EARTHQUAKE RISK MANAGEMENT LESSONS AND PROPOSALS FOR A SUSTAINABLE FUTURE

by

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Yanev: Brief History

We specialize in **earthquake risk consulting**: risk management, insurance consulting, earthquake engineering, and risk improvement with emphasis on quantifying and reducing property loss and business interruption

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- 1971: Started the earthquake experience database - now more than 100 earthquakes - most major quakes worldwide
- 1974: Wrote "Peace of Mind in Earthquake Country" - the first & best-selling book on Earthquake Risk Management (now in 4th edition)
- 1978: First earthquakes in Japan (Izu M6.5 & Miyagi-Ken-oki M7.4), including the Fukushima NPS and Tohoku EPCo power system.
- 1981: Founded EQE International specializing in Earthquake engineering and risk management. First engineering company to do that. Developed PML analysis.
- 1994: Founded EQECAT with Marsh to address insurance and financial industries catastrophe risk through CAT modeling
- 1994: Founded EQE-Japan. First engineering risk management company in Japan.
- 2001: Had 33 offices and 750 people worldwide. Sold EQE in 2000; left in 2001
- 1992 - Today: Consulting in earthquake and risk engineering for the World Bank; On going large projects around the world
- 2009: Founded Yanev Associates (San Francisco, Los Angeles, New York)

100+ Earthquakes Investigated 1971 - 2012

1971 San Fernando, CA (M6.5)
1972 Managua, Nicaragua (M6.3)
1973 Point Mugu, CA (M5.9)
1973 Managua, Nicaragua (M5.8)
1975 Ferndale, CA (M5.5)
1975 Lice, Turkey (M6.8)
1976 Friuli, Italy (M6.5)
1977 Vrancia, Romania (M7.4)
1978 Izu Peninsula, Japan (M6.7)
1978 Miyagi-Ken-oki, Japan (M7.4)
1978 Santa Barbara, CA (M5.1)
1979 Bishop, CA (M5.8)
1979 Gilroy, CA (M5.5)
1979 Imperial Valley, CA (M6.6)
1980 Livermore, CA (M5.5 and 5.8)
1980 Eureka, CA (M7.0)
1980 Mammoth Mt., CA (M6.5, 6.5, 6.7)
1981 Brawley, CA (M5.6)
1983 Coalinga, CA (M6.7)
1983 Borah Mt., Idaho (M6.9)
1984 Morgan Hill, CA (M6.2)
1985 Santiago, Chile (M7.8 and 7.2)
1985 Mexico City, Mexico (M8.1 and 7.5)
1986 Painesville, Ohio (M5.0)
1986 Adak Island, Alaska (M7.7 and 6.5)
1986 North Palm Springs, CA (M6.0)
1986 Chalfant Valley, CA (M6.0 and 5.5)
1986 San Salvador, El Salvador (M5.4)
1986 Northern Taiwan (M6.8)
1987 Cerro Prieto, Mexico (M5.4)
1987 Bay of Plenty, New Zealand (M6.2)
1987 Whittier, CA (M5.9)
1987 Superstition Hills, CA (M6.3)
1988 Gorman, CA (M5.2)
1988 Alum Rock, CA (M5.1)
1988 Saguenay, Quebec (M6.0)
1988 Armenia, USSR (M6.9)
1989 Acapulco, Mexico (M6.8)
1989 Loma Prieta, CA (M7.1)
1989 Newcastle, Australia (M5.5)
1990 Upland, California (M5.5)
1990 Bishop's Castle, Wales (M5.4)
1990 Manjil, Iran (M7.7)
1990 Central Luzon, Philippines (M7.7)
1991 Valle de la Estrella, Costa Rica (M7.4)
1991 Sierra Madre, CA (M5.8)
1992 Erzincan, Turkey (M6.8)
1992 Roermond, Netherlands (M5.8)
1992 Desert Hot Springs, CA (M6.1)
1992 Cape Mendocino, CA (M7.0, 6.0, & 6.5)
1992 Landers-Big Bear, CA (M7.6 and 6.7)
1992 Cairo, Egypt (M5.9)
1993 Scotts Mill, OR (M5.3)
1993 Nansei-oki Hokkaido, Japan, (M7.8)
1993 Agana, Guam (M8.2)
1993 Klamath Falls, OR (M5.7)
1994 Northridge, CA (M6.6)
1994 Tohoko-oki, Hokkaido, Japan (M8.1)
1995 Great Hanshin (Kobe), Japan (M7.2)
1995 Pereira, Colombia (M6.5)
1995 Sakhalin Islands, Russia (M7.2)
1995 Antofagasta, Chile (M7.4)
1995 Manzanillo, Mexico (M7.6)
1996 Duvall (Seattle,), WA (M5.3)
1997 Calico, CA (M5.0)
1997 Umbria, Italy (M5.5)
1998 Adana-Ceyhan, Turkey (M6.2)
1999 Armenia, Colombia (M5.0)
1999 Puerto Escondido, Mexico (M7.5)
1999 Western Washington (M5.8)
1999 Izmit, Turkey (M7.4)
1999 Duzce, Turkey (M7.2)
1999 Central Taiwan (M7.6)
1999 Athens, Greece (M5.9)
1999 Algeria (M5.5)
1999 Hector Mine, California (M7.1)
2000 Napa, CA (M5.2)
2000 Tottori, Japan (M6.7)
2001 Gujarat, India (M7.6)
2001 Seattle, WA (M6.8)
2002 San Simeon (Paso Robles), CA (M6.5)
2007 West Sumatra, Indonesia (M6.3)
2007 Niigata (Kashiwazaki), Japan (M6.8)
2008 Wells, Nevada (M6.3)
2008 Sichuan, China (M8.0)
2009 L'Aquila, Italy (M6.3)
2010 Haiti (M6.9)
2010 Chile (M8.8)
2010 Baja California, Mexico & CA (M7.2)
2011 Christchurch, New Zealand (M6.3)
2011 Tohoku (Sendai), Japan (M9.0)
2011 Mineral, Virginia (M5.9)
2011 Van, Turkey (M7.2)

Earthquake Risk Management Lessons and Proposals for a Sustainable Future

Most effective future actions for both country-wide and specific public and private companies:

1. Developing and enforcing ***pro-active* zoning and building codes** based on well understood and widely accepted natural disaster sustainability goals. I will discuss only two aspects of the codes – earthquake maps and high-rise buildings.

2. Supporting **country-wide and industry-wide earthquake loss control programs** in the public and private sectors.

3. **Learning the positive lessons of earthquakes.** In general, we have a difficult time learning positive lessons from natural disasters. The nuclear industry, their regulators, and governments around the world, including Japan and the USA, concentrated quickly on the negative lessons of the Fukushima disaster and took actions. They forgot to look at the successes in the earthquake, particularly the Onagawa NPS and its "remarkable performance" vs. Fukushima, and are making important decisions on the basis of incomplete information.

The best “Disaster Risk Control” is Pro-Active Risk Management

I have observed that consistently for more than 40 years and more than 100 earthquakes plus many floods and typhoons.

