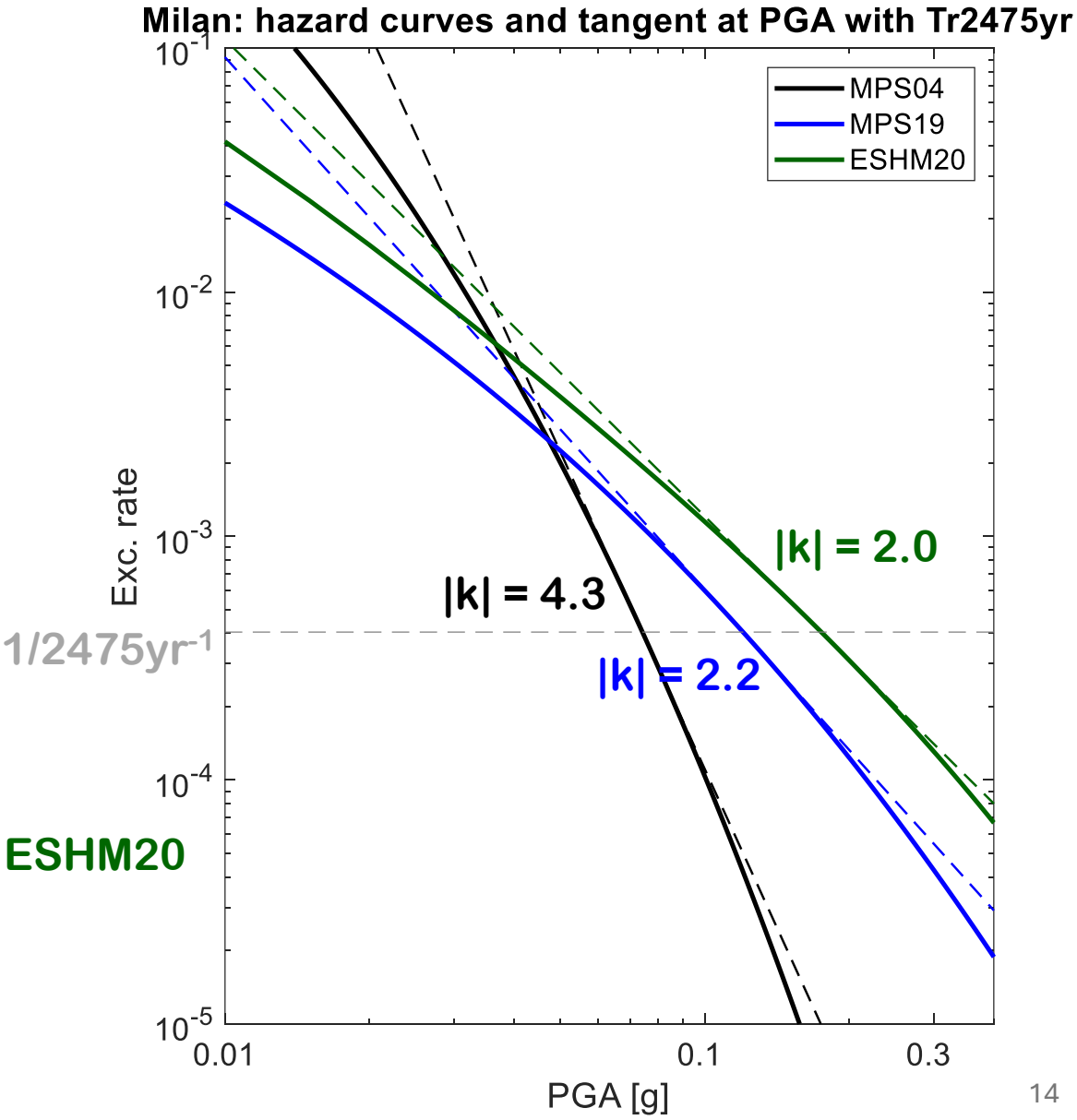
$$S_{\alpha,475} = S_{\alpha,\mathrm{ref}} \left(\frac{475}{T_{\mathrm{ref}}}\right)^{1/k}$$

Table 5.2 — Range of $S_{\alpha,475}$ values to define seismicity levels

Seismicity level	$S_{\alpha,475}$ (m/s²)
Very low	$S_{\alpha,475} < 1{,}0$ m/s²
Low	$1{,}0$ m/s² $\leq S_{\alpha,475} < 2{,}5$ m/s²
Moderate	$2{,}5$ m/s² $\leq S_{\alpha,475} < 5{,}0$ m/s²
High	$S_{\alpha,475} \geq 5{,}0$ m/s²

MPS19 ESHM20

MPS04



Slope of the hazard curve (k)

