Earthquake effects

ground shaking

liquefaction

surface rupture

tsunami

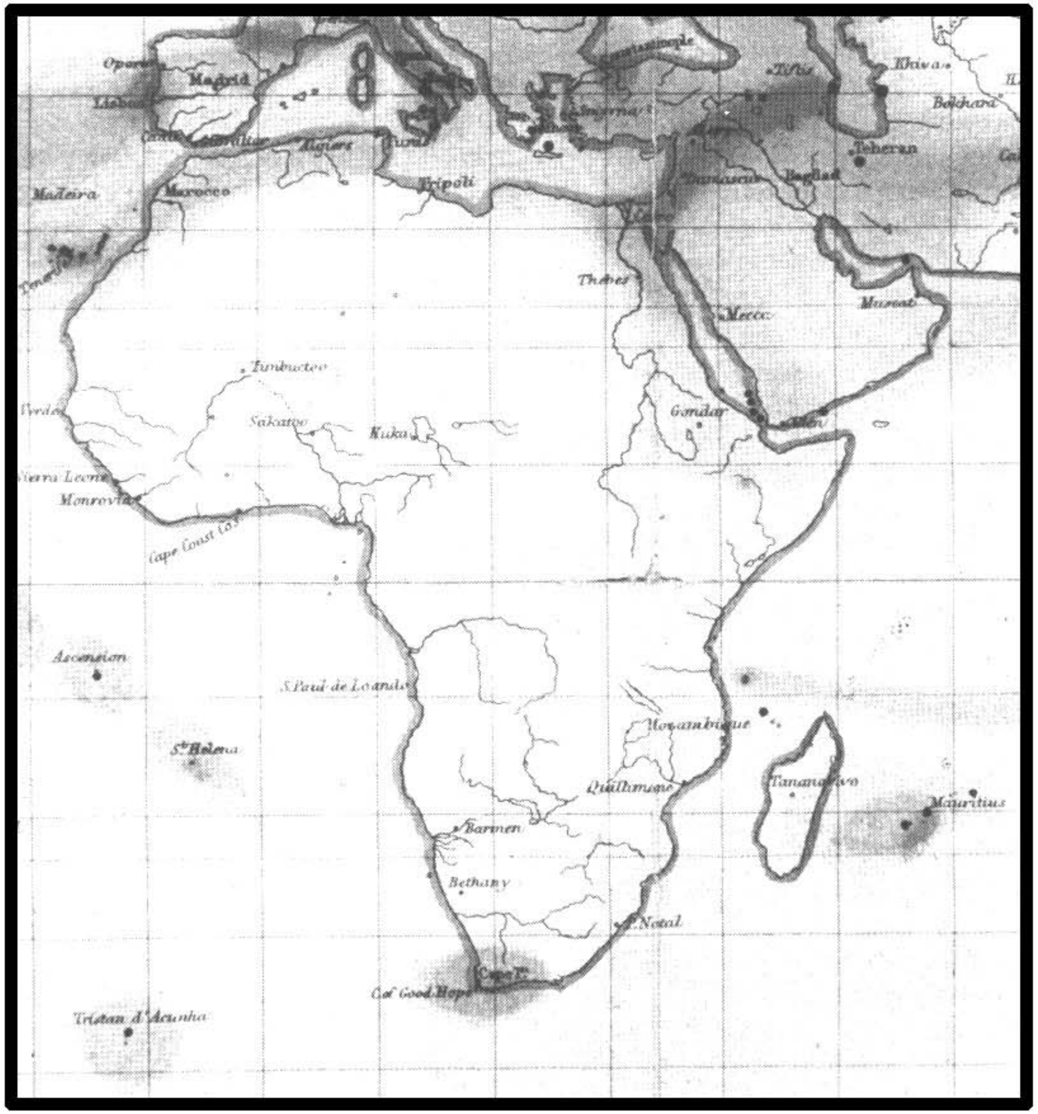
Any strategy for seismic risk reduction should be outlined trying to answer two basic questions:

- When, where and how big we have to expect a strong earthquake to strike a region?
- What should we expect when it occurs?

The answer to the first question is matter for earthquake prediction,

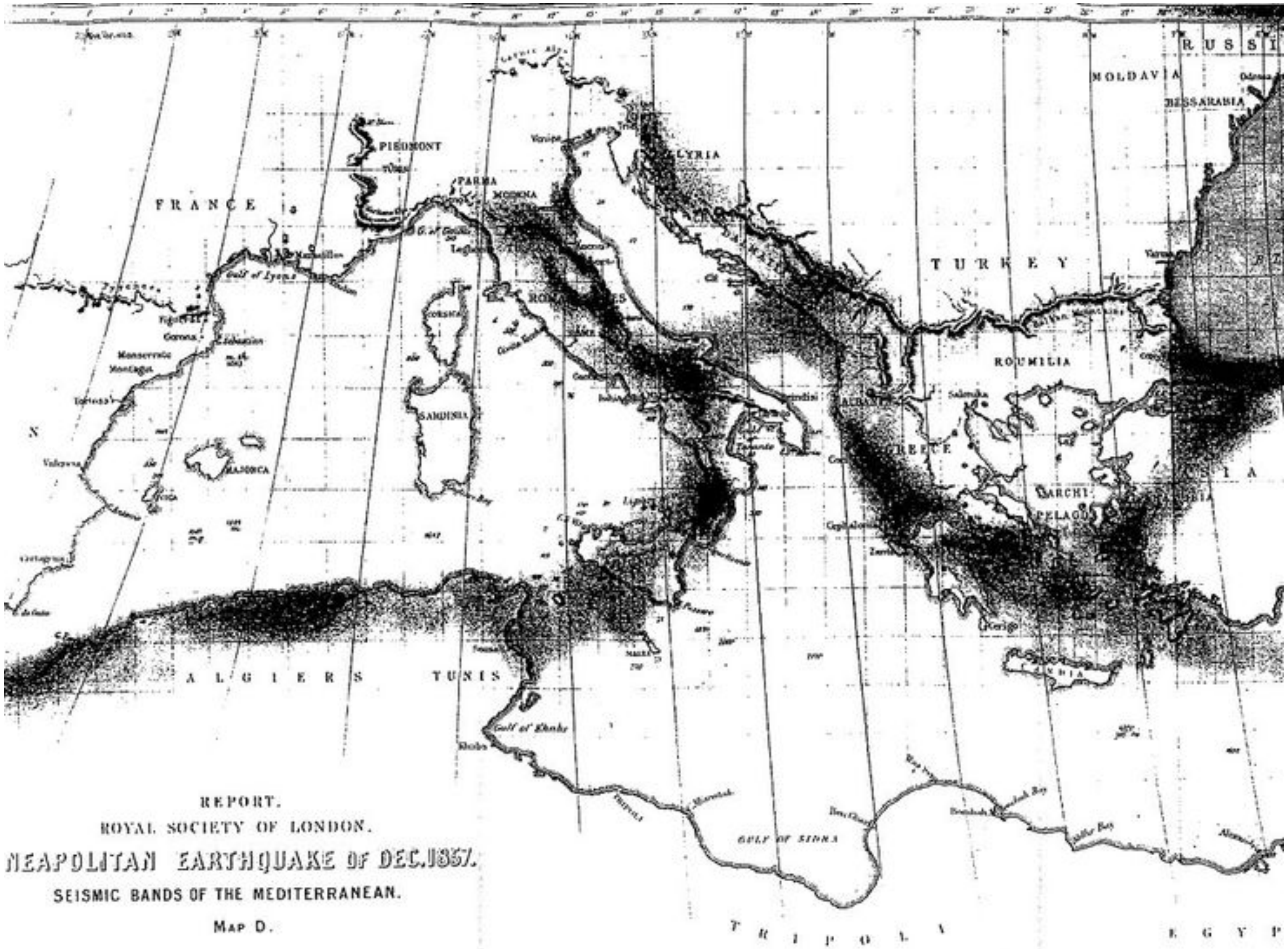
while the second one is matter for sound seismic (& tsunami) hazard assessment...