Risk management was also the basic difference between Onagawa and Fukushima NPS - Under the same regulatory conditions.

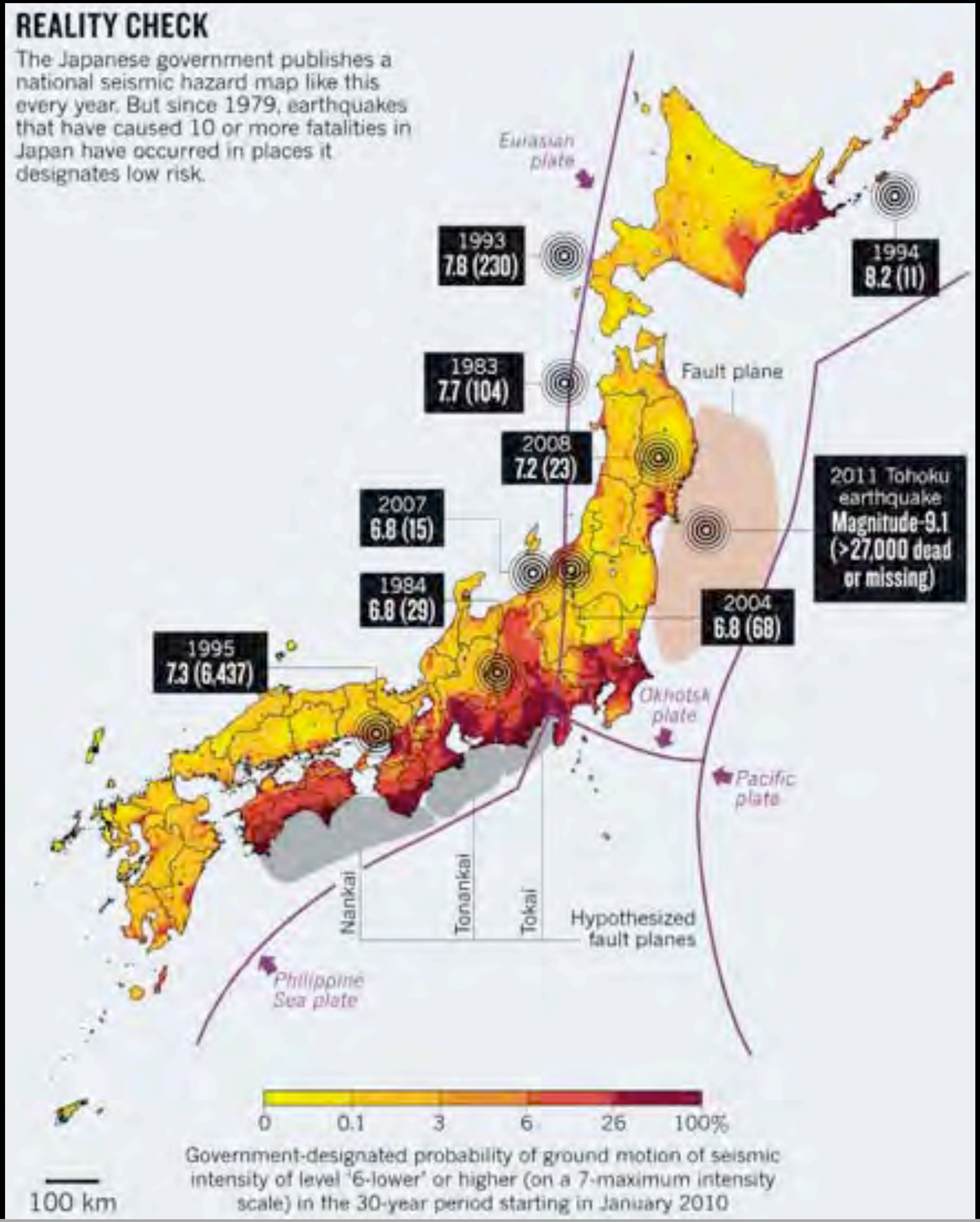
Pro-active zoning and building codes

- Earthquake Hazard Mapping
- High-rise buildings

Earthquake Hazard Mapping - My personal experience since I finished graduate engineering school in 1970: **The four earthquake in the LA region that caused severe damage and casualties (1971 San Fernando (M6.5), 1987 Whittier (M5.9), 1992 Landers-Big Bear (M7.6 & M6.7), and 1994 Northridge (M6.7) all occurred on “Unknown” Faults**

Before the 1994 Northridge earthquake, the fault map of the LA area included only the faults indicted by the heavy lines (only major faults shown). The yellow blocks on the right are the “blind trust” faults now known, following the 1994 quake. This has dramatically altered the risk in Los Angeles. Now every building in LA is on very near or on top of a fault.

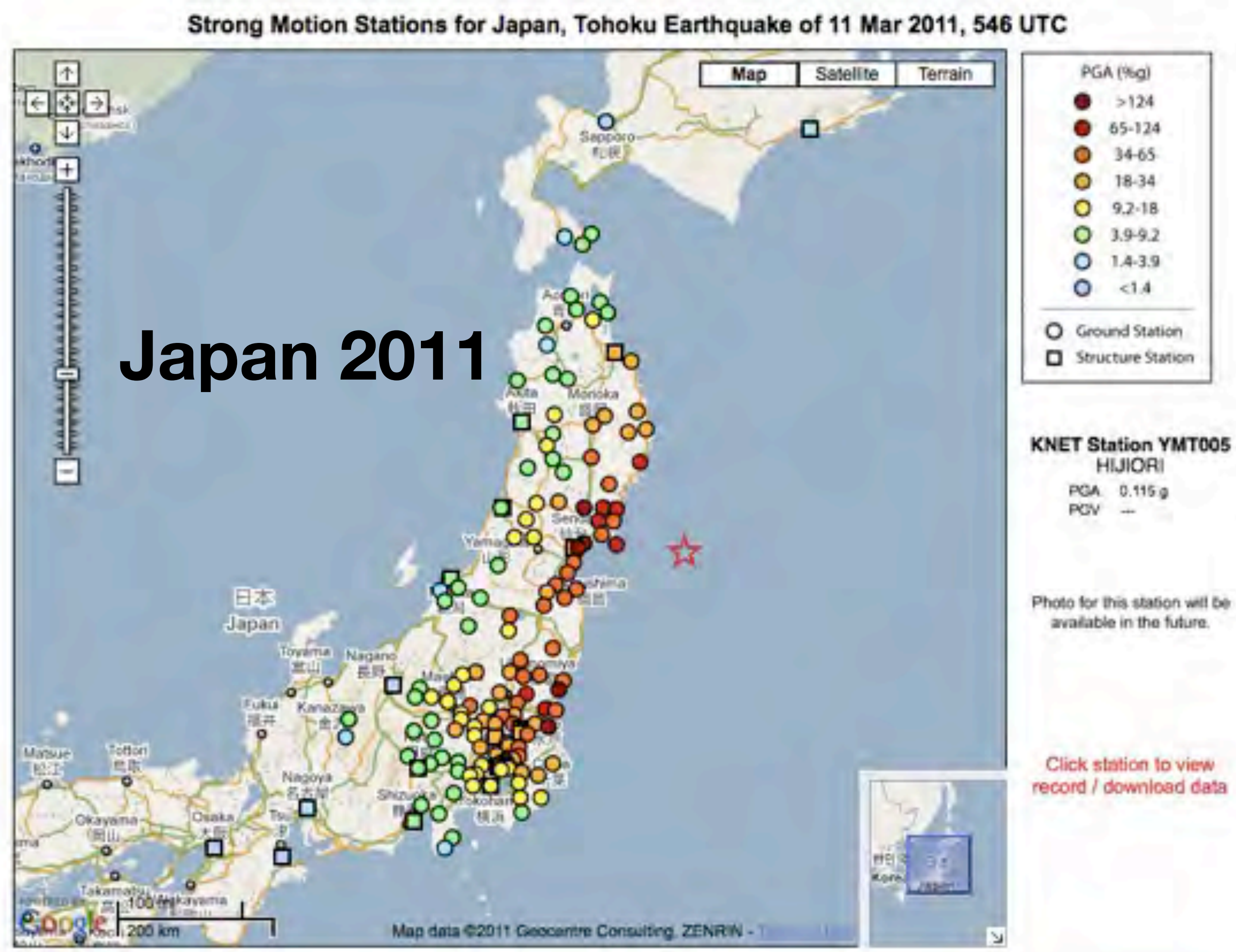
Earthquake Hazard Mapping - The recent history of earthquakes in Japan is very similar to Los Angeles. Earthquakes since 1979 have all occurred in the designated lower risk areas.



