Introducing Catastrophe Risk*

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Topic Owners of CATRISK – subgroup of Strategic areas

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*This presentation expresses the views of the author and neither the views of EIOPA nor the IRSG.

Insurance and Reinsurance Stakeholder Group meeting ***29 April 2014***

Natural Hazards: Trends, Models and Impact on Insurance

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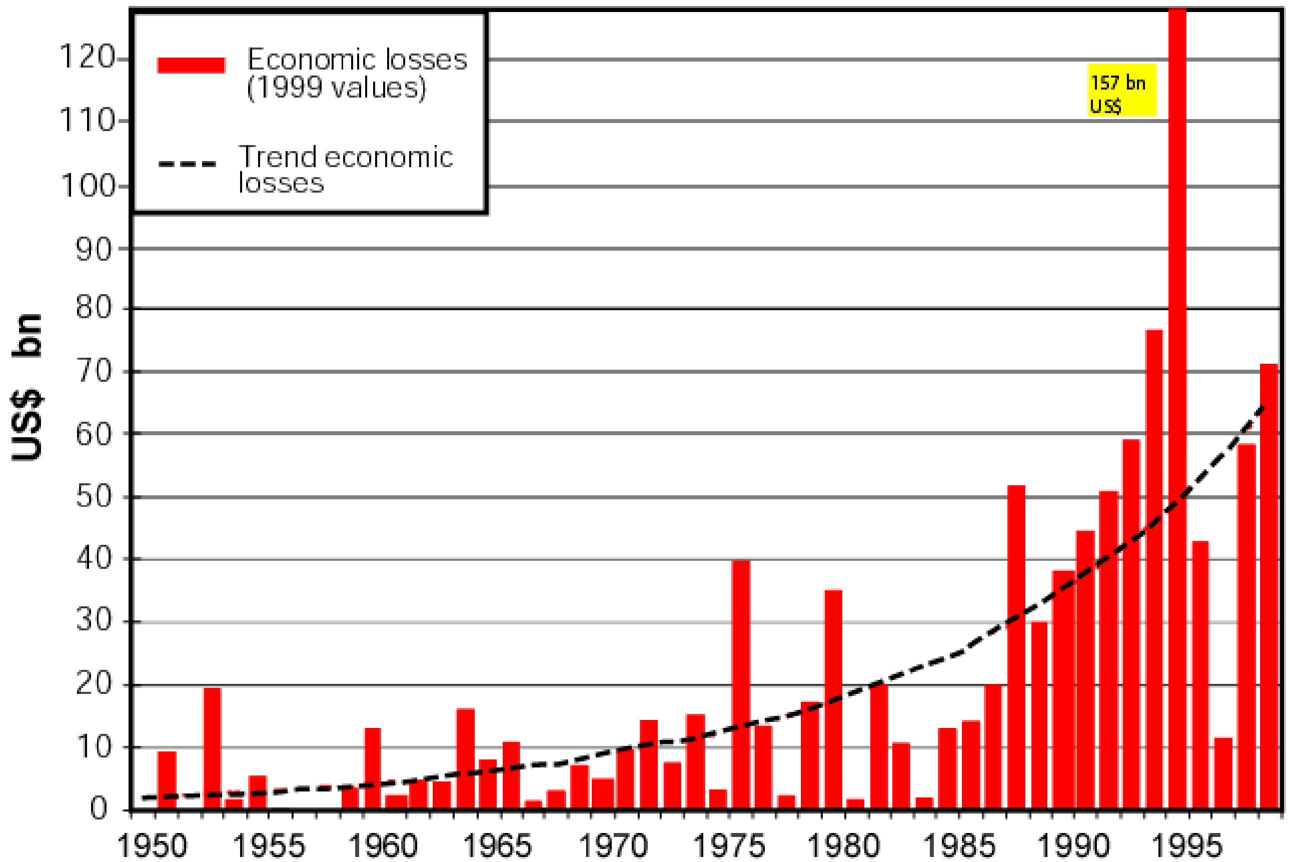
Natural Hazards Economic losses

380 bn US$



…. 2011

Figure 1.1 Chart showing the development of economic losses (in US dollars projected to 1999 values) due to great natural catastrophes since 1950 (After Munich Re Group, 1999).

Table 1.1 Number of great natural catastrophes and economic losses for every decade since 1950 – A comparison. Natural catastrophes are classed as great if the ability of the region to help itself is distinctly overtaxed, making interregional or international assistance necessary (After Munich Re Group, 1999)

	Decade 1950-1959	Decade 1960-1969	Decade 1970-1979	Decade 1980-1989	Decade 1990-1999
Number	20	27	47	63	82
Economic losses	38.5	69.0	124.2	192.9	535.8

Comparison of decades 1950 -1999

	Factor 90s:80s	Factor 90s:70s	Factor 90s:60s	Factor 90s:50s
Number	1.3	1.7	3.0	4.1
Economic losses	2.8	4.3	7.8	13.9

The number of "great" natural catastrophes have increased by a factor of 4 since the 1950s

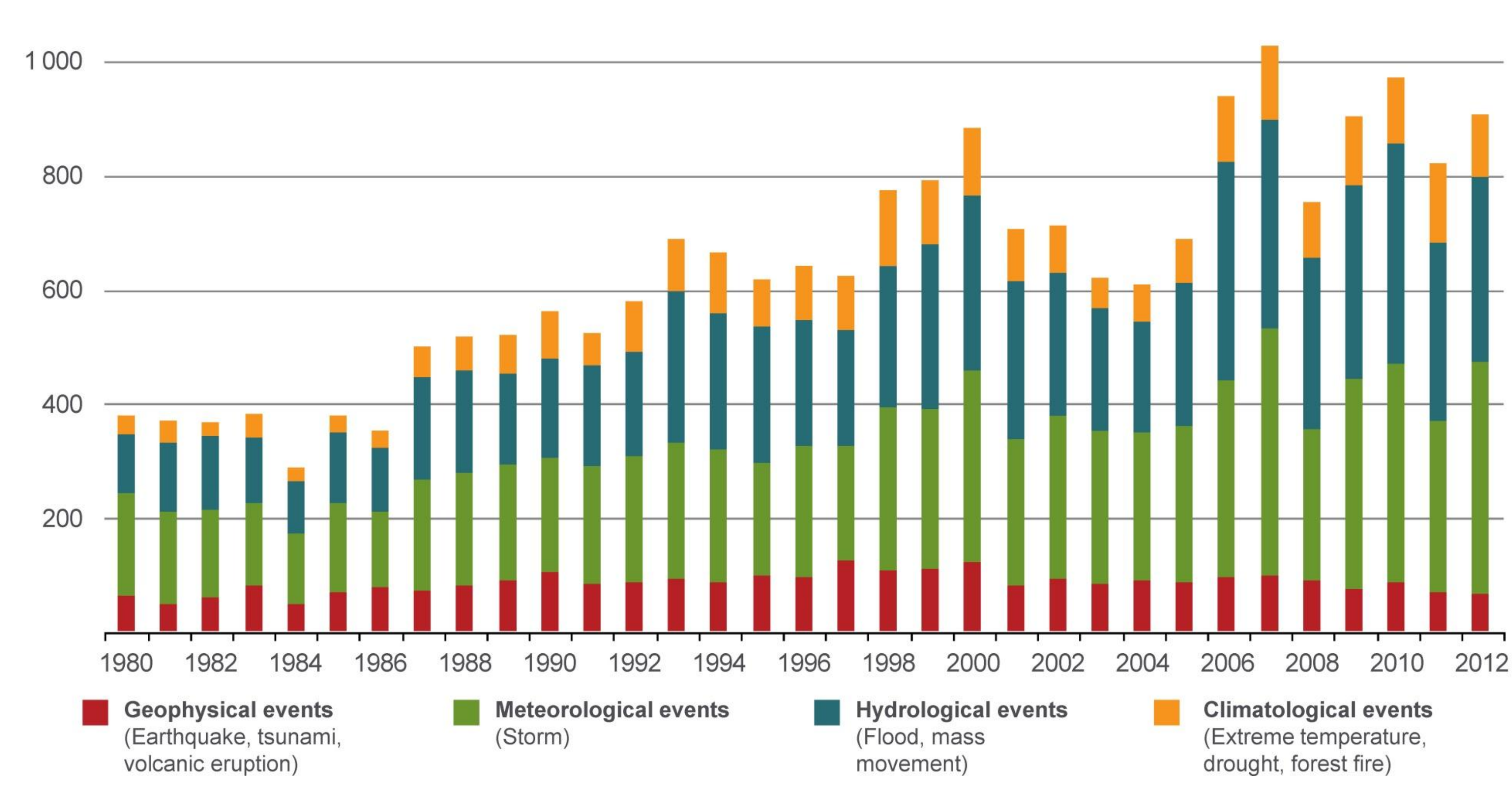
Economic losses have been increased by a factor of 14

NatCatSERVICE

Natural catastrophes worldwide 1980 – 2012

Number of events

Following the year 2000 there is a ~35% increase in the number of catastrophic events since the 90ies and 2 fold increase since the 80ies