Earthquake zoning - history



Oldest seismic hazard map,
compiled by Mallett in 1853-1855

Earthquake zoning - history



Earthquake zoning - history

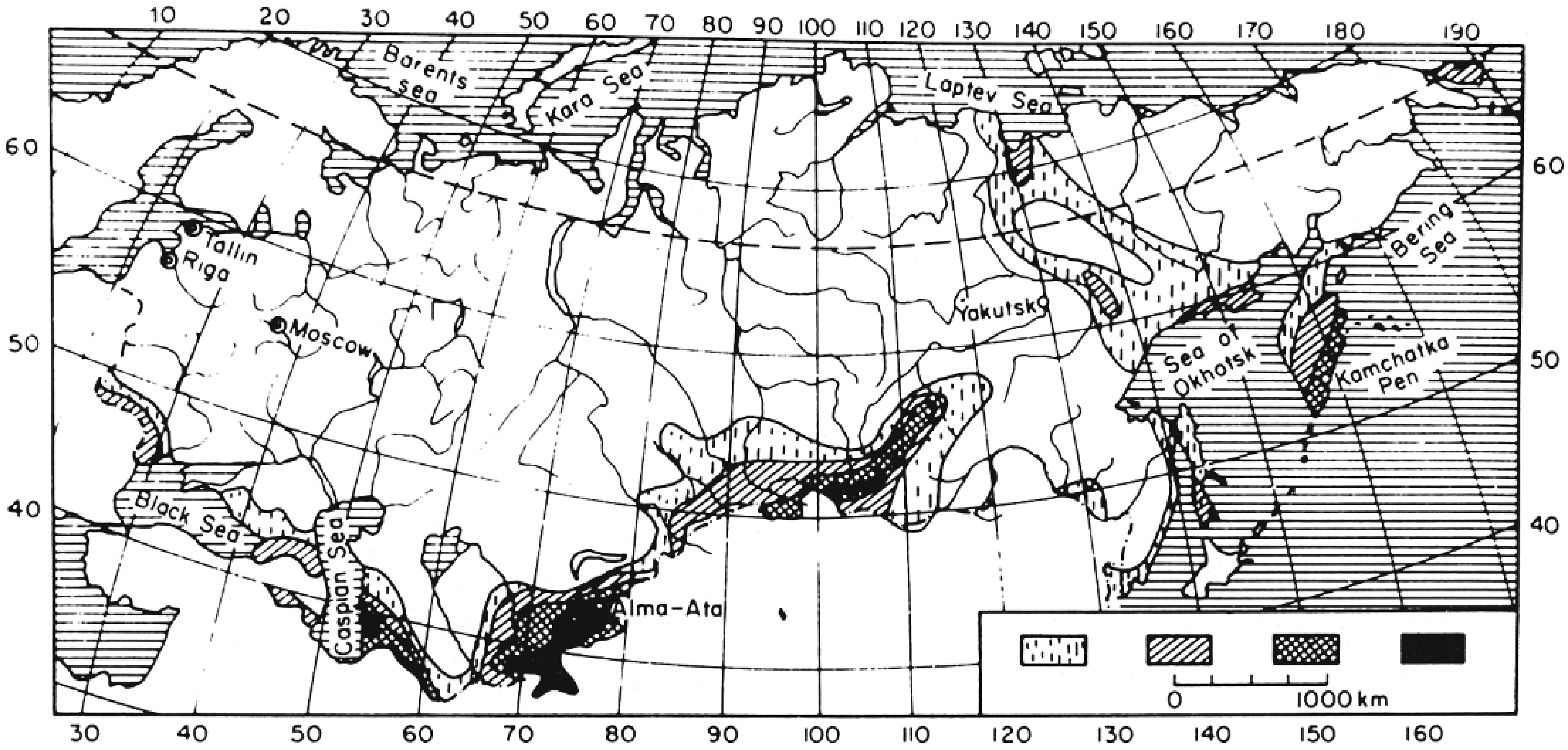


Fig.9.1. Earthquake zoning map of the U.S.S.R. (Normy i pravila stroitel' stva v seismicheskikh raionakh SN8–57, Stroiizdat, 1958).

Moscow Institute of Physics of the Earth, 1937

These maps were first incorporated into the building code for the Russian Federative Republic. Later, the Institute of Physics of the Earth prepared more detailed maps, which were incorporated in the 1957 Zoning (Rayonirovanye) of the Soviet Union. These maps became an official part of the Earthquake Building Code SN8-57 of the U.S.S.R.