Geller, R.J., 2011 Shake-up time for Japanese seismology, Nature 472, 407-409

Recent Earthquake in the Most Advanced Countries:

In all three earthquakes the code requirements for design were exceeded substantially



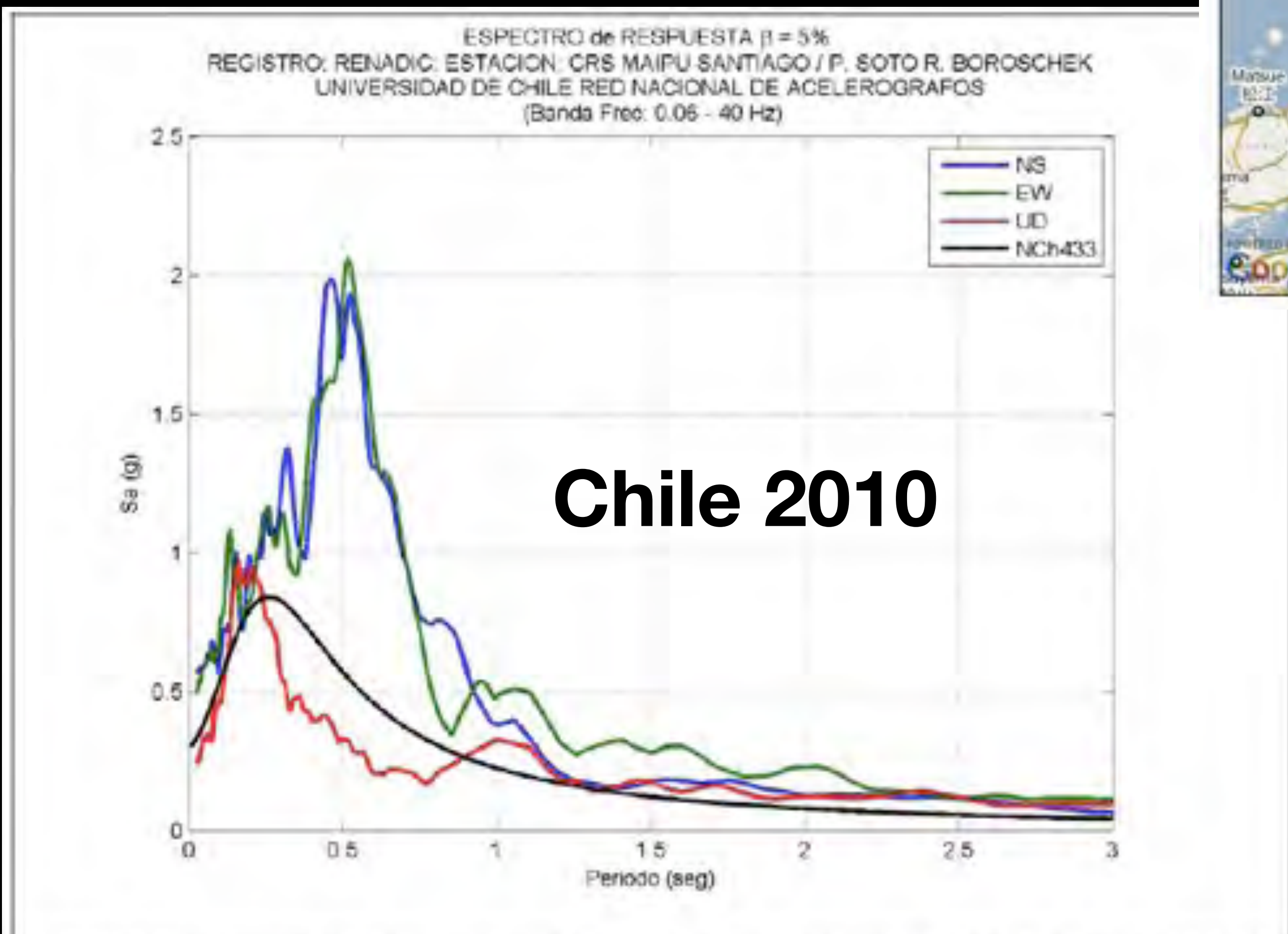
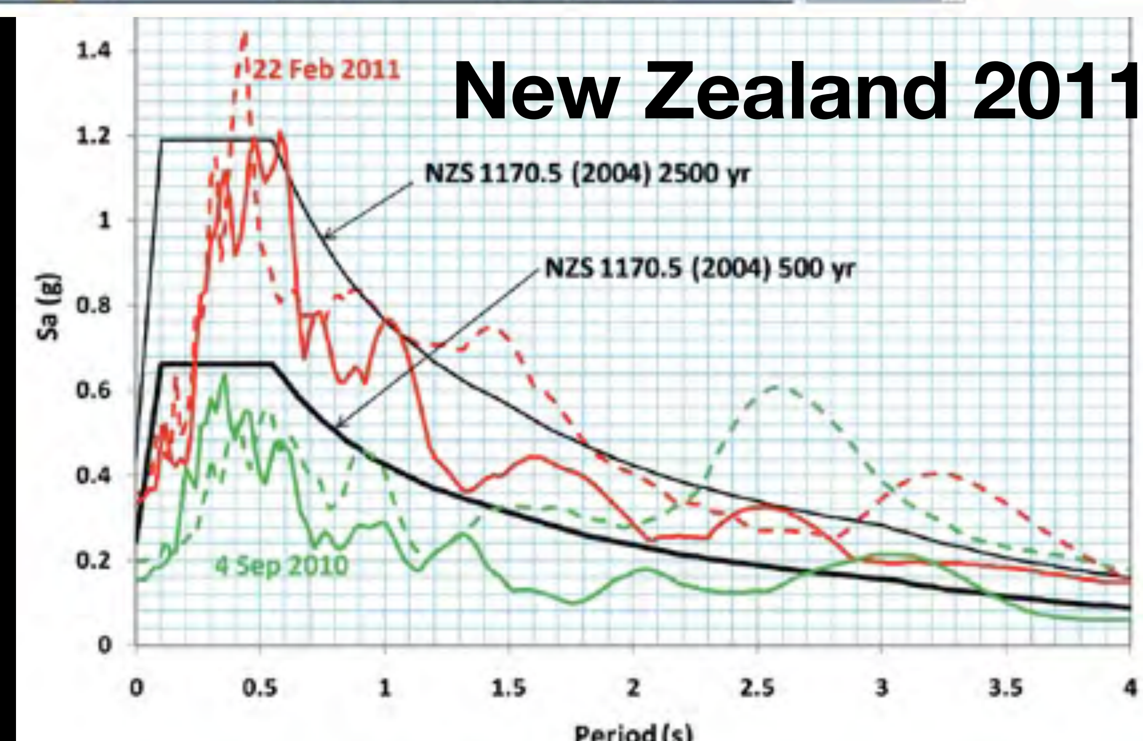
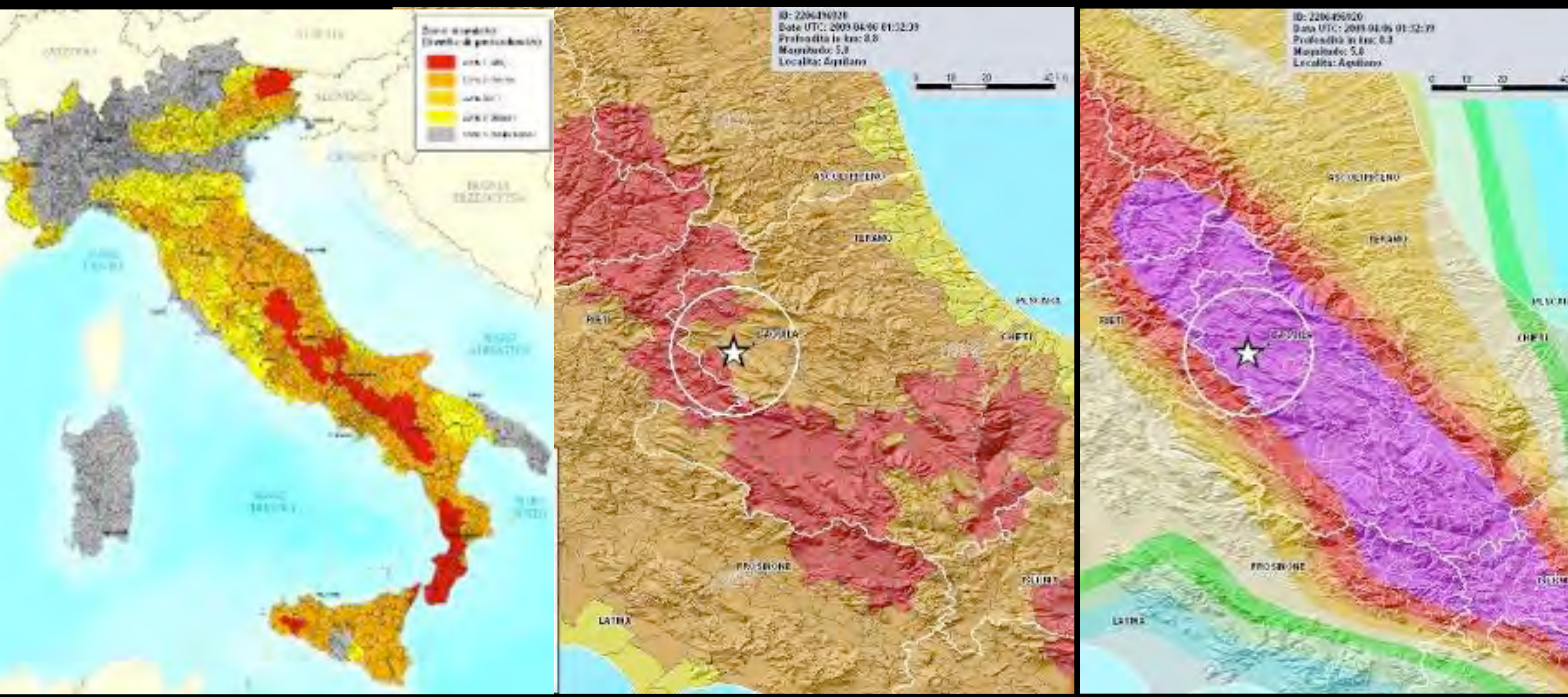


Figura 9 Comparación Espectro de Diseño Norma Chilena NCh433 – Estación CRS MAIPU RM. (Ver Nota General)



Improperly Used Seismicity and Historical Data
Coupled with Inadequate Code Requirements, Engineering Design, and Inspection: A Worldwide Problem