Example 2/2: reliability assessment following EC8-2g

$$P_{LS} = H(S_{e,LS}) \exp\left(0{,}5\, k^2 \beta^2_{S_{e,LS}}\right)$$

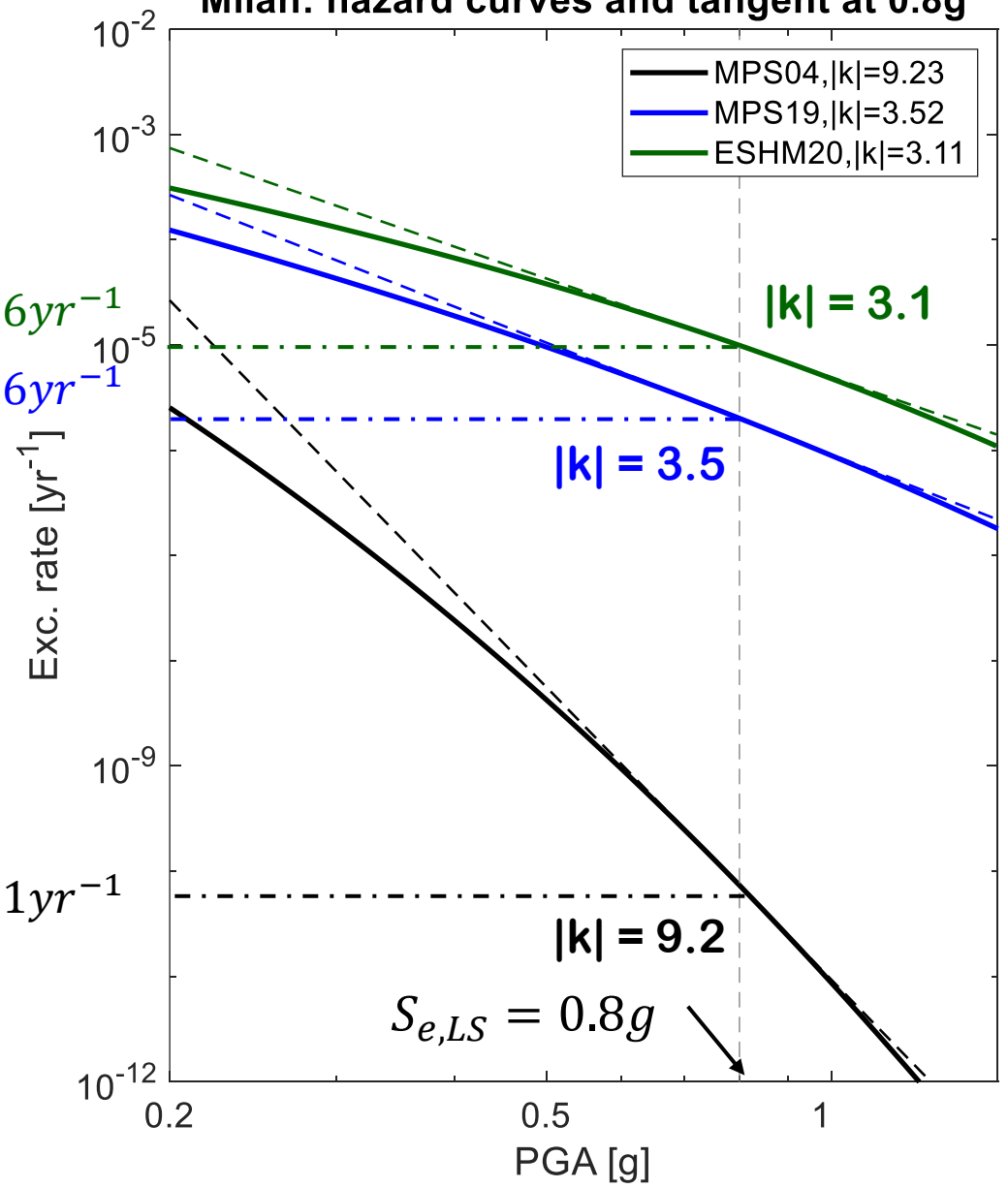
$$\beta^2_{Se,LS} = 0.5$$

	$e^{0.5 \cdot k^2 \cdot \beta^2_{Se,LS}}$	P_{LS}
MPS04	7.47E+07	5.30E-03
MPS19	1.38E+01	2.76E-05
ESHM20	7.83E+00	7.75E-05

$H(S_{e,LS}) = 9.9E-06 yr^{-1}$

$H(S_{e,LS}) = 2.0E-06 yr^{-1}$

$H(S_{e,LS}) = 7.1E-11 yr^{-1}$



Slope of the hazard curve (k)