SHA dualism: P & D

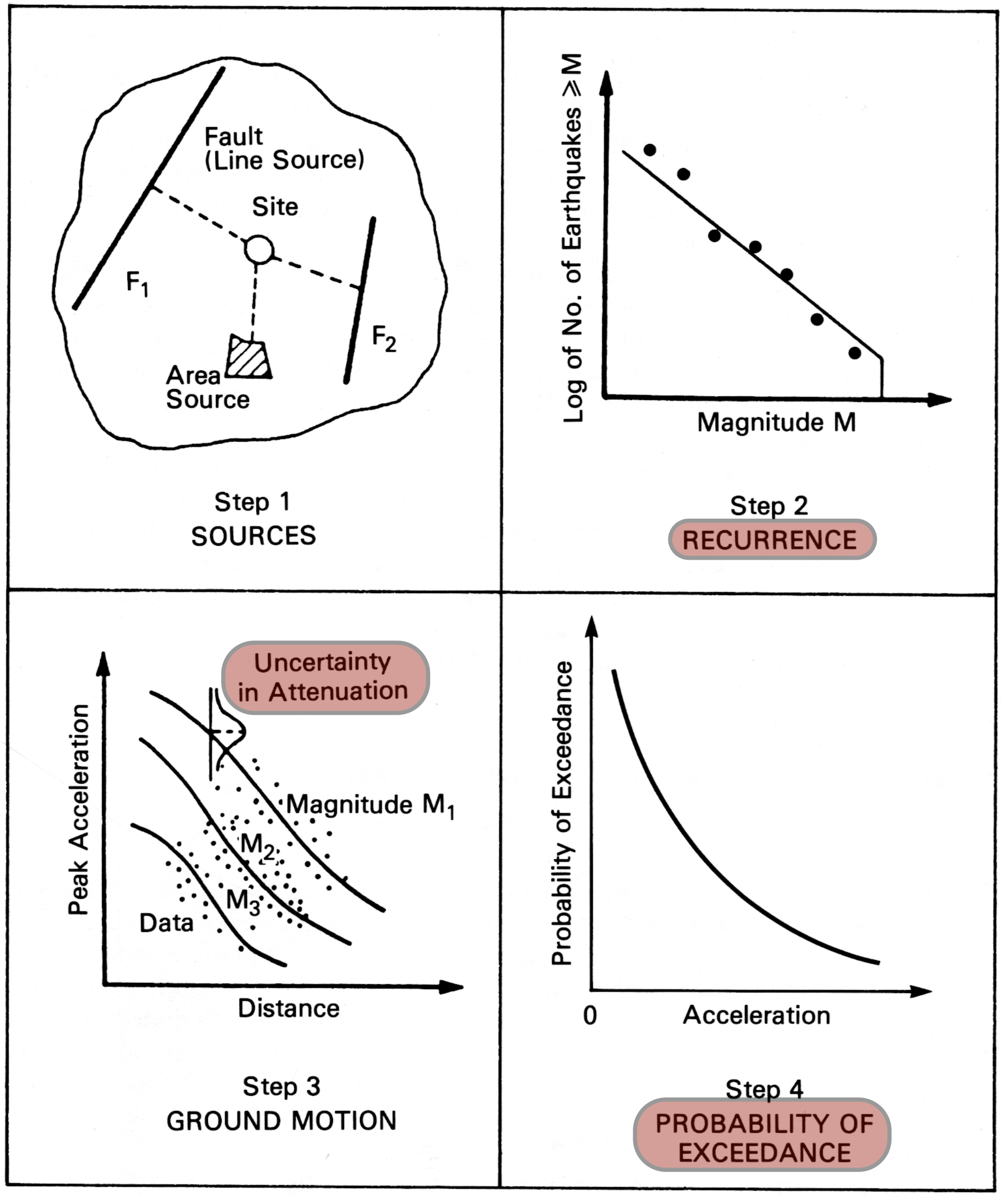


FIGURE 10.2 Basic steps of probabilistic seismic hazard analysis (after TERA Corporation 1978).