2009 L’Aquila, Italy (M6.3)

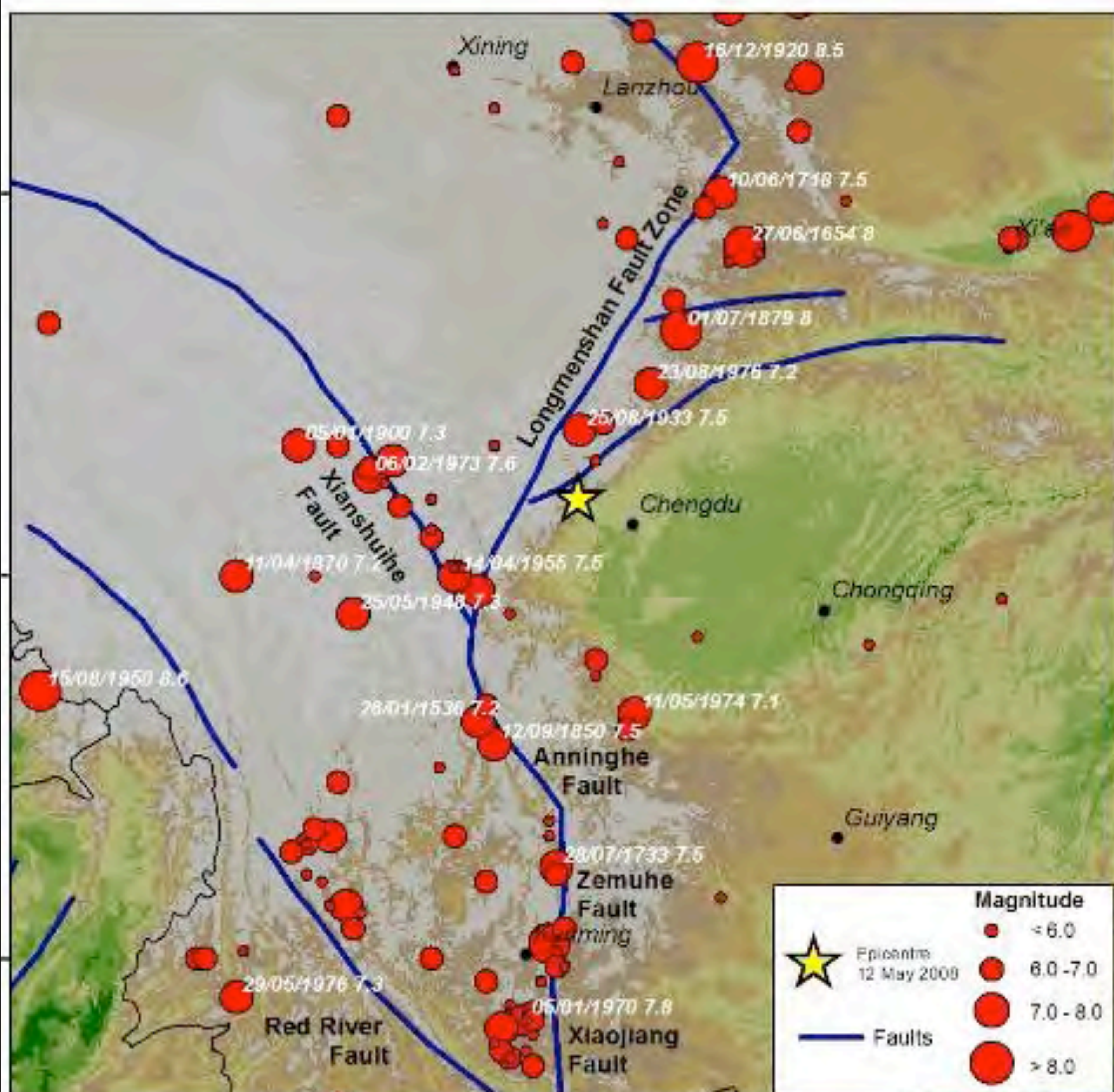


2009 L'Aquila, Italy (M6.3)

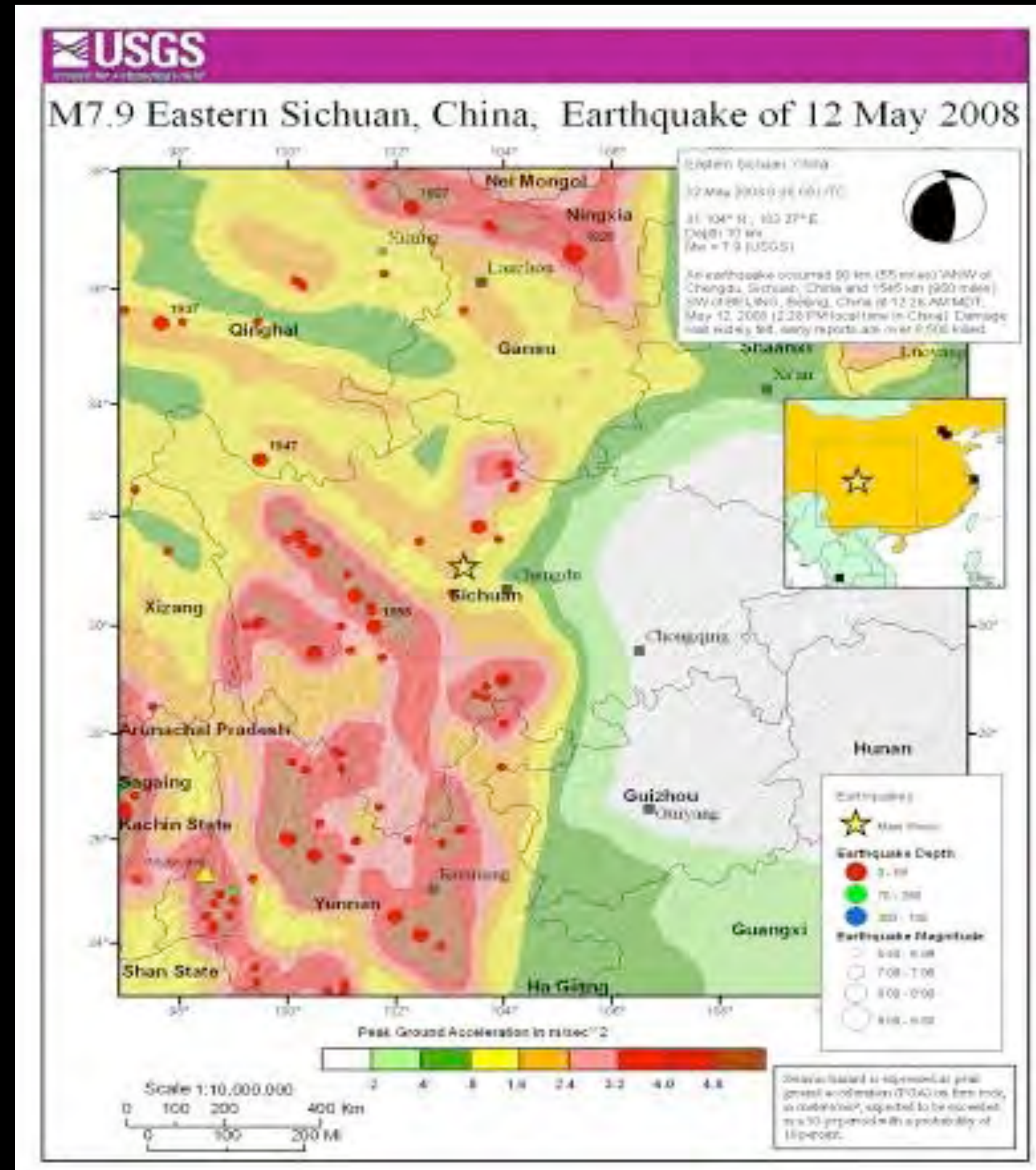
University of L'Aquila Faculty of Engineering Building