Example 2/2: reliability assessment following EC8-2g

$$P_{LS} = H(S_{e,LS}) \exp\left(0{,}5\, k^2 \beta^2_{S_{e,LS}}\right)$$

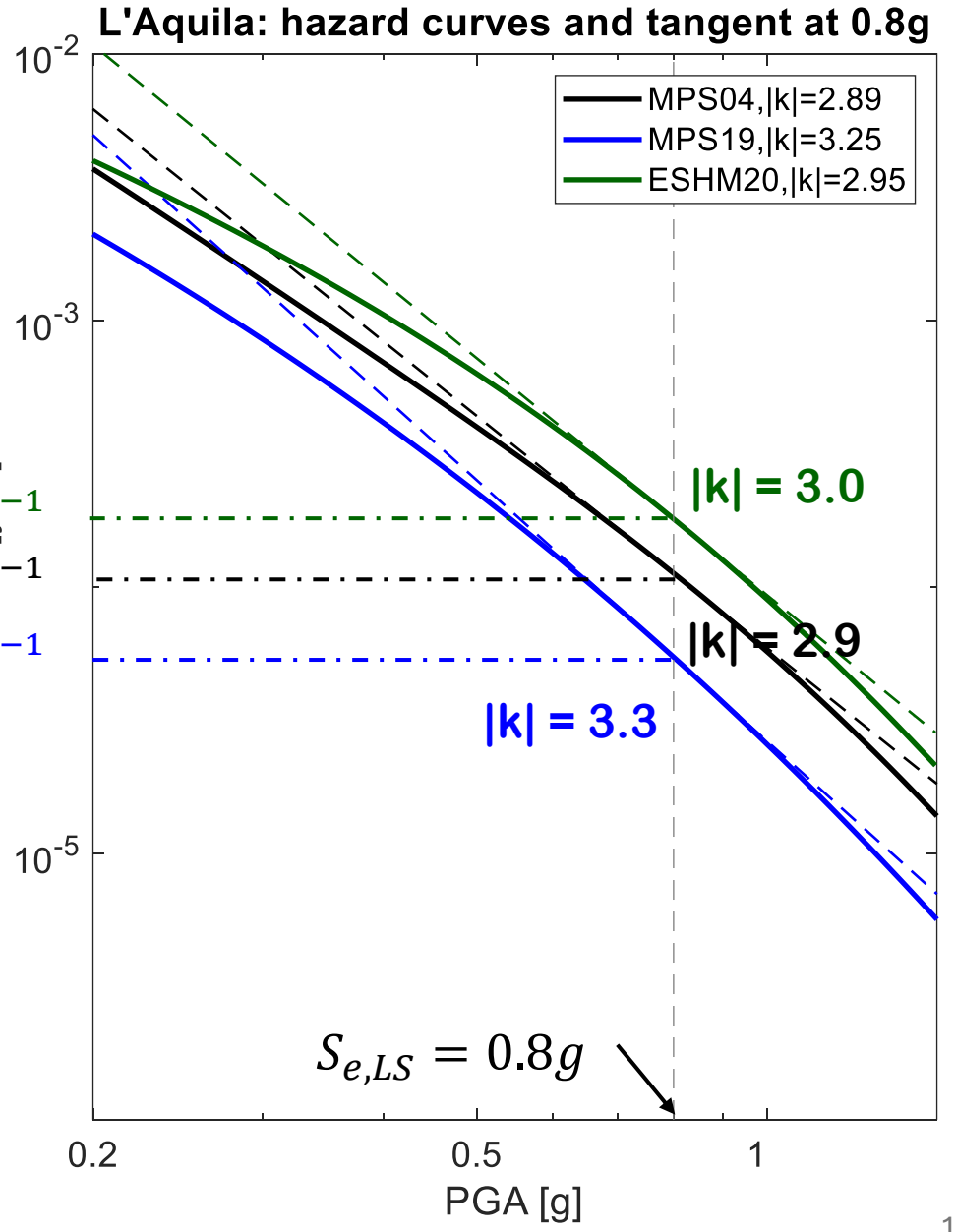
$$\beta^2_{Se,LS} = 0.5$$

	$e^{0.5 \cdot k^2 \cdot \beta^2_{Se,LS}}$	P_{LS}
MPS04	5.98E+00	6.58E-04
MPS19	9.61E+00	5.19E-04
ESHM20	6.45E+00	1.16E-03

$H(S_{e,LS}) = 1.8E-04 yr^{-1}$

$H(S_{e,LS}) = 1.1E-04 yr^{-1}$

$H(S_{e,LS}) = 5.4E-05 yr^{-1}$



EC8-2G

Il nuovo standard europeo per la progettazione sismica

EUCENTRE FOR YOUR SAFETY.

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Sessione 1 – Azioni sismiche di progetto

Pericolosità sismica di progetto

Iunio Iervolino, Università degli Studi di Napoli Federico II, IUSS Pavia

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