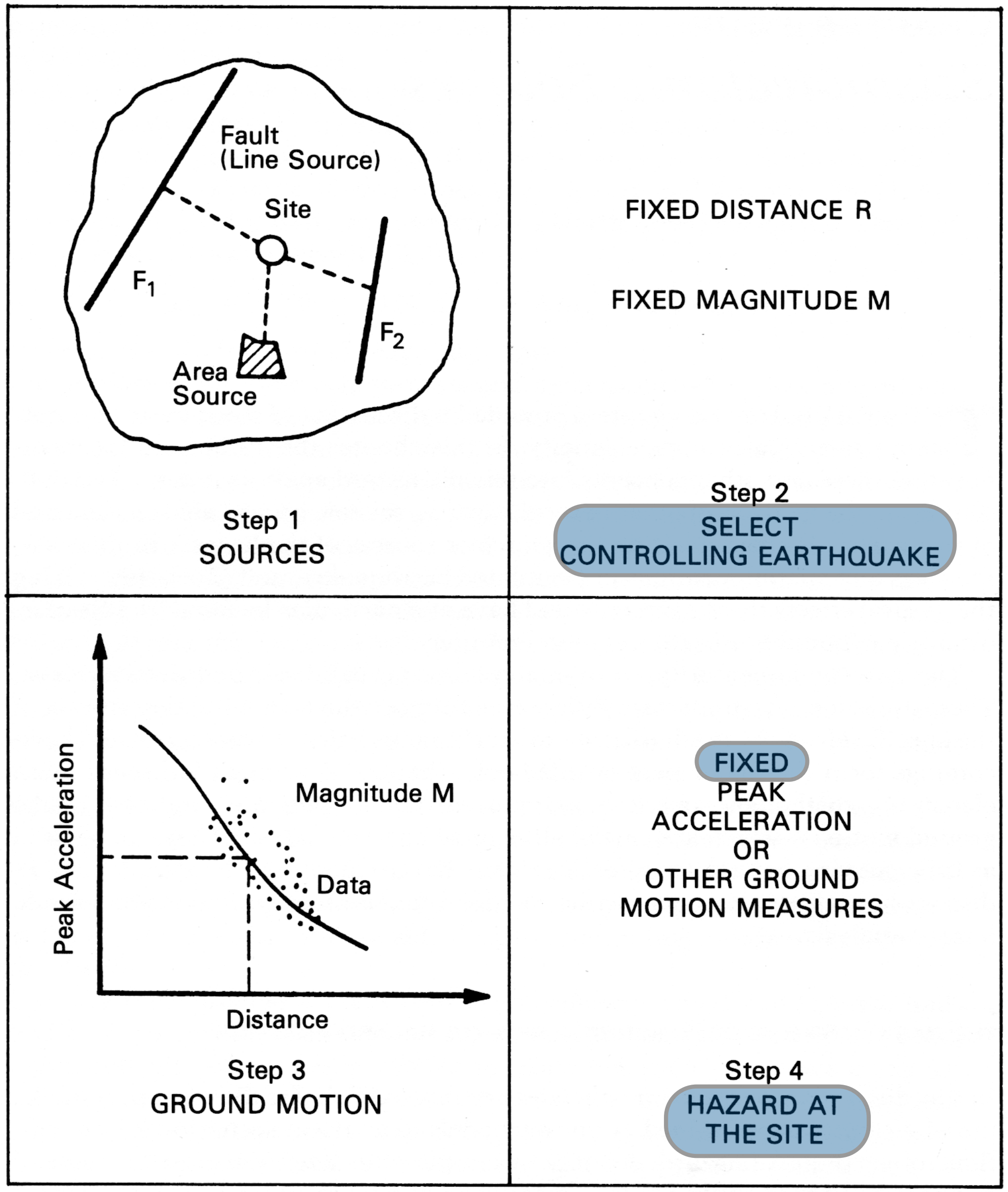
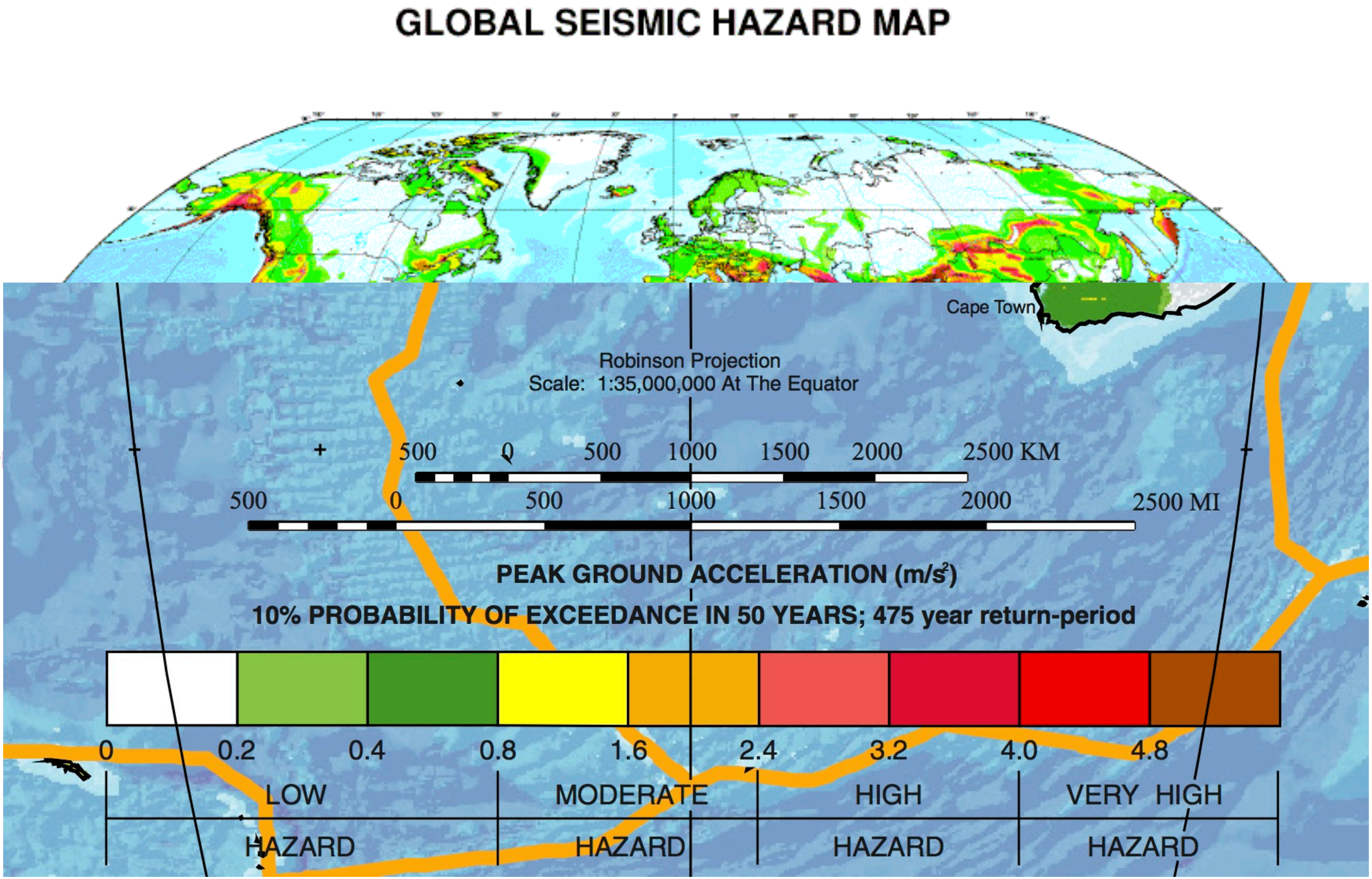