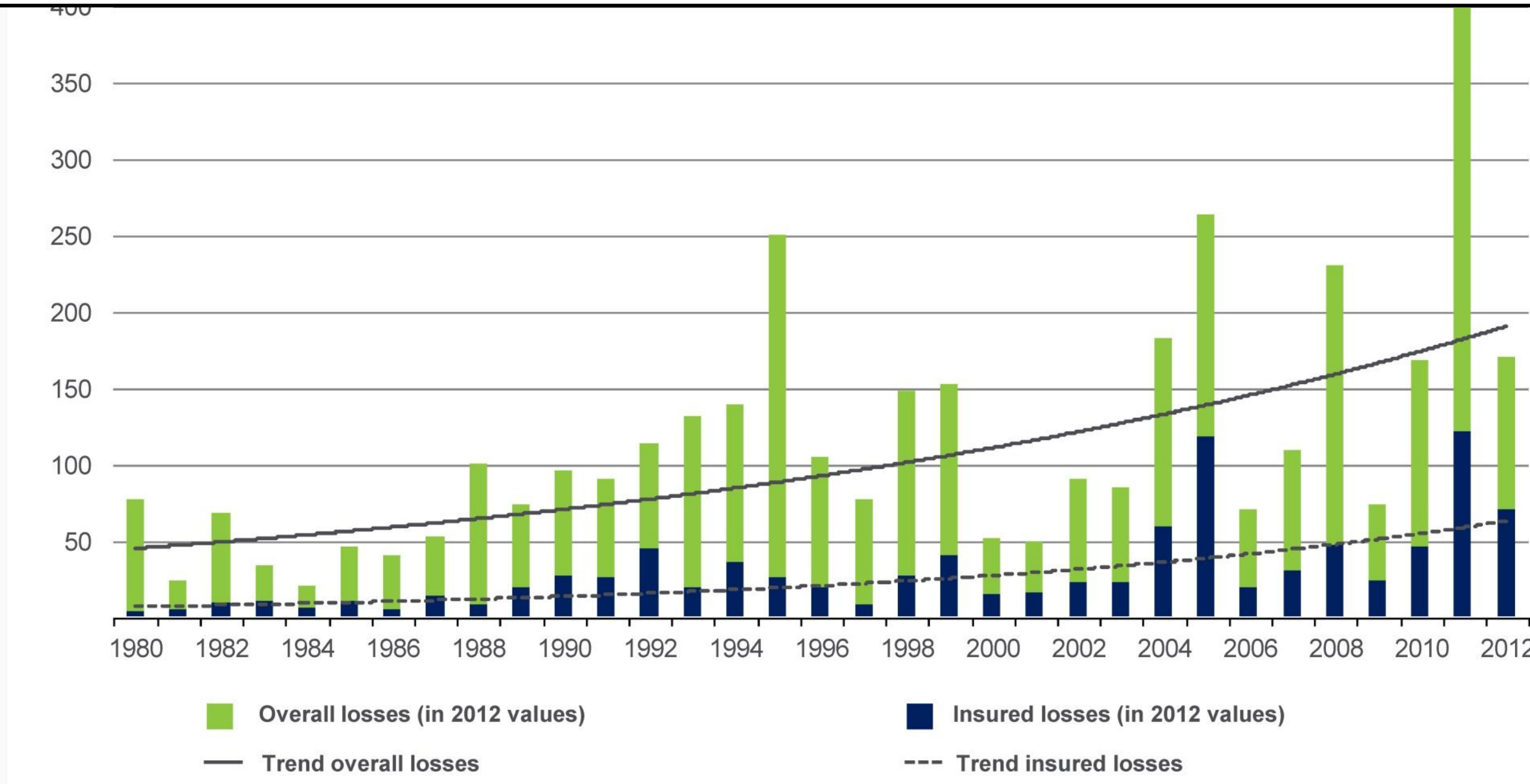
NatCatSERVICE

Natural catastrophes worldwide 1980 – 2012

Overall and insured losses with trend

Munich RE

Following the year 2000 there is approx. a two fold increase in the cost of catastrophic events since the 90ies and 3 fold increase since the 80ies



The main question to ask:

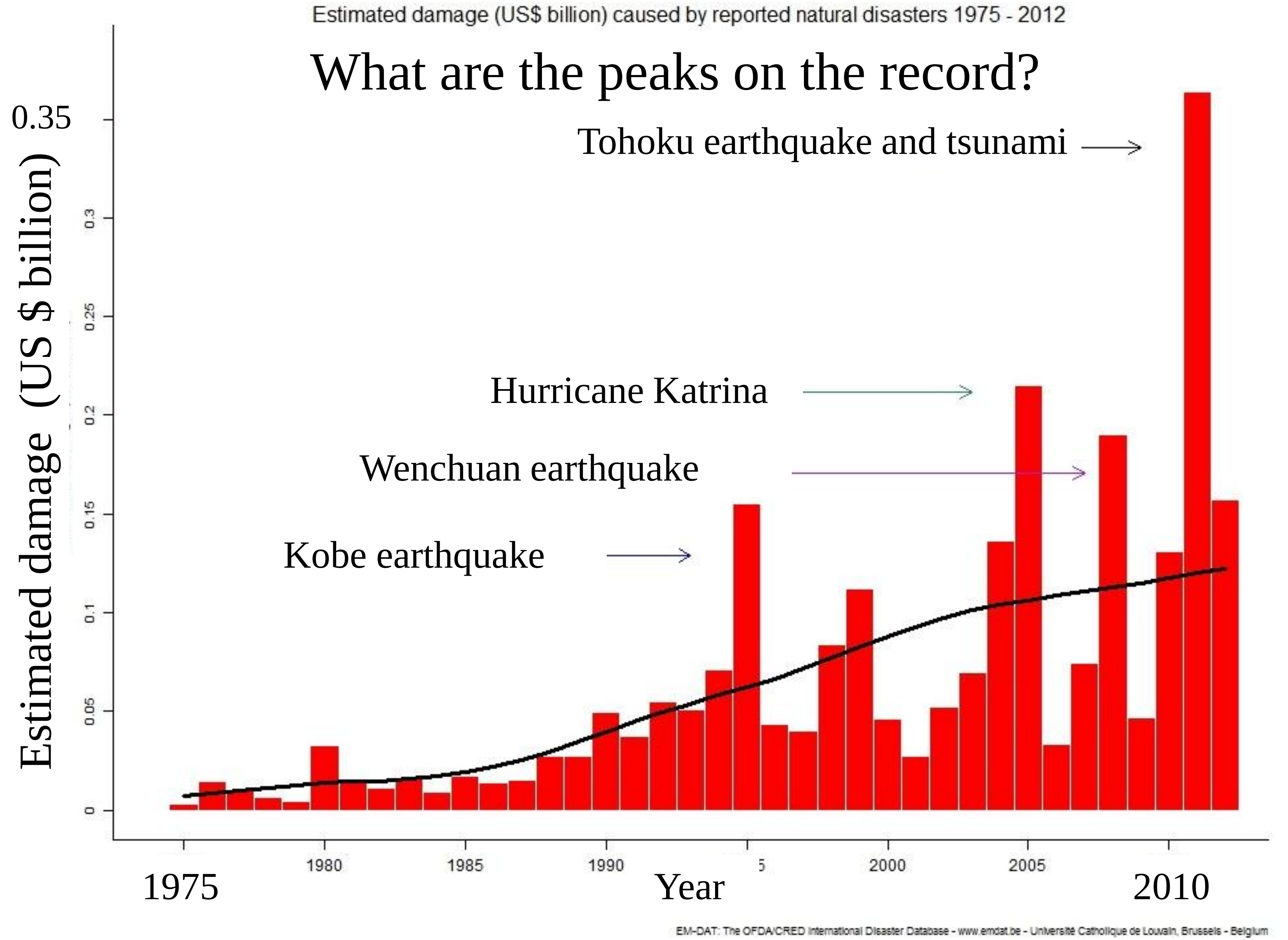
Why this dramatically increasing trend exists both in terms of the number and costs of natural hazards?

Have the earth processes and mechanisms been modified?

Well mostly not, the answer is vulnerability

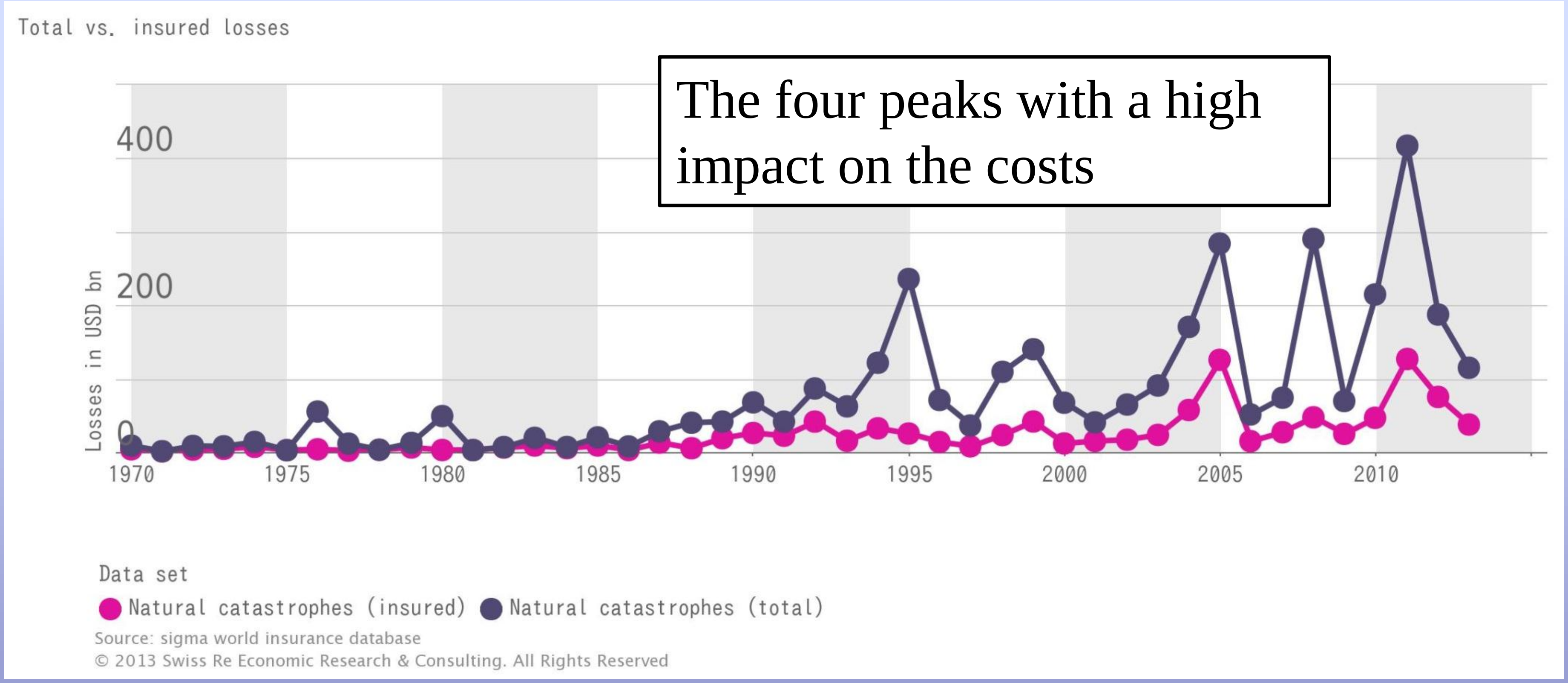
(population growth, population located in vulnerable sites, near coastlines, rivers and close to tectonic plate boundaries, resettlement from rural areas to megacities, modern way of living etc)