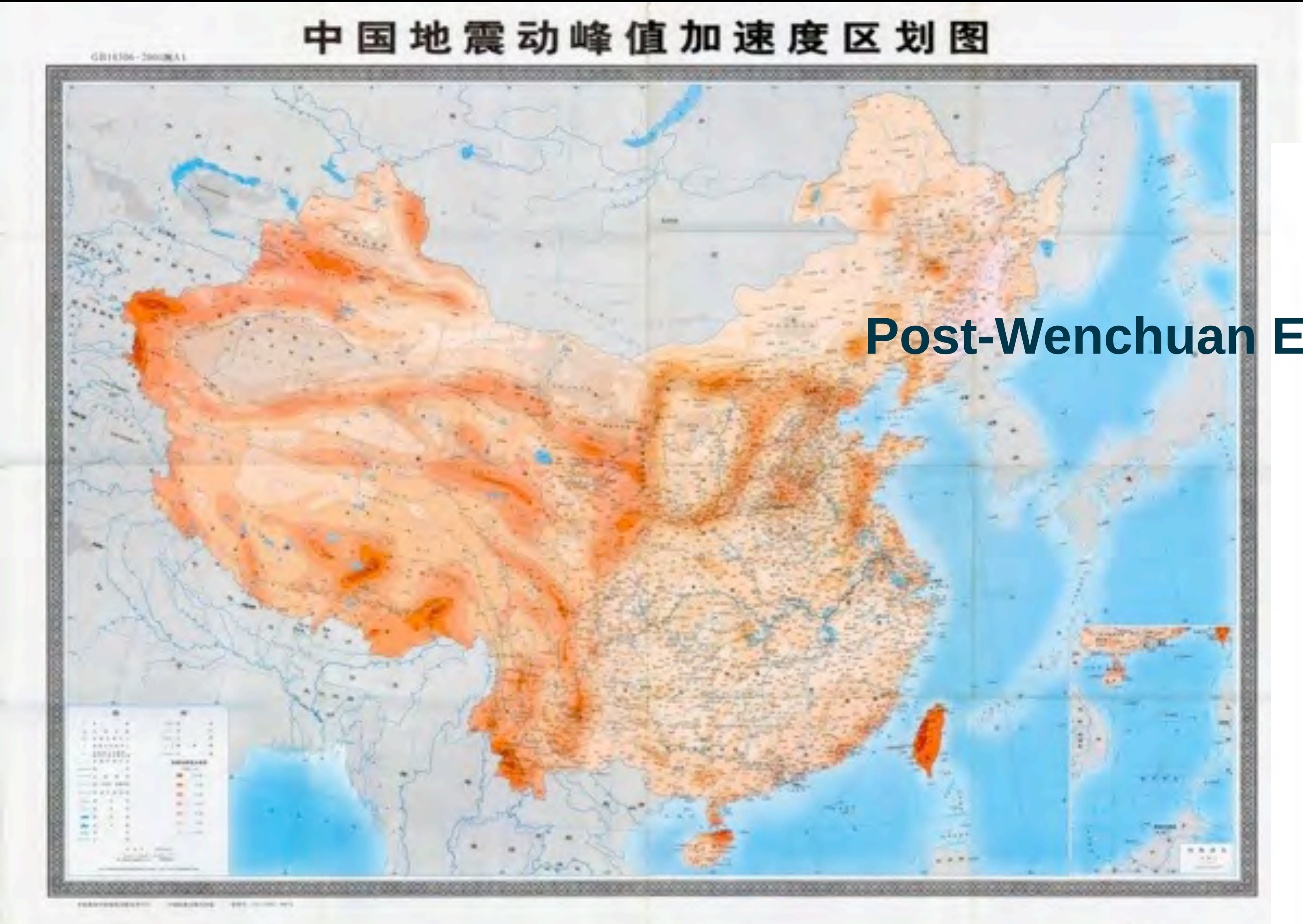
2008 Sichuan, China M8.0: The History of Earthquakes in the Region, the Risk Maps and the Building Code Are Inconsistent. The next earthquake will likely a “surprise” also.

Major (7.2+) Earthquakes occurred in the Region in 1933, 1948, 1955, 1973, 1976, etc.