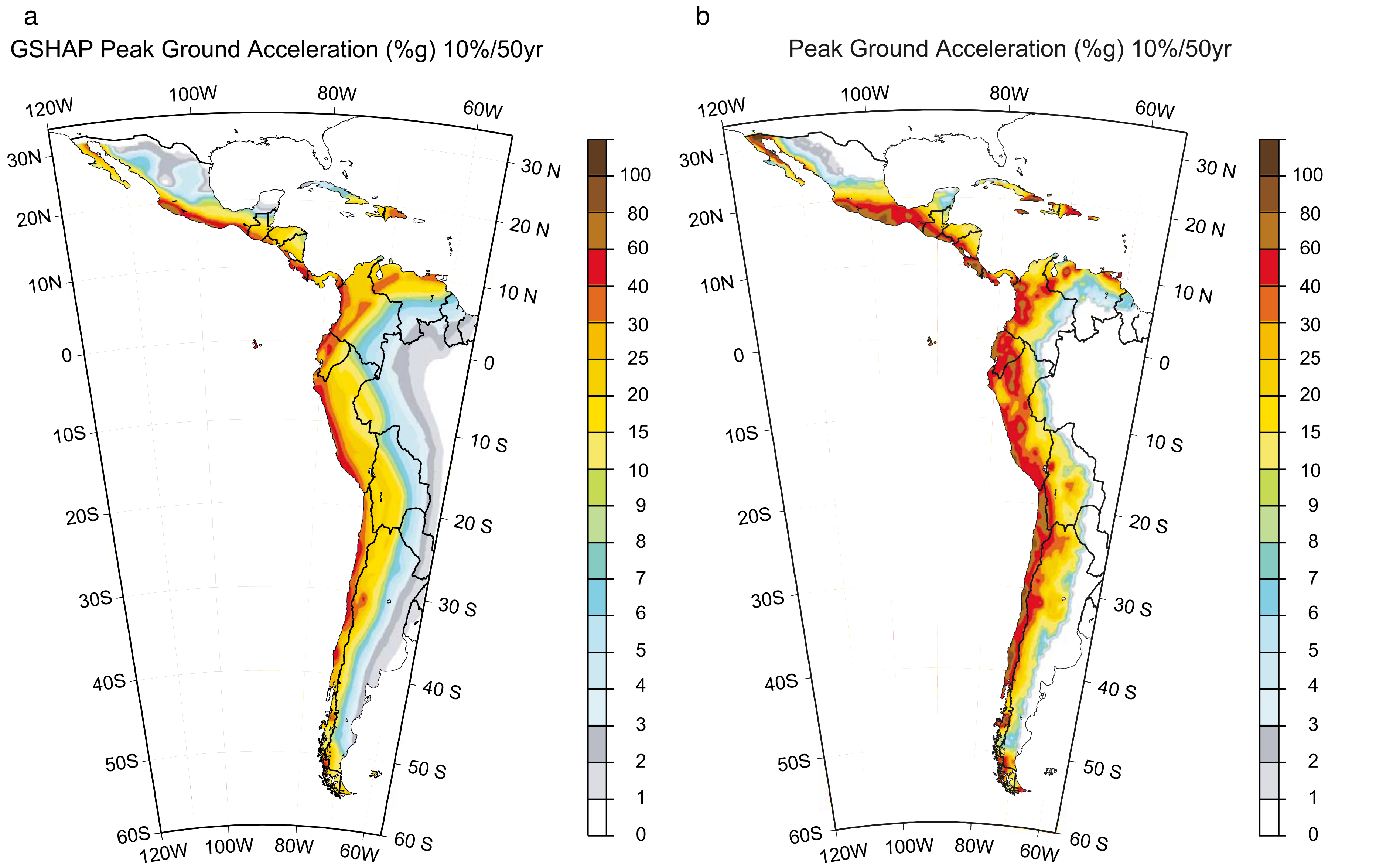
FIGURE 4.1 Basic steps of deterministic seismic hazard analysis (after TERA Corporation 1978).