What are the peaks on the record?

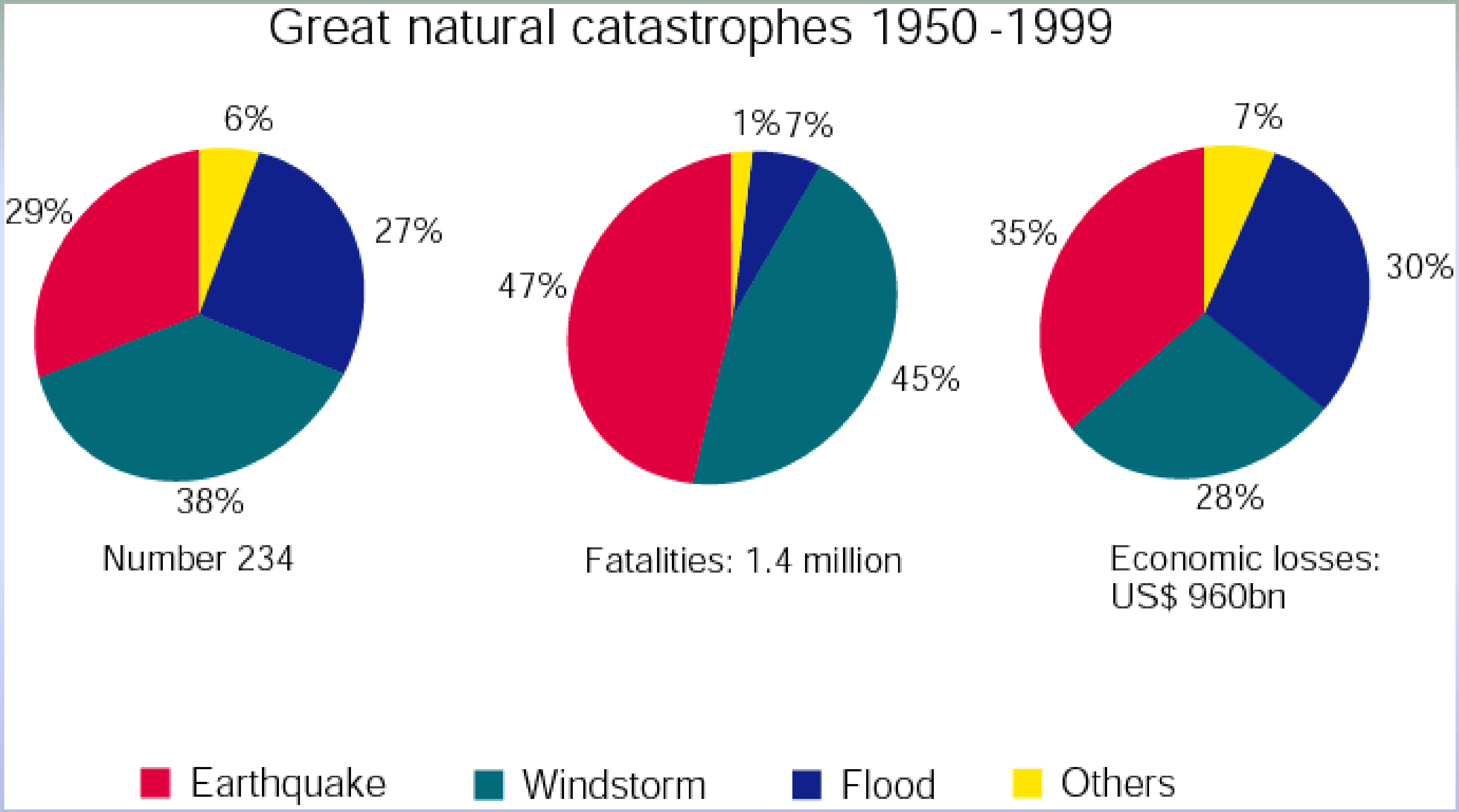


EM-DAT Universite Catholique de Louvain

Total vs Insured losses since 1970



Munich Re



Great natural catastrophes 1950 -1999
6%
29%
27%
38%
Number 234
1%
7%
47%
45%
Fatalities: 1.4 million
7%
35%
30%
28%
Economic losses: US$ 960bn
Earthquake
Windstorm
Flood
Others

Munich Re

- UN warns that economic losses from natural hazards are out of control and urges private sector to reduce risk (UN press release 2013)
- So far this century, direct losses from disasters are in the range of $2.5 trillion.
- Losses will continue to escalate unless disaster risk management becomes a core part of business investment strategies.
- Disaster risk is a new multi-trillion dollar asset class: Global capital flows have transformed the landscape of disaster risk, creating a new pile of toxic assets for businesses and governments that do not currently appear on balance.
- Globally, US$71 trillion of assets would be exposed to one in 250 year earthquakes.
- Insurance is critical to business resilience. Yet insurance pricing often does not reflect risk levels.

Global Assessment Report on Disaster Risk Reduction United Nations 2013

Catastrophe Models

Main components

- Hazard module
- Exposure data
- Vulnerability/Risk module
- Financial module (loss)

Final outcome $\Longrightarrow$ EP Curve

An EP curve communicates the probability of any given financial loss being exceeded

Currently all models are closed “black” boxes, without any possibility for validation or evaluation from users.

Failure of Existing Catastrophe models

- Tens of examples mostly regarding geohazards
- Most spectacular failure examples

The two of the three strongest earthquakes followed by the two strongest tsunami events ever recorded during the instrumental period

  – The 2004 Great Sumatra-Andaman Earthquake (Mw)= 9.2 killing over 230,000 people in fourteen countries,
  – The Tohoku 2011 Japan (Mw)= 9.0 (19000 fatalities, 380.000 buildings totally or partly collapsed, total 1.2 million houses damaged. 340.000 evacuated, 90% of 29000 fishing boats unusable. Honda, Toyota, Nissan suspended auto production for several days. Japan reports first trade deficit in 32 years after the tsunami. Total estimated damages ranging from 208 to 574 billions US$, Insured losses ~30 billion US$.

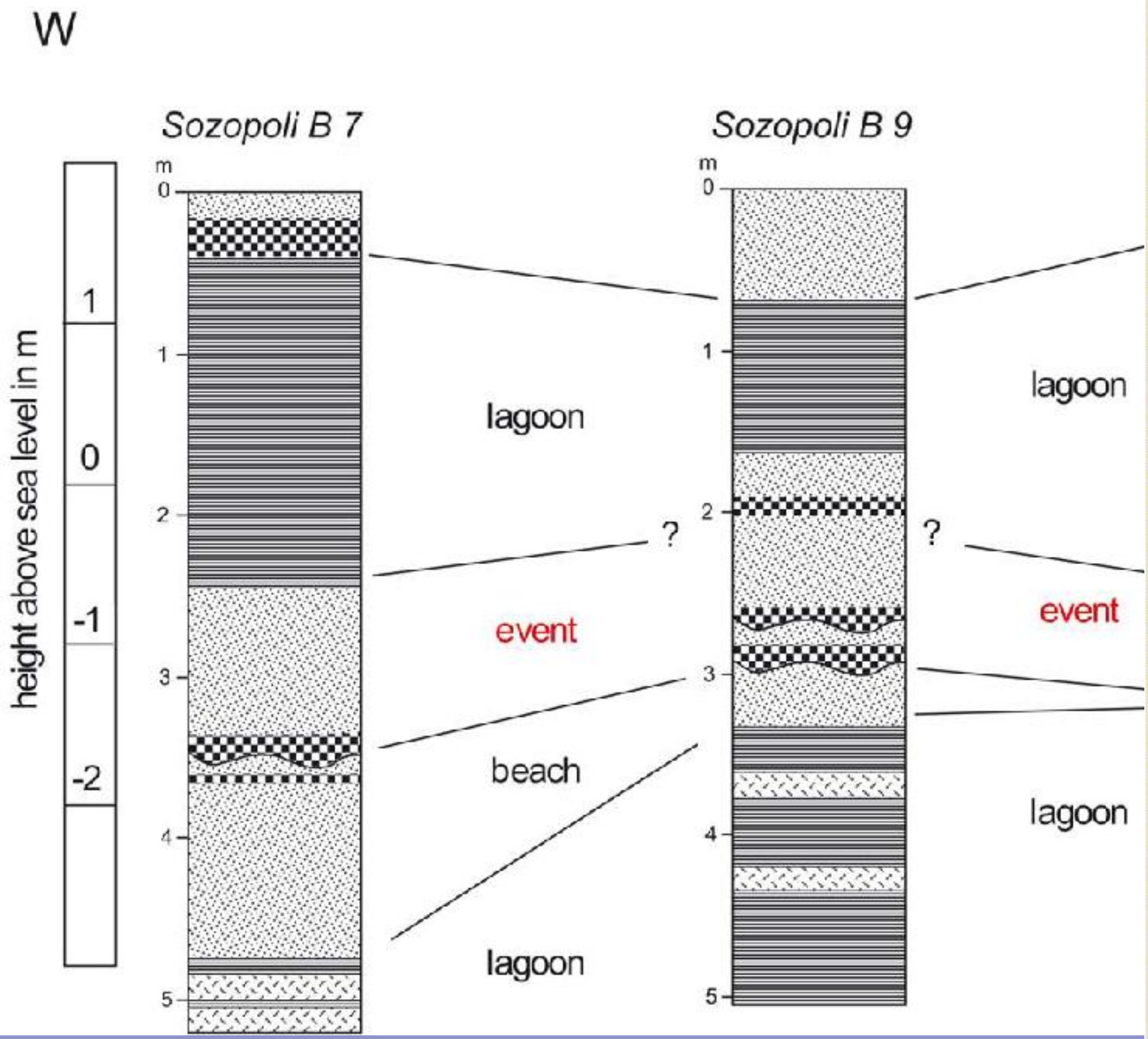
nature Vol 455|30 October 2008|doi:10.1038/nature07373