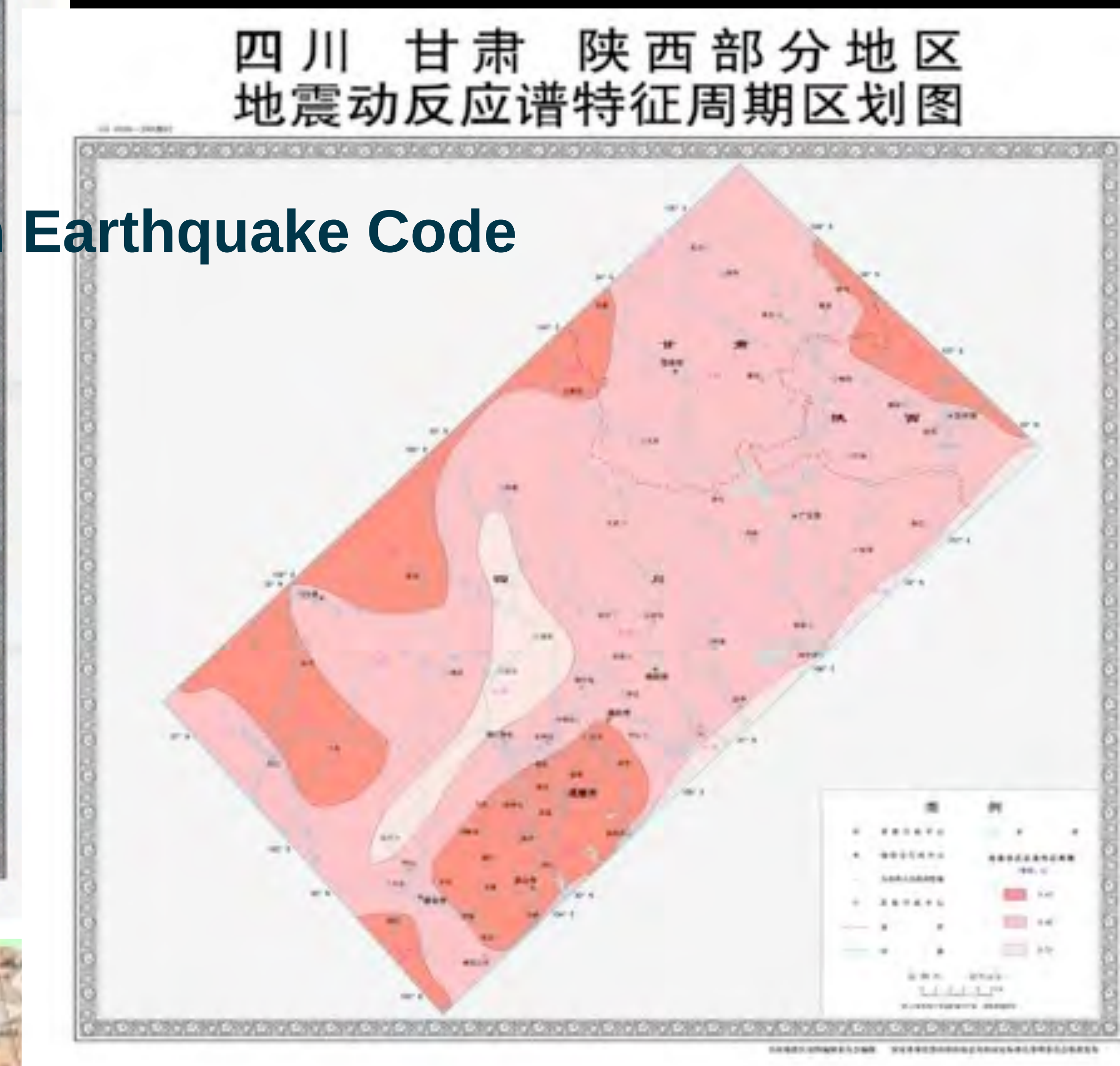


From: British Geological Survey

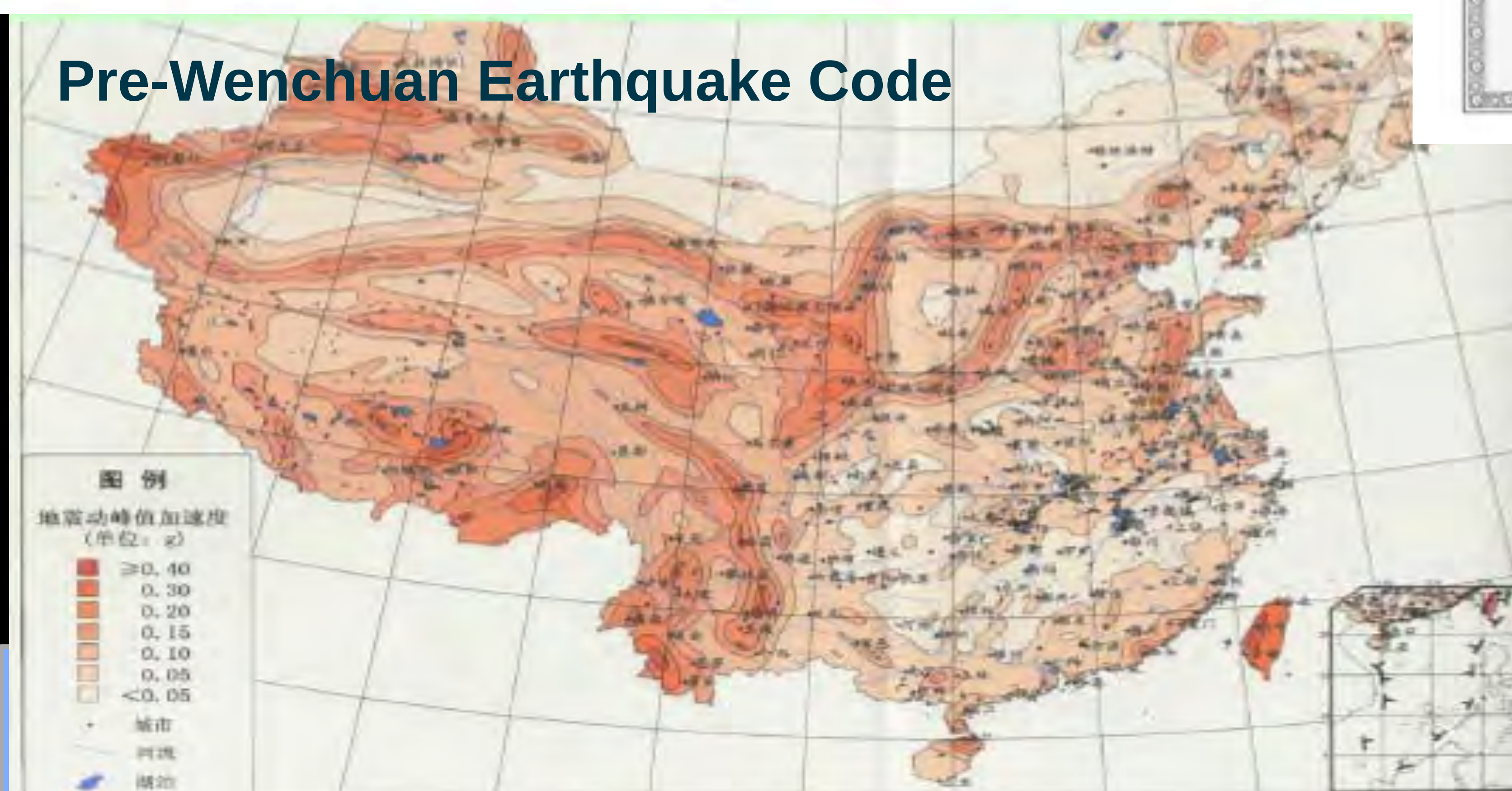




Post-Wenchuan Earthquake Code



Pre-Wenchuan Earthquake Code