"Earthquake Hazard Analysis", Reiter, 1990

SHA global map



GSHAP maps for LA

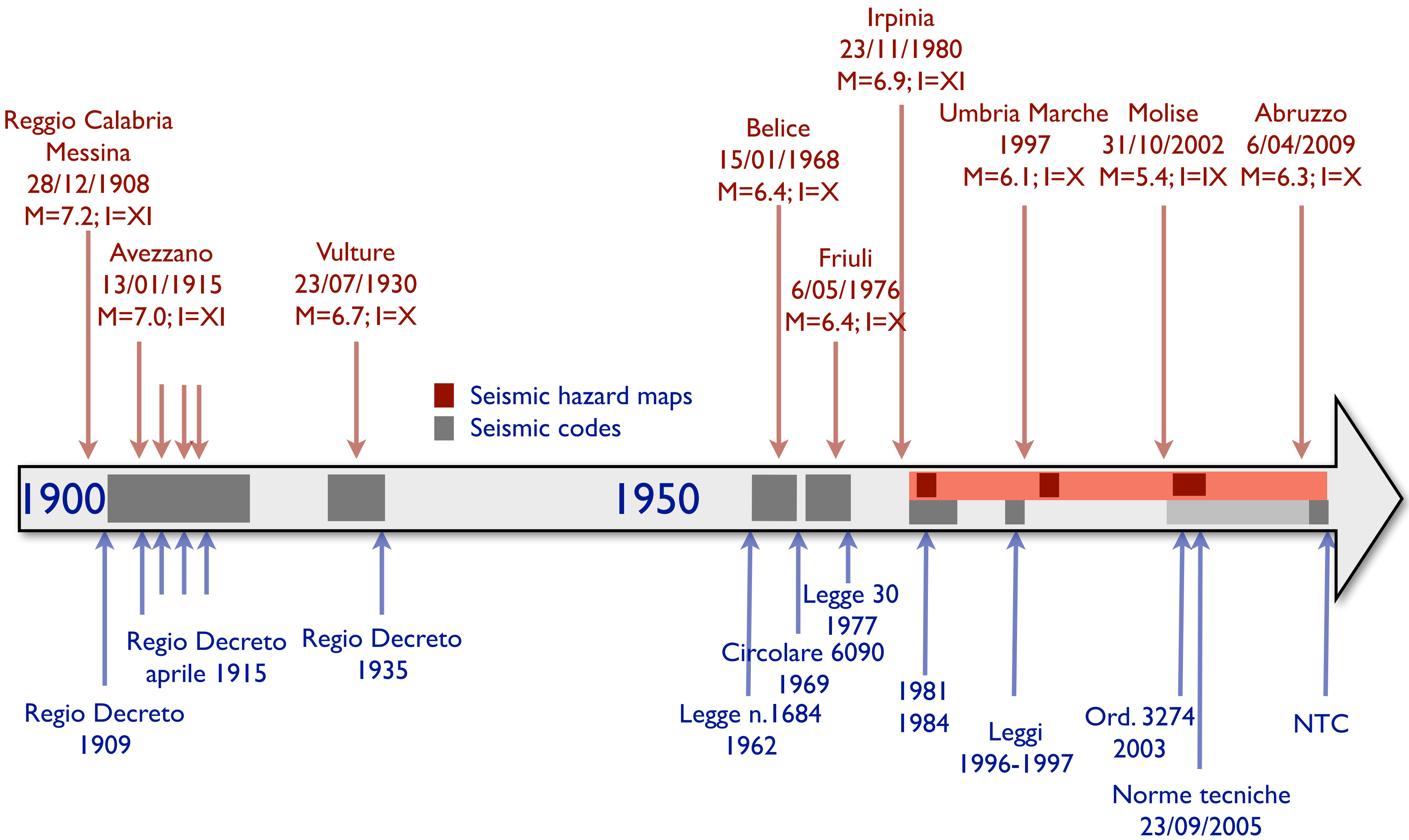


J.G. Tanner, K.M. Shedlock / Tectonophysics 390 (2004) 159–175

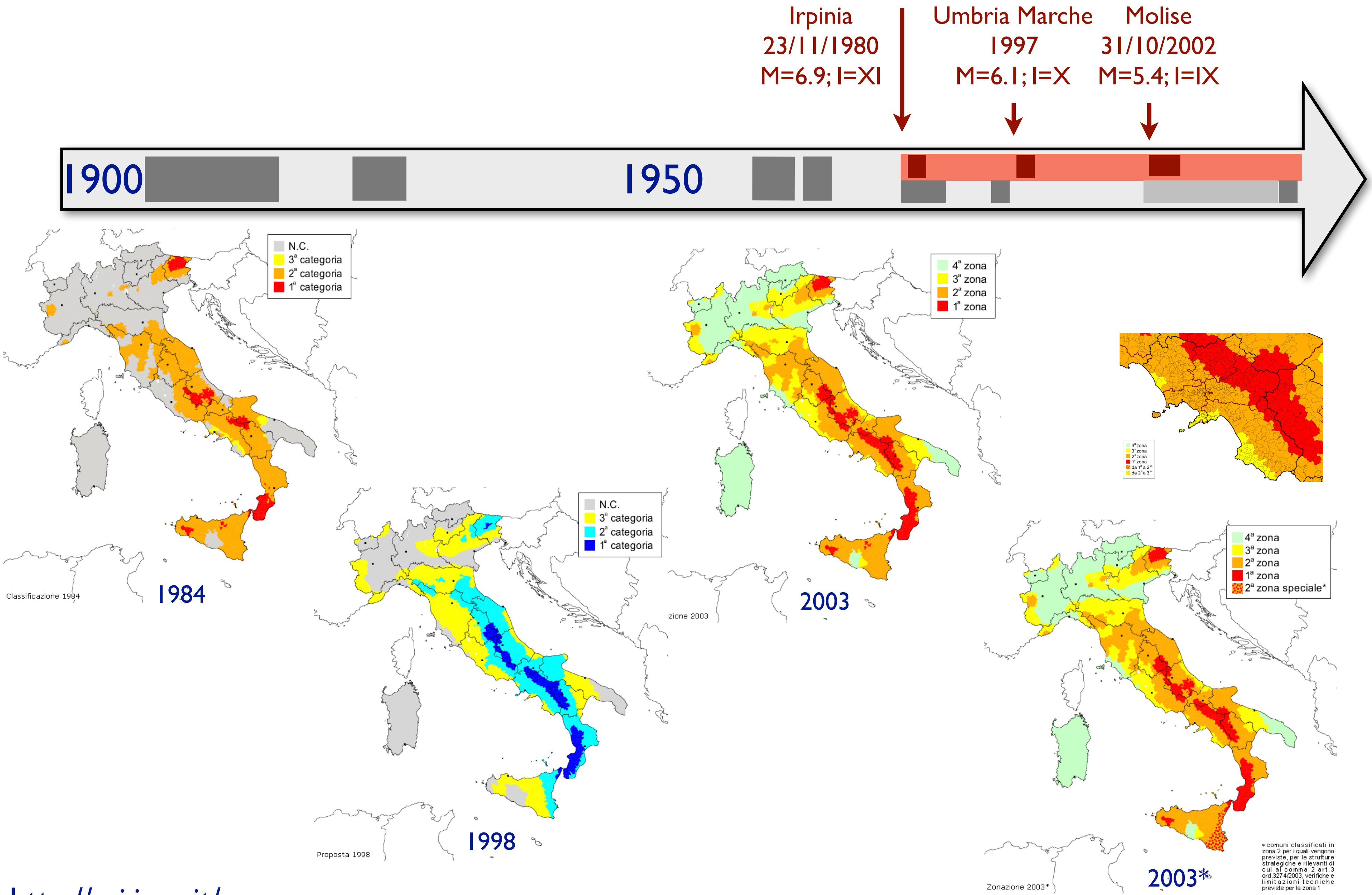
Fig. 3. Peak ground acceleration (pga) with a 10% chance of exceedance in 50 years. The site condition is a rock. (a) The values published as part of the GSH map (Giardini et al., 1999) plotted in %g. (b) The values calculated using the method and attenuation relationships described herein. Note the difference in smoothness between the two approaches.