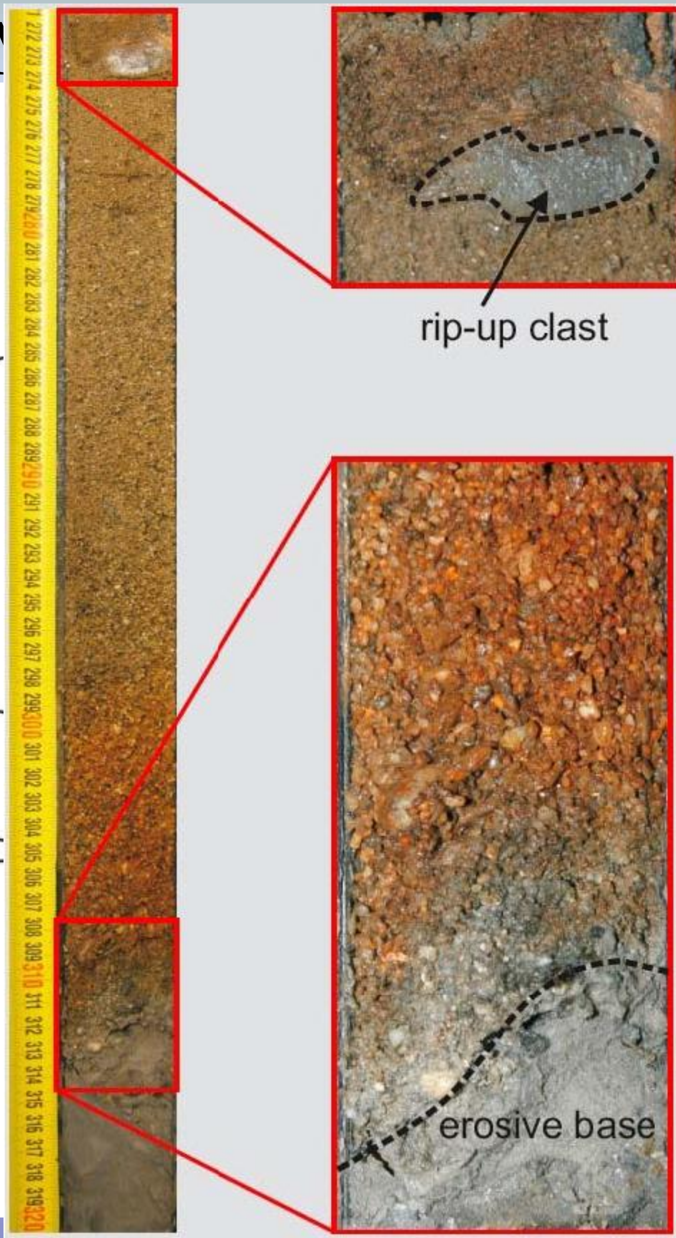
LETTERS

Recent centuries provide no precedent for the 2004 Indian Ocean tsunami, either on the coasts it devastated or within its source area. The tsunami claimed nearly all of its victims on shores that had gone 200 years or more without a tsunami disaster[1]. The associated earthquake of magnitude 9.2 defied a Sumatra–Andaman catalogue that contains no nineteenth-century or twentieth-century earthquake larger than magnitude 7.9 (ref. 2). The tsunami and the earthquake together resulted from a fault rupture 1,500 km long that expended centuries' worth of plate convergence[2–5]. Here, using sedimentary evidence for tsunamis[6], we identify probable precedents for the 2004 tsunami at a grassy beach-ridge plain 125 km north of Phuket. The 2004 tsunami, running 2 km across this plain, coated the ridges and intervening swales with a sheet of sand commonly 5–20 cm thick. The peaty soils of two marshy swales preserve the remains of several earlier sand sheets less than 2,800 years old. If responsible for the youngest of these pre-2004 sand sheets, the most recent full-size predecessor to the 2004 tsunami occurred about 550–700 years ago.

The 2004 Indian Ocean tsunami, cresting higher in Thailand than it did anywhere else east of Sumatra (Fig. 1b), rose as much as 20 m

HOW DO WE TRACE TSUNAMI DEPOSITS? AN EXAMPLE FROM THE THERM





Reicherter, Papanikolaou et al. (2010)

Following the 2004 Sumatra event did new Cat Risk models incorporate new data and adapt new scenarios?

- The answer is NO, despite overwhelming evidence from the paleoseismological and geological record
- Only when the initial shock had passed, the public learned that the region had experienced paleoearthquakes and palaeotsunami events in the past which were similar to the 2011 event, if not even greater (Minoura & Nakaya 1991, Nishimura & Miyaji 1995, Minoura al. 2001, Sawai et al. 2008 etc), several publications from different researchers

Journal of Natural Disaster Science, Volume 23, Number 2, 2001, pp83-88

The 869 Jōgan tsunami deposit and recurrence interval of large-scale tsunami on the Pacific coast of northeast Japan

K. MINOURA

...of cells, the side of each cell being 1000 m. A grid size of 100 ...s used near the coastline. Using the fault parameters present... Satō (1989) and comparing the simulation results of several ... models and the estimated tsunami heights in the present ..., we established a composite-fault model for the most plausi... ...ource of the Jōgan tsunami. The proposed tsunami source is ...ion: lat. 37° to 39°N, long 143° to 144°30'E; magnitude: 8.3; ... size: 200 km long; 85 km wide; 1 km deep; fault angle: 25° ..., 45° dip, 90° slip; vertical displacement of the sea bottom 5.6 ... Figure 3 giving results of the numerical simulation of the ... tsunami, shows that a train of waves with a maximum height ...m reached the shores of Sendai Bay 30 minutes after the earth... ...e occurred.

DISCUSSION AND CONCLUSIONS

Despite the moderate wave height (~8 m) scale inferred from ...

... associated with widespread flooding. The depositional ages inferred from ^{14}C dating suggest that gigantic tsunamis occurred three times during the last 3000 years (Fig. 2). The respective calendar age ranges of the lower two layers are BC 140 - AD 150 and ca. B.C. 670-910 (1 σ range). The recurrence interval for a large-scale tsunami is 800 to 1100 years. More than 1100 years have passed since the Jōgan tsunami and, given the reoccurrence interval, the possibility of a large tsunami striking the Sendai plain is high. Our numerical findings indicate that a tsunami similar to the Jōgan one would inundate the present coastal plain for about 2.5 to 3 km inland.

ACKNOWLEDGMENTS

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The Holocene 18,4 (2008) pp. 517–528

Marine incursions of the past 1500 years and evidence of tsunamis at Suijin-numa, a coastal lake facing the Japan Trench

from a tephra within the peat that separates units B and C. The age constraints permit correlation of unit B with a tsunami in AD 869 that reportedly devastated at least 100 km of coast approximately centred on Sendai. Unit

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Conclusion

As many as three marine incursions in the past 1500 years are recorded by sand beds beneath the floor of Suijin-numa on northern Honshu, Japan. The youngest of these corroborates historical evidence that the

RESEARCH PAPER

The lake lacks obvious signs of tsunamis from the region's largest twentieth-century earthquakes, which were centred to the north in 1933 (M 8.1) and directly offshore in 1936 (M 7.5), and 1978 (Mw 7.6).