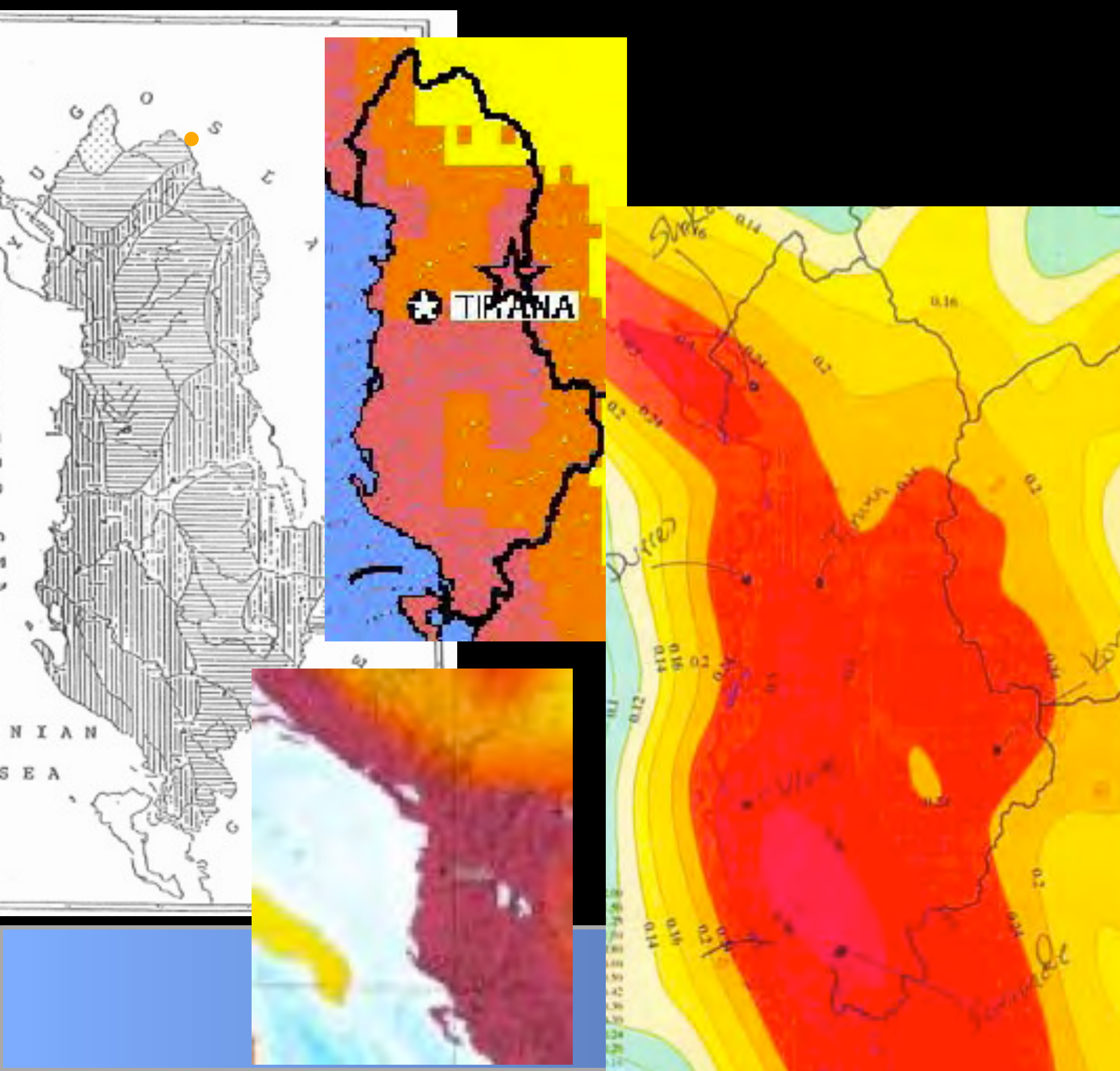
After theWenchuan earthquake the Chinese code Hazard Map was changed slightly. There is still inadequate recognition of the risk and inadequate zoning, including the Wenchuan area.

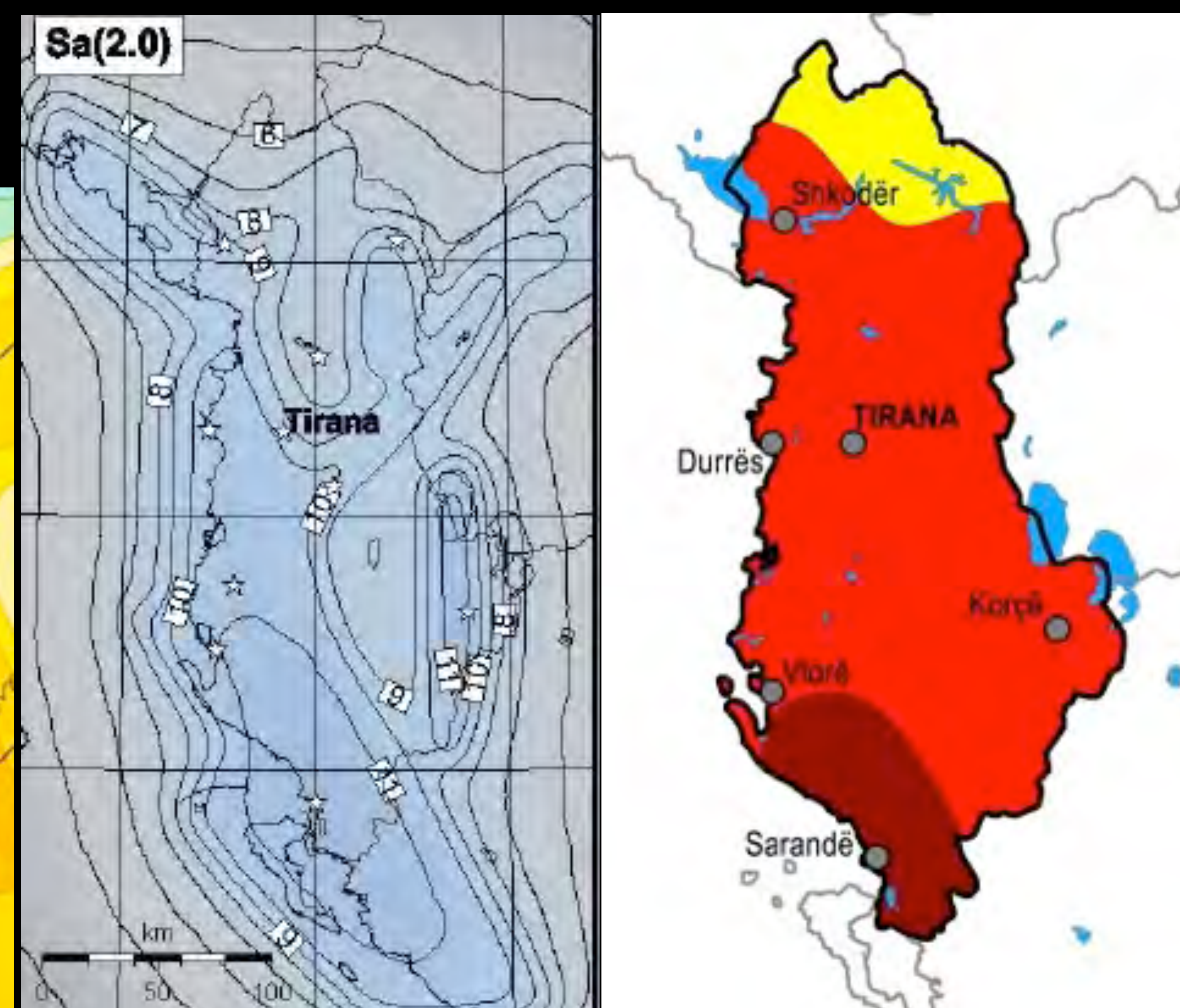
World Bank - Albania Country-Wide Assessment and a Suggested Approach to Hazard Mapping

- One of many similar WB projects (Turkey, China, Philippines, Chile, etc)
- Assessed residential buildings country-wide for an online risk assessment tool for homeowners (Europa Re)
- Rapidly surveyed hundreds of buildings
- Very limited seismicity data; reasonable historical/archaeological data. Critical to use all available data + judgement

World Bank - Albania Country-Wide Assessment and a Suggested Approach to Hazard Mapping

- Generally enveloped the existing data, smoothed it out, and increased the intensities by at least one MMI unit
- Grossly simplified (generalized) the hazard map - shown on the extreme right - using engineering judgement, common sense, & experience





Pro-active zoning and building codes

- Earthquake Hazard Mapping
- High-rise buildings

High-Rise Design Requirements

Throughout the world high-rises are designed to ordinary building criteria and present very high life-loss risks from beyond-code earthquakes.

The building below is a typical new structure in Asia, a few hundred meters from an active fault.

Sustainability calls for much better and stronger designs.

New Tall Buildings - Lessons from Chile, M8.8 - 2010

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When a new high-rise building (Chile, 2010) is severely damaged:

(1) The area around the building is cordoned off to protect the occupants of adjacent buildings. That results in a long business interruption. (2) The building has to be torn down. (3) A new building is built in its place.

The overall cost of the damage is then (1) the cost of the original building, plus (2) the cost of tearing down the building (which, in the CBD may cost as much as the original construction), plus (3) the cost of the replacement building, plus (4) the cost of business interruption and the inconvenience to the occupants. **So, one seriously damaged building now costs 3 to 4 times the original cost of the building. Higher design criteria would avoid that and improve sustainability.**