Seismic Provisions in Italy - Evolution

- Earthquakes and seismic codes since 1900



Seismic hazard maps in Italy - Evolution



http://mi.ingv.it/

Seismic hazard maps in Italy - Evolution

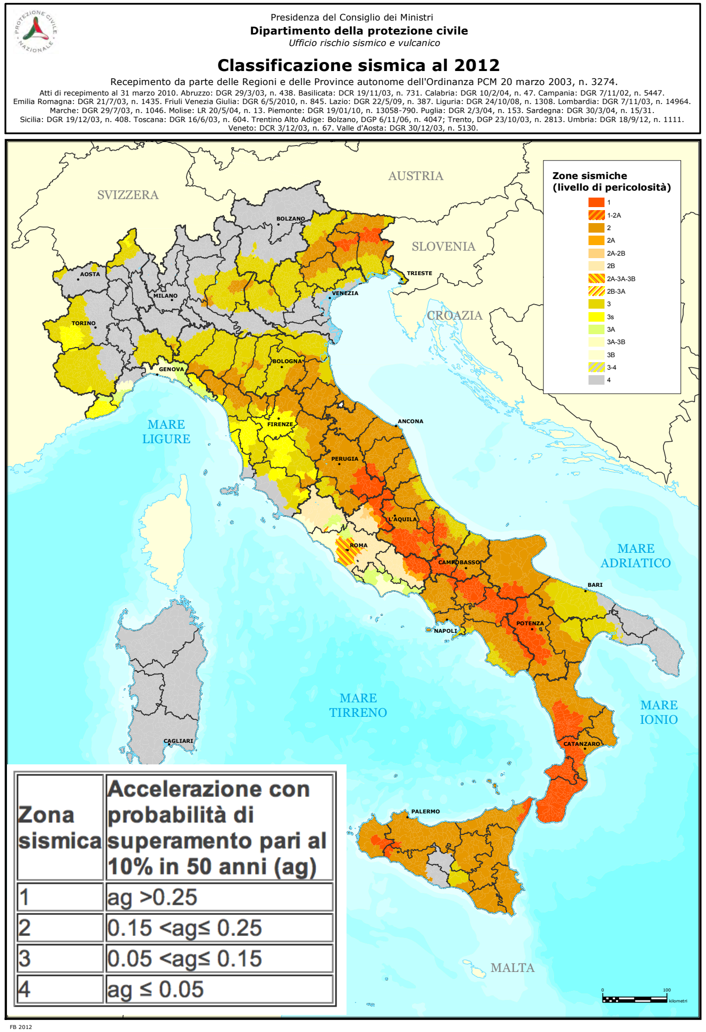
PCM 3519
28/04/2006

1900 1950

Normativa regionale di classificazione sismica
(Atti di recepimento al 18 settembre 2012)

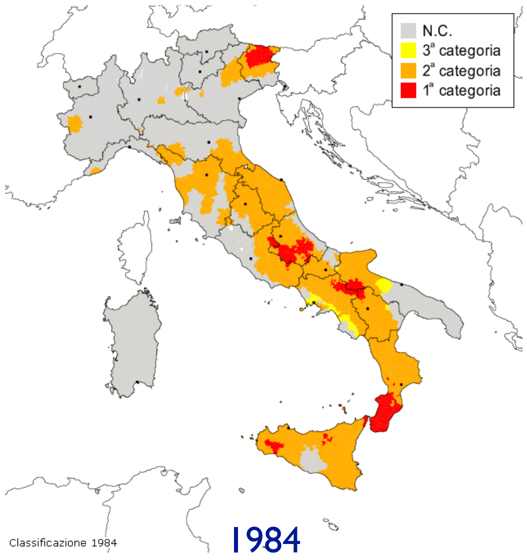
Classificazione sismica

Regione	Normativa	N.	Data
Abruzzo	Delibera Giunta Regionale	438	29 marzo 2003
Basilicata	Deliberazione Consiglio Regionale	731	19 novembre 2003
Calabria	Delibera Giunta Regionale	47	10 febbraio 2004
Campania	Delibera Giunta Regionale	5447	7 novembre 2002
Emilia Romagna	Delibera Giunta Regionale	1435	21 luglio 2003
Friuli Venezia Giulia	Delibera Giunta Regionale	845	6 maggio 2010
Lazio	Delibera Giunta Regionale	387	22 maggio 2009
Liguria	Delibera Giunta Regionale	1308	24 ottobre 2008
Lombardia	Delibera Giunta Regionale	14964	7 novembre 2003
Marche	Delibera Giunta Regionale	1046	29 luglio 2003
Molise	Legge Regionale	13	20 maggio 2004
Piemonte	Delibera Giunta Regionale	13058-790	19 gennaio 2010
Puglia	Delibera Giunta Regionale	153	2 marzo 2004
Sardegna	Delibera Giunta Regionale	15/31	30 marzo 2004
Sicilia	Delibera Giunta Regionale	408	19 dicembre 2003
Toscana	Delibera Giunta Regionale	604	16 giugno 2003
Trentino Alto Adige – Bolzano	Delibera Giunta Provinciale	4047	6 novembre 2006
Trentino Alto Adige – Trento	Delibera Giunta Provinciale	2813	23 ottobre 2003
Umbria	Delibera Giunta Regionale	1111	18 settembre 2012
Veneto	Deliberazione Consiglio Regionale	67	3 dicembre 2003
Valle d'Aosta	Delibera Giunta Regionale	5130	30 dicembre 2003