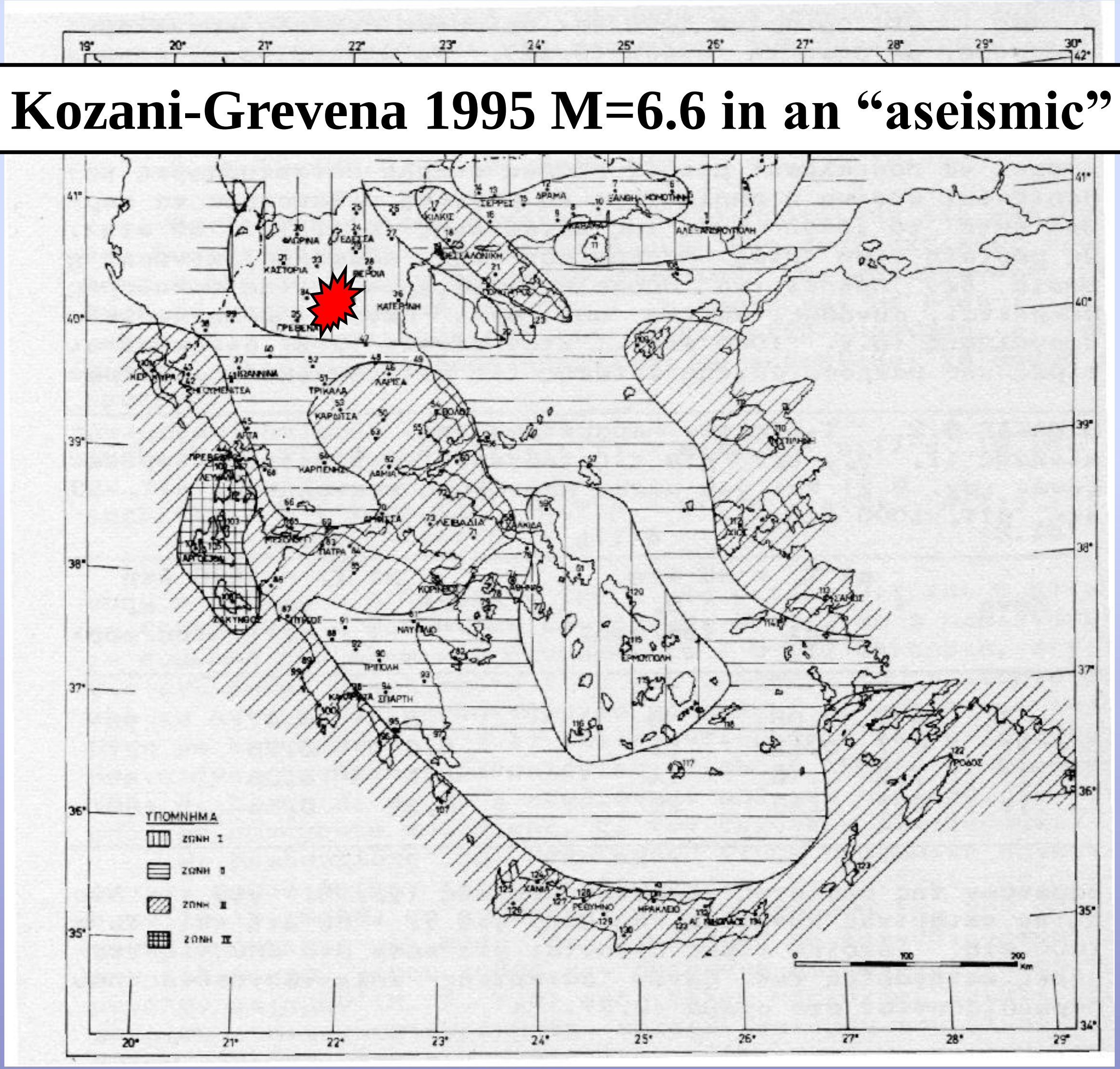
Key words: Tsunami deposits, diatoms, coastal lakes, historical records, Japan Trench, late Holocene.

Introduction

Coastal lakes and lagoons can serve as sediment traps for tsunamis and storms. High energy inflows associated with such

Another example demonstrating the incompleteness of the historical record. Greece has one of the longest seismic historical catalogues worldwide with dating events since 550BC. However, …

Kozani-Grevena 1995 M=6.6 in an "aseismic" region

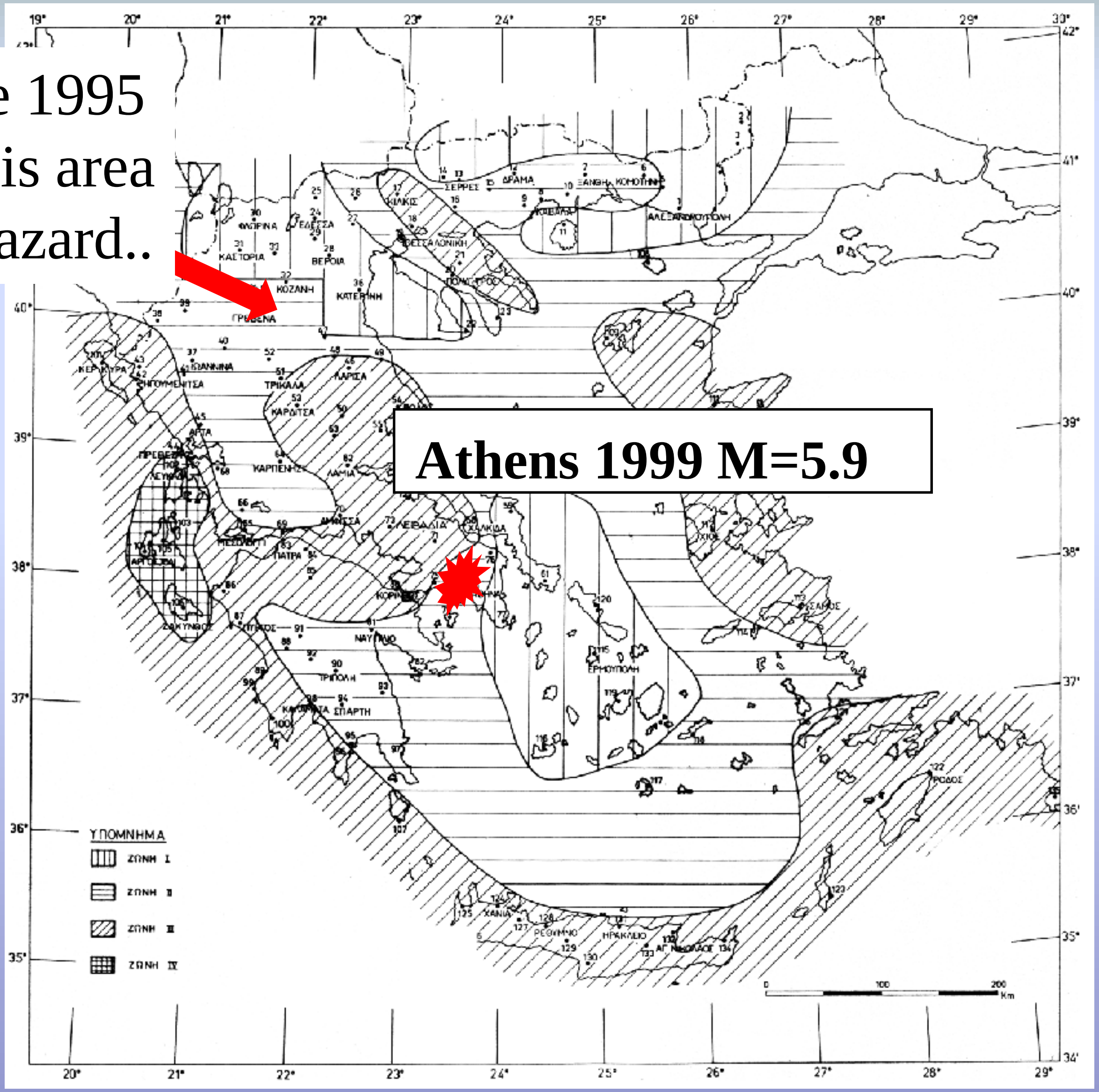


This map is only based on historical seismicity

National Seismic Building Code (EAK-1984)

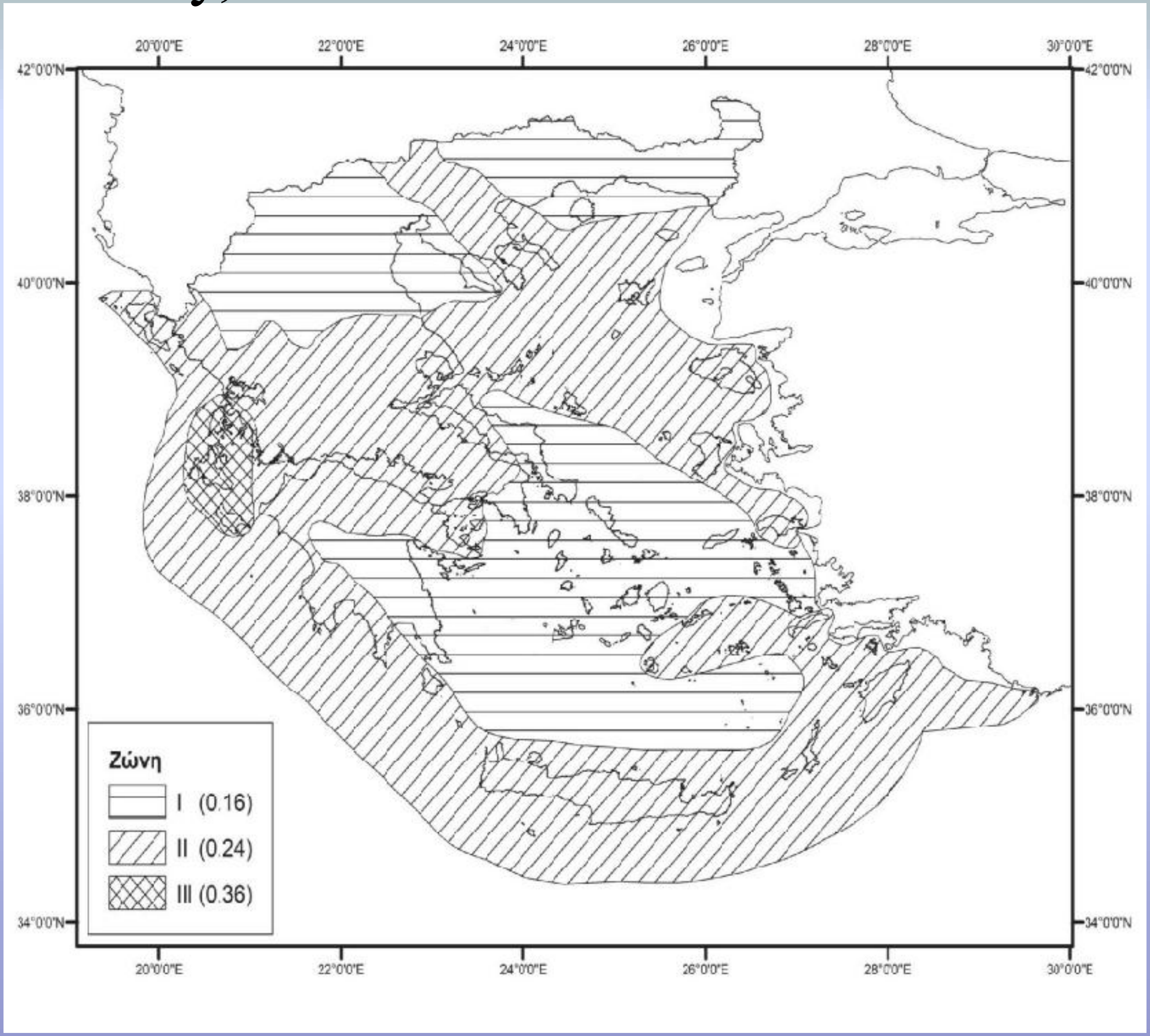
Therefore, the map has been modified, but..

Following the 1995 event, now this area is of higher hazard..



National Seismic Building Code (EAK-2000)

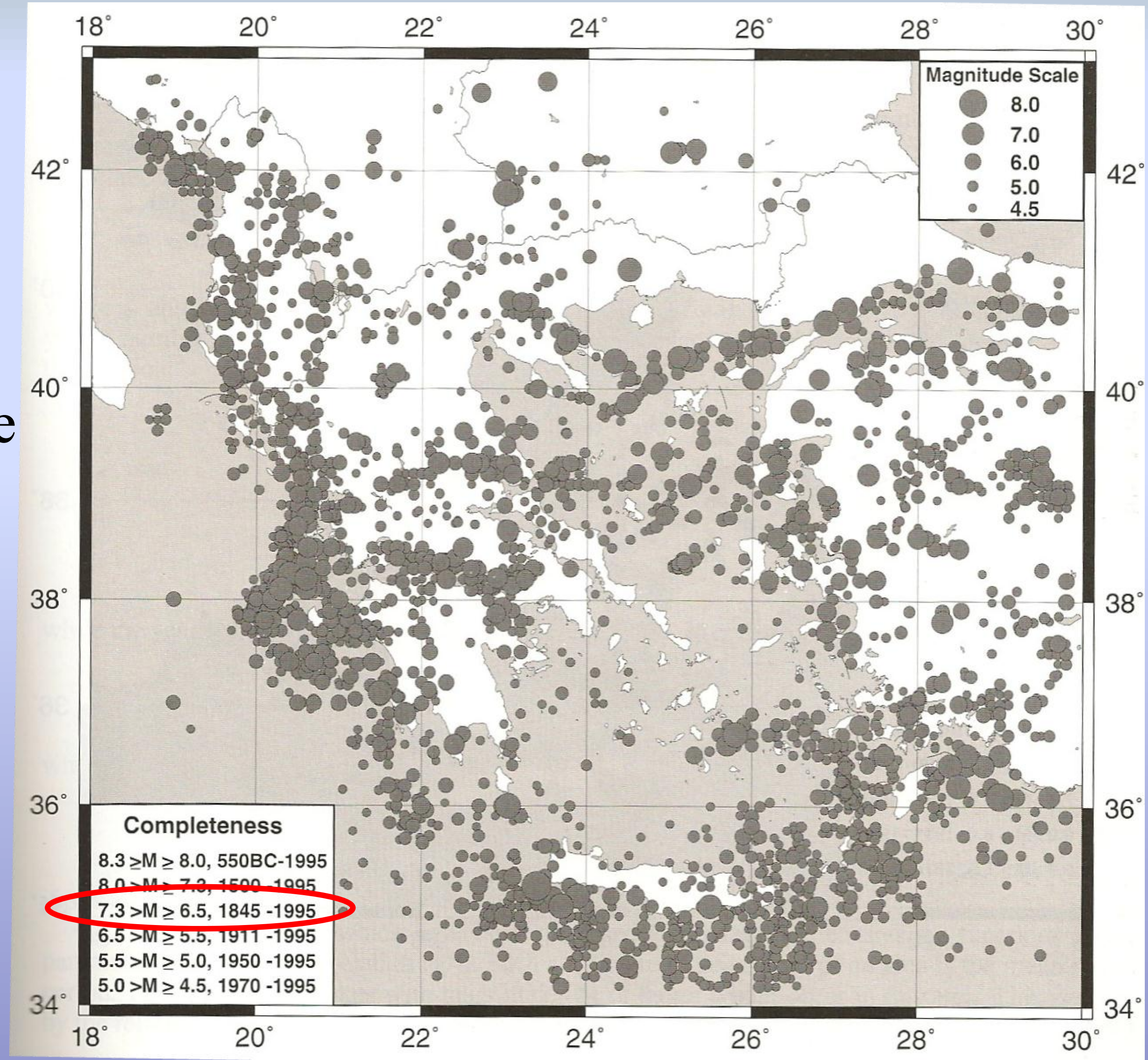
Finally, no “aseismic” area in Greece



National Seismic Building Code (EAK-2003)

Seismicity of Greece

Despite the long catalogue, it is considered complete for events M≥7.3 since 1500 and for M≥6.5 only since 1845



Papazachos et al. (2000)

- The record is complete for events $M \geq 7.3$ for 500 years and for events $M \geq 6.5$ for less than 200 years.
- However, active faults have recurrence intervals ranging from a few hundred years to several thousand of years.
- As a result, historic catalogues are generally too short compared to the recurrence interval of particular faults. The latter implies that <u>the sample from the historical record is clearly incomplete</u> even for Greece and that a large number of faults would not have been ruptured during the completeness period of the historical record.
- Moreover, maps based on historical seismicity can give erroneous pictures of the present day hazard (Scholz 2002). Events appearing on the record originate from faults that were activated recently with their energy now released, being at an early stage in their new seismic cycle. However, missing events from the record could correspond to faults which are "mature", approaching the end of their cycle, so that events are pending in the near future.

The role of Geological Data

We use geological data in order to extend the history back many thousand of years eliminating the incompleteness of the historical catalogues.

In particular, in seismic hazard assessment:

a) so as to identify all possible seismic sources (localities of active faults)

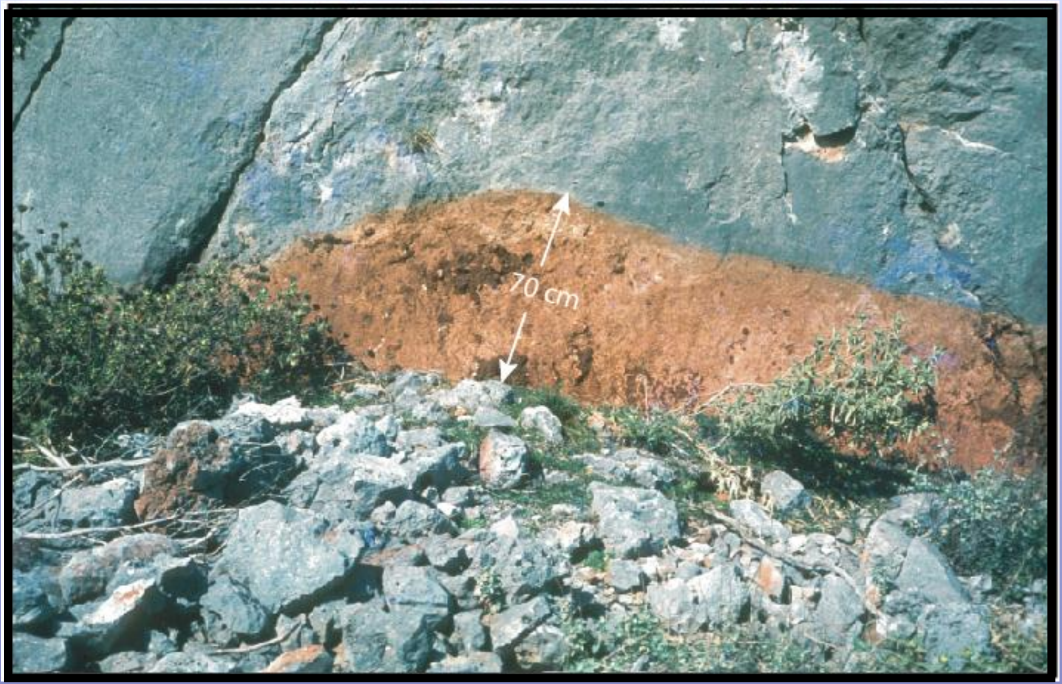
b) so as to assess which faults slip in earthquakes most often (define slip-rates and earthquake recurrence)

c) so as to define the elapsed time since the last event on a given fault

Current CatRisk models tend to use mainly the historical record (historical epicenters not faults) and do not keep up with emerging scientific knowledge

Offsets caused by earthquakes

1980 Irpinia earthquake ruptures



1981 Corinth earthquake ruptures

Cumulative slip, hundreds of earthquakes

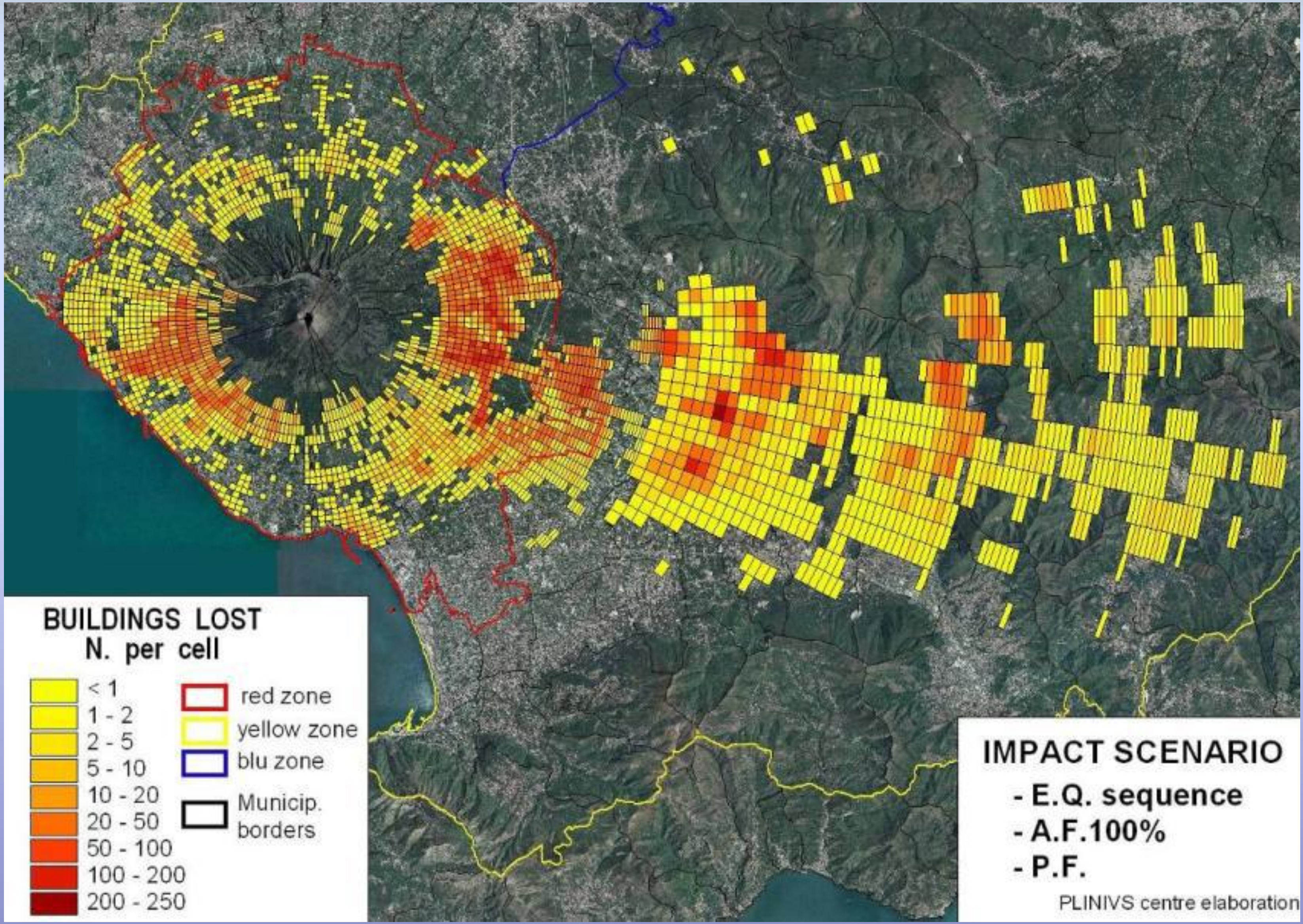
Faults leave their signatures on the landscape and the geology.

Past Major Catastrophic Events in Europe

- 1650 BC Santorini volcanic eruption and tsunami
- Vesuvius 79 AD Eruption
- 365 A.D. M~8.2 Crete-Hellenic Arc Strongest earthquake and tsunami in Europe in historical times
- 1755 Lisbon earthquake and tsunami (~55.000 fatalities)
- 1816 Year without a summer (due to volcanic Mount Tambora volcanic eruption in 1815) food shortages famine, hundreds of thousands lost their lives
- 1908 Messina Mw=7.1, 123.000 fatalities
- 1915 Fucino Earthquake Mw=7.0, 33.000 fatalities

Question: Recurrence of these events? Other events not been recorded historically but pending?

Vesuvius is located just 10 km from the centre of Naples with 1.2 million inhabitants. Estimated total economic loss US $24 billions



Willis Research Network Spence et al. (2010)

- We have not experienced such a major catastrophic event in Europe over the last few decades yet
- What would be the impact to consumers confidence if insurance fails to deliver? Particularly if other types of insurance fail as well (life, health etc).

Solvency II requires Transparency

The Alliance for Global Open Risk Analysis (AGORA) makes an effort to create and disseminate open multi-hazard cat risk modelling tools

Florida International University (FIU) in Miami has begun developing a public loss model to assess hurricane risk in Florida. Consumers also need to know and the European Parliament support this idea as well (see 2013/2174)

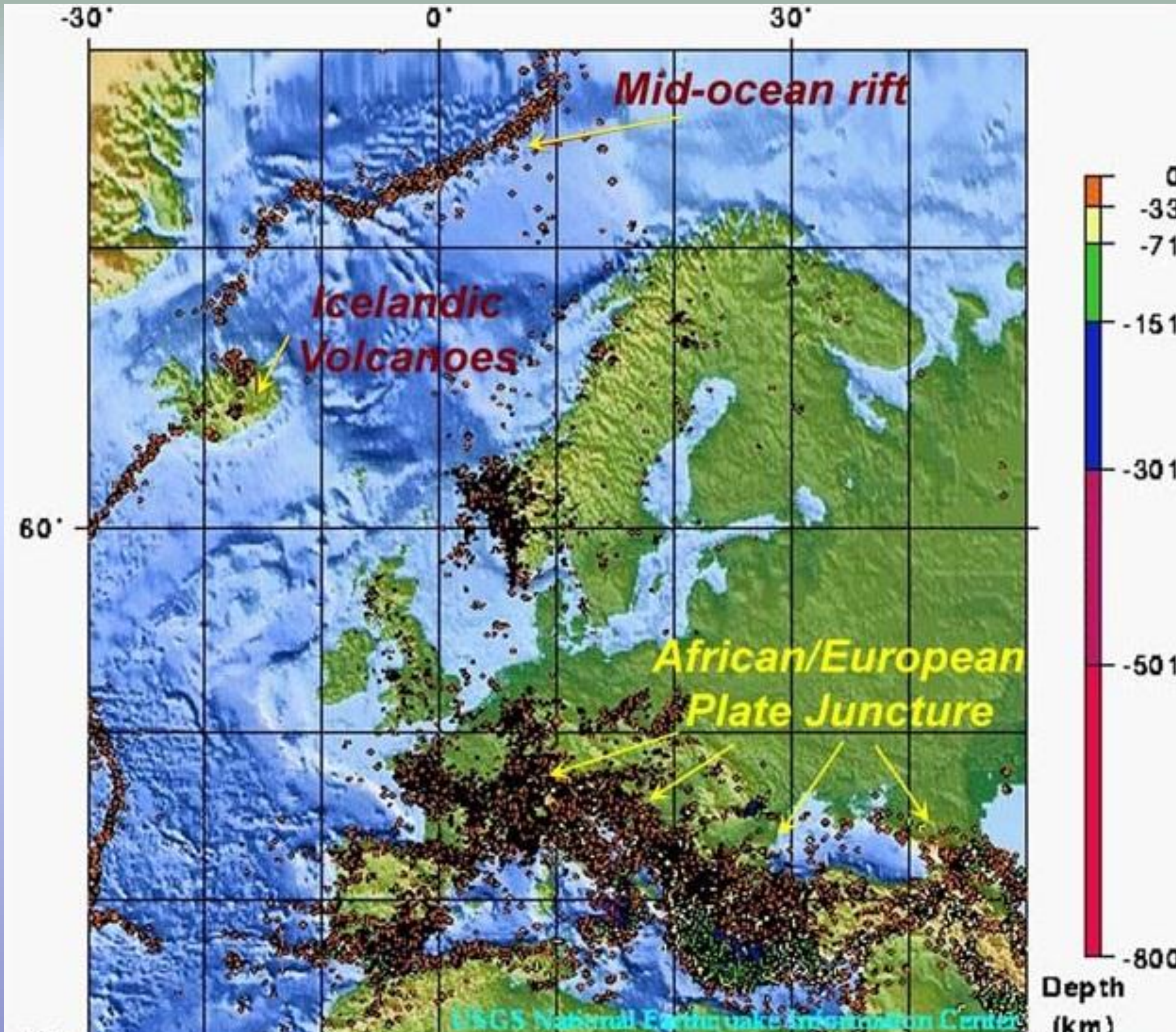
To address the challenges of transparency and credibility of the models, the Bank of Greece as a supervisor is developing a fault specific high spatial resolution seismic catastrophe model in cooperation with universities providing results on expected insured losses for specific properties by ZIP code

- EIOPA in 2012 introduced some Standard Formula with tables showing the gross loss damage ratio (Qcountry) for 1 in 200 year catastrophe events
- Aggregate country level exposure data are inadequate to properly reflect the high spatial and temporal variability in natural catastrophe risk
- Risk factors for some countries are too high, (e.g. Cyprus, Romania), whereas others too low (Italy, France) compared to their hazard module

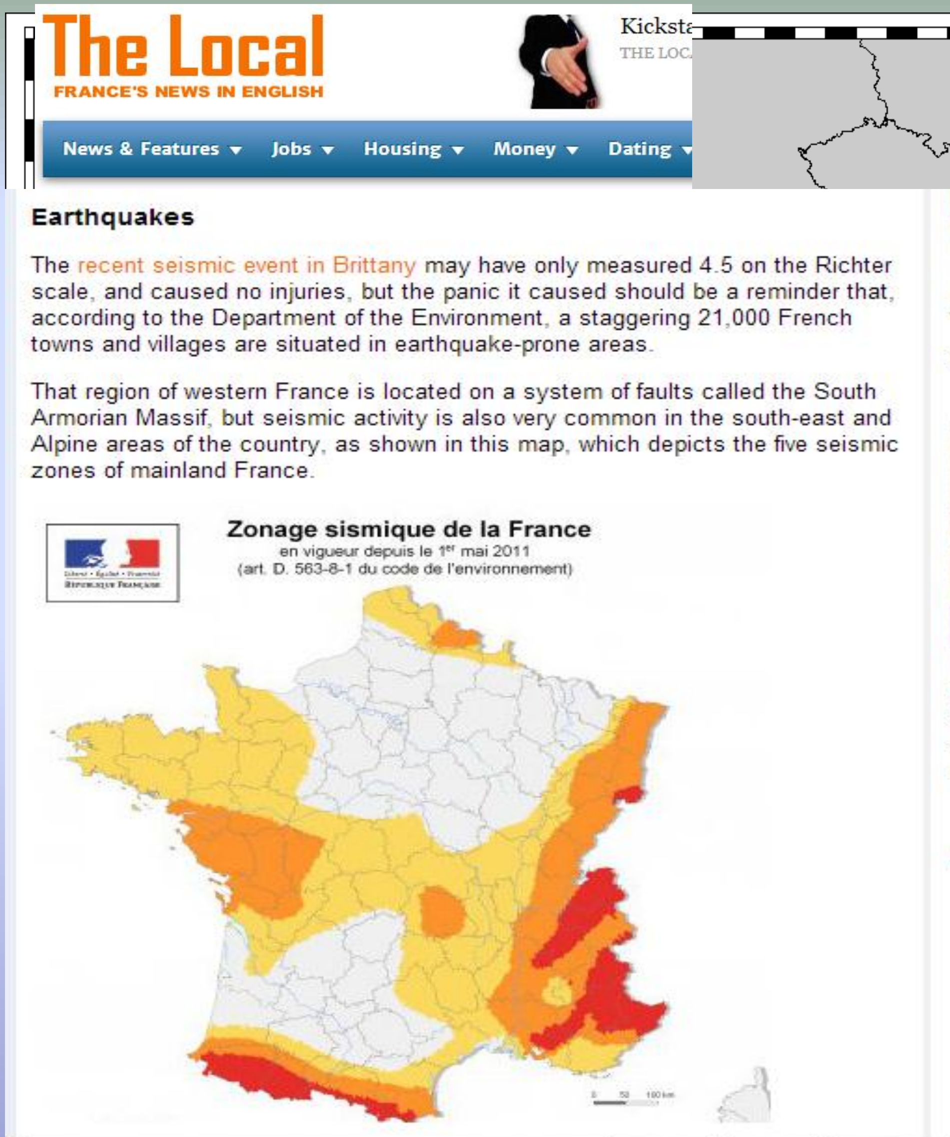
EIOPA-DOC-12/467
21 December 2012

ANNEX P - Regions and earthquake risk factors

Abbreviation of region *r*	**Region *r***	**Earthquake risk factor $Q_{(earthquake,r)}$**
AT	Republic of Austria	0.10 %
BE	Kingdom of Belgium	0.02 %
BG	Republic of Bulgaria	1.60 %
CR	Republic of Croatia	1.60 %
CY	Republic of Cyprus	2.12%
CZ	Czech Republic	0.10 %
CH	Swiss Confederation; Principality of Lichtenstein	0.25 %
FR	French Republic[3]	0.06 %
DE	Federal Republic of Germany	0.10 %
HE	Hellenic Republic	1.85 %
HU	Republic of Hungary	0.20 %
IT	Italian Republic; Republic of San Marino; Vatican City State	0.80 %
MT	Republic of Malta	1.00 %
PT	Portuguese Republic	1.20 %
RO	Romania	1.70 %
SK	Slovak Republic	0.15 %
SI	Republic of Slovenia	1.00 %


-30°
0°
30°
60°
Mid-ocean rift
Icelandic Volcanoes
African/European Plate Juncture
0
-33
-71
-151
-301
-501
-800
Depth (km)
USGS National Earthquake Information Center

USGS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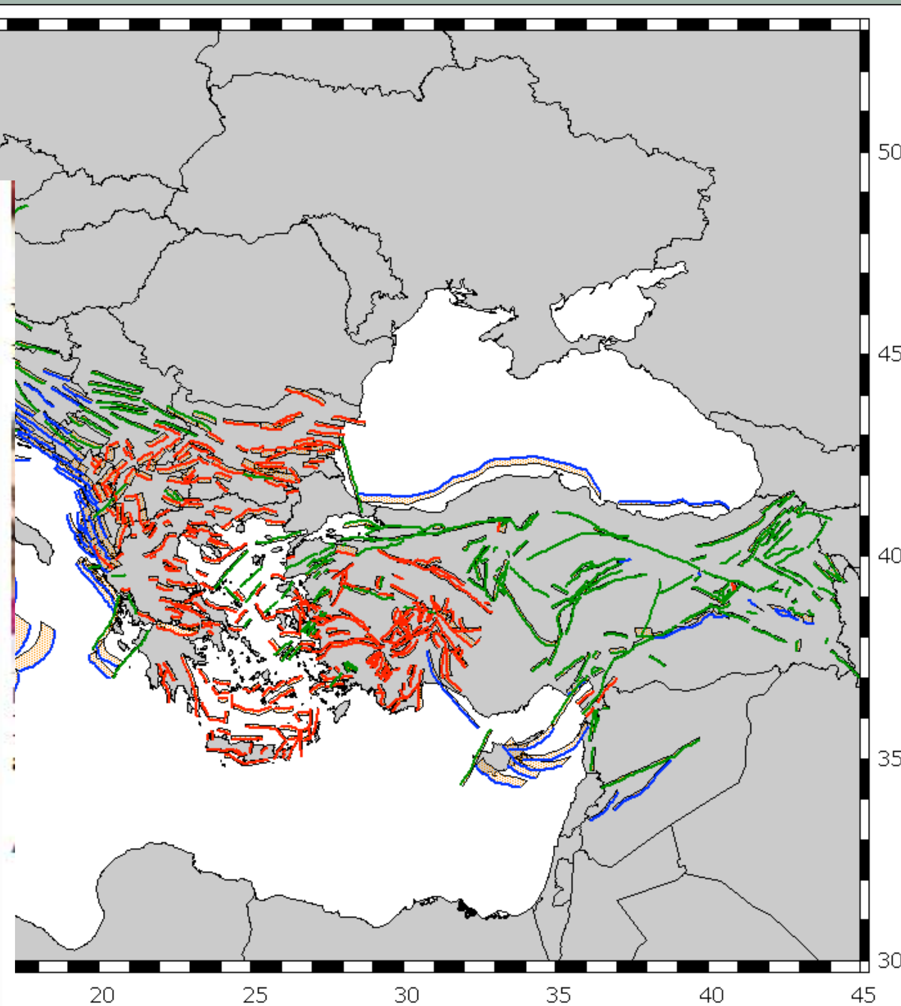
Earthquakes

The recent seismic event in Brittany may have only measured 4.5 on the Richter scale, and caused no injuries, but the panic it caused should be a reminder that, according to the Department of the Environment, a staggering 21,000 French towns and villages are situated in earthquake-prone areas.

That region of western France is located on a system of faults called the South Armorian Massif, but seismic activity is also very common in the south-east and Alpine areas of the country, as shown in this map, which depicts the five seismic zones of mainland France.



posite Seismogenic Sources from Share Project

Impact of CAT RISK on other types of insurance

- Life insurance
- Health insurance
- Economic growth
  - the 1999 5.9 Athens event was a moderate earthquake however it cost 3% of Greece’s GDP (Greece today due to the crisis would be unable to cope),
  - The Japan Tohoku cost 4.5% of the country GDP, Japan reports first trade deficit in 32 years after the tsunami
  - The next Great Kanto Earthquake scenario in Tokyo (similar to the catastrophic 1923 event with 120.000 fatalities) will cost ~1.1$ trillion, about 20% of Japan’s GDP with a high default risk of the Japanese government. Japanese holdings around the world are sold in order to finance the reconstruction after the loss. Globalization of risk?

- Finally, last but not least
- Following a catastrophic event there is an extremely large number of claims being filed at the same time. Can catastrophe insurance issuers effectively manage risk?

Overall, is Cat Risk the weakest link of insurance that could undermine people's confidence to insurance?