5th International Workshop on Statistical Seismology:
Physical and Stochastic Modeling of Earthquake Occurrence and Forecasting
Section 5. Living in an Uncertain World: Interfacing Statistical Seismology and Society

Probabilistic estimates of seismic hazard and public awareness in Japan

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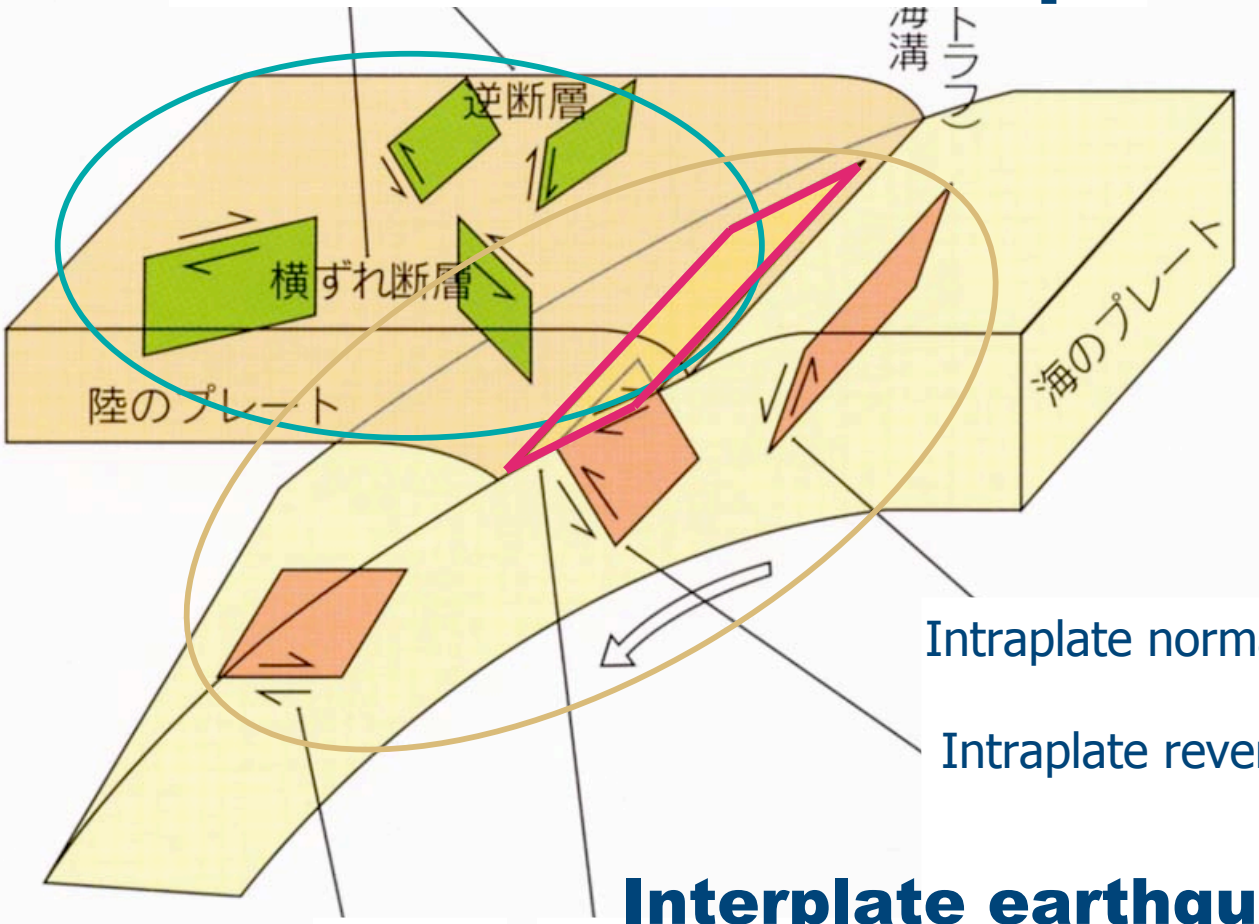
16:00-16:30, 04 June 2007

Ettore Majorana Foundation and Centre for Scientific Culture, Erice, Sicily

Japanese earthquakes can be classified into two type.

1.Shallow crustal earthquakes



Intraplate normal-fault eq.

Intraplate reverse-fault eq.

Interplate earthquakes

Deep intraplate earthquakes

2.Subduction zone earthquakes

Evaluation of earthquake potential

<table>
<tr><td></td><td>Subduction-zone EQ</td><td>Shallow crustal EQ</td></tr>
<tr><td>Identifiable sources</td><td colspan="2">Time-dependent & time-independent long-term forecasts</td></tr>
<tr><td rowspan="2">Unidentifiable ones</td><td>Smaller-than-the largest EQ</td><td rowspan="2">Distributed sources</td></tr>
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Source interactions are alluded to but no probability is given except for Tokai, Tonankai, Nankai earthquake sequence.

Evaluation of earthquake potential

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<tr><td></td><td>Subduction-zone EQ</td><td>Shallow crustal EQ</td></tr>
<tr><td>Identifiable sources</td><td>Av.repeat time
∽100yrs
Historical eq data</td><td>Av.repeat time
∽1000yrs or more
Active fault survey</td></tr>
<tr><td rowspan="2">Unidentifiable ones</td><td>Smaller-than-the largest EQ</td><td rowspan="2">Distributed sources</td></tr>
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Small probabilities for EQ on active faults

The figure taken from news article of Kyodo News Agency shows why much smaller probabilities are obtained for earthquakes on active faults relative to earthquakes along the oceanic trench.

Probability less than 10% tends to be neglected by general public

Classification of small probabilities and verbal expression are necessary because small probability does not mean safe.