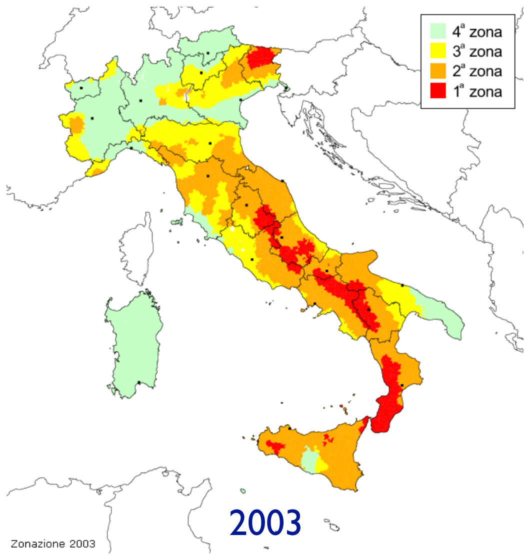


Seismic hazard maps in Italy - Evolution

Abruzzo
6/04/2009
M=6.3; I=X



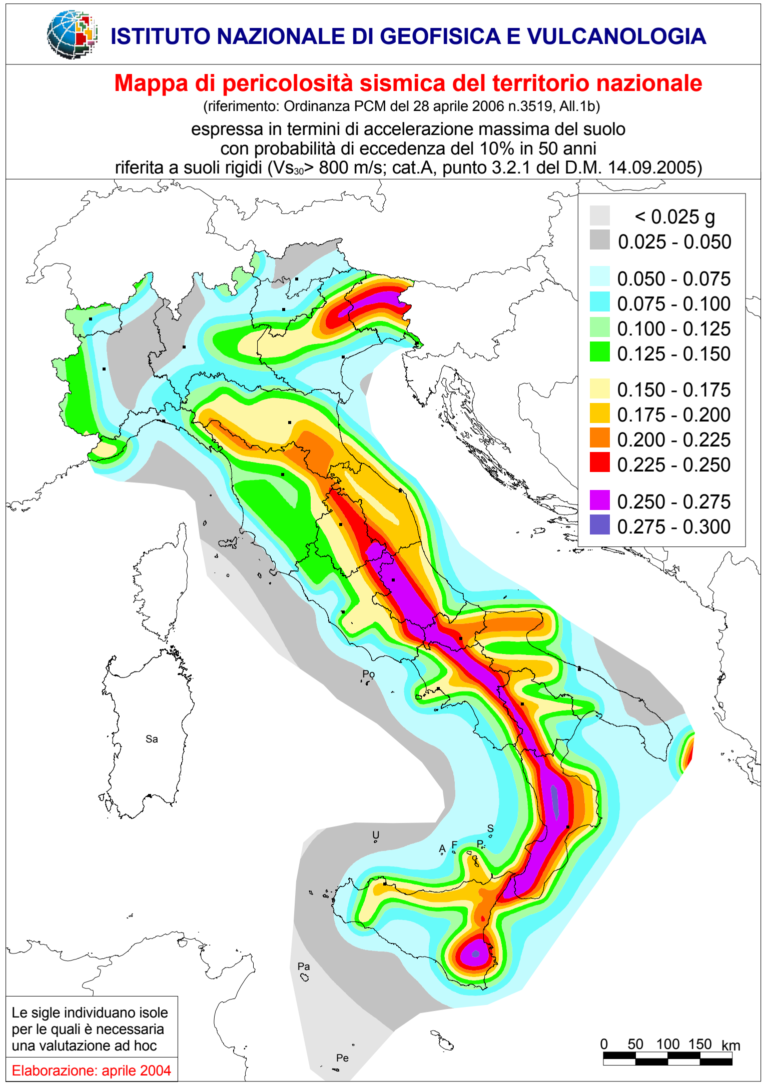
1984



2003

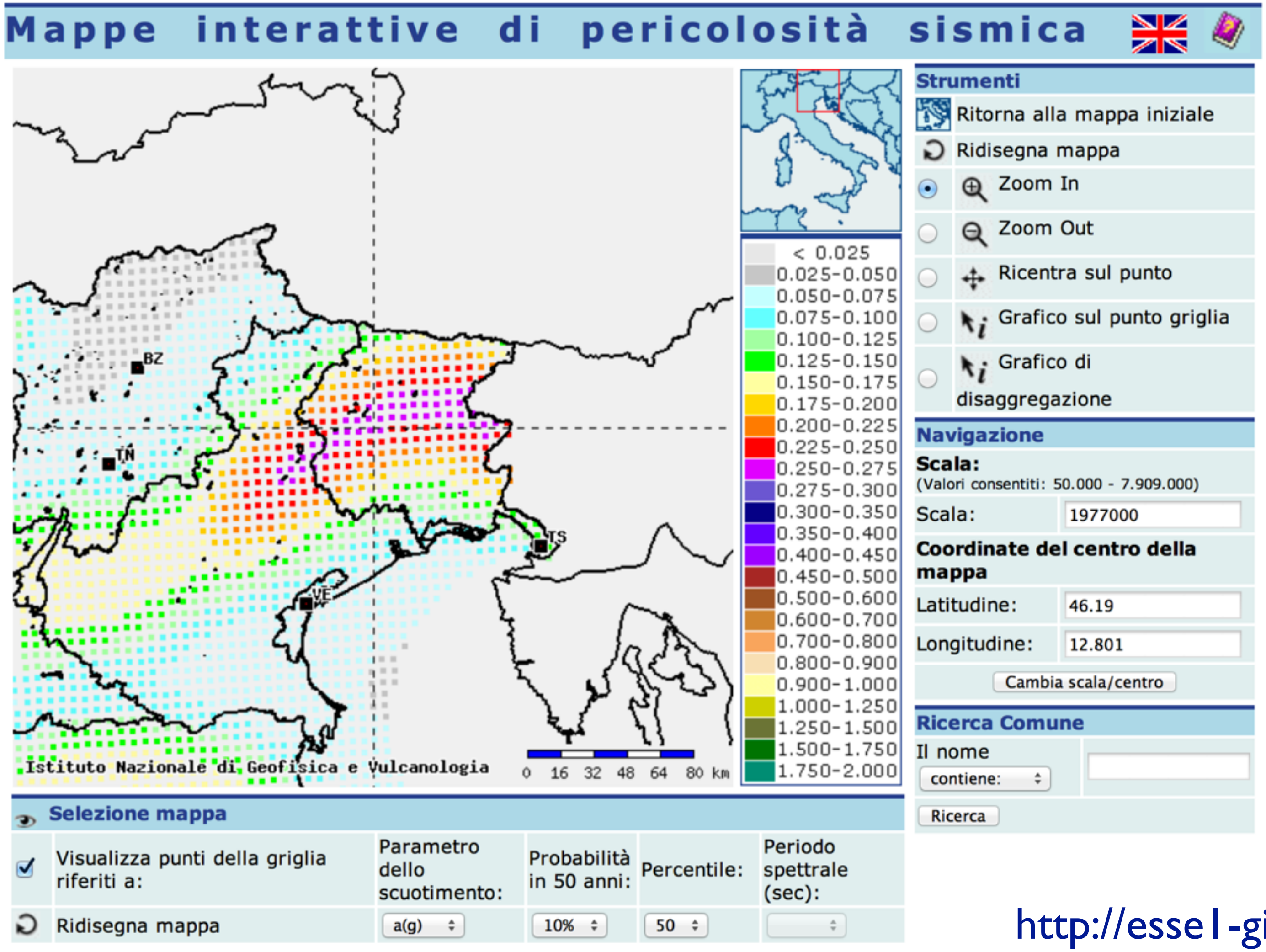
NTC
14/01/2008

Zona sismica	Accelerazione con probabilità di superamento pari al 10% in 50 anni (ag)
1	ag >0.25
2	0.15 <ag≤ 0.25
3	0.05 <ag≤ 0.15
4	ag ≤ 0.05



http://zonesismiche.mi.ingv.it

Seismic hazard maps in Italy - Evolution



http://esse1-gis.mi.ingv.it

SHA Dualism

Deterministic vs. probabilistic approaches to assessing earthquake hazards and risks have differences, advantages, and disadvantages that often make the use of one advantageous over the other.

Probabilistic methods can be viewed inclusive of all deterministic events with a finite probability of occurrence. In this context, proper deterministic methods that focus on a single earthquake ensure that that event is realistic, i.e. that it has a finite probability of occurrence.

Determinism vs. probabilism is not a bivariate choice but a continuum in which both analyses are conducted, but more emphasis is given to one over the other. Emphasis here means weight in the decision-making process...

Modified from: Mc Guire, 2001

SHA dualism revisited

	Deterministic	⟷		Probabilistic
Risk mitigation decision	Emergency response			Design/Retrofit
Seismic environment	Next to active fault	High hazard, plate margin	Moderate hazard, anywhere	Low hazard, midplate
Scope of the project	Regional risk		Multiple properties lifelines	Specific site
	Qualitative			Quantitative

Modified from: Mc Guire, 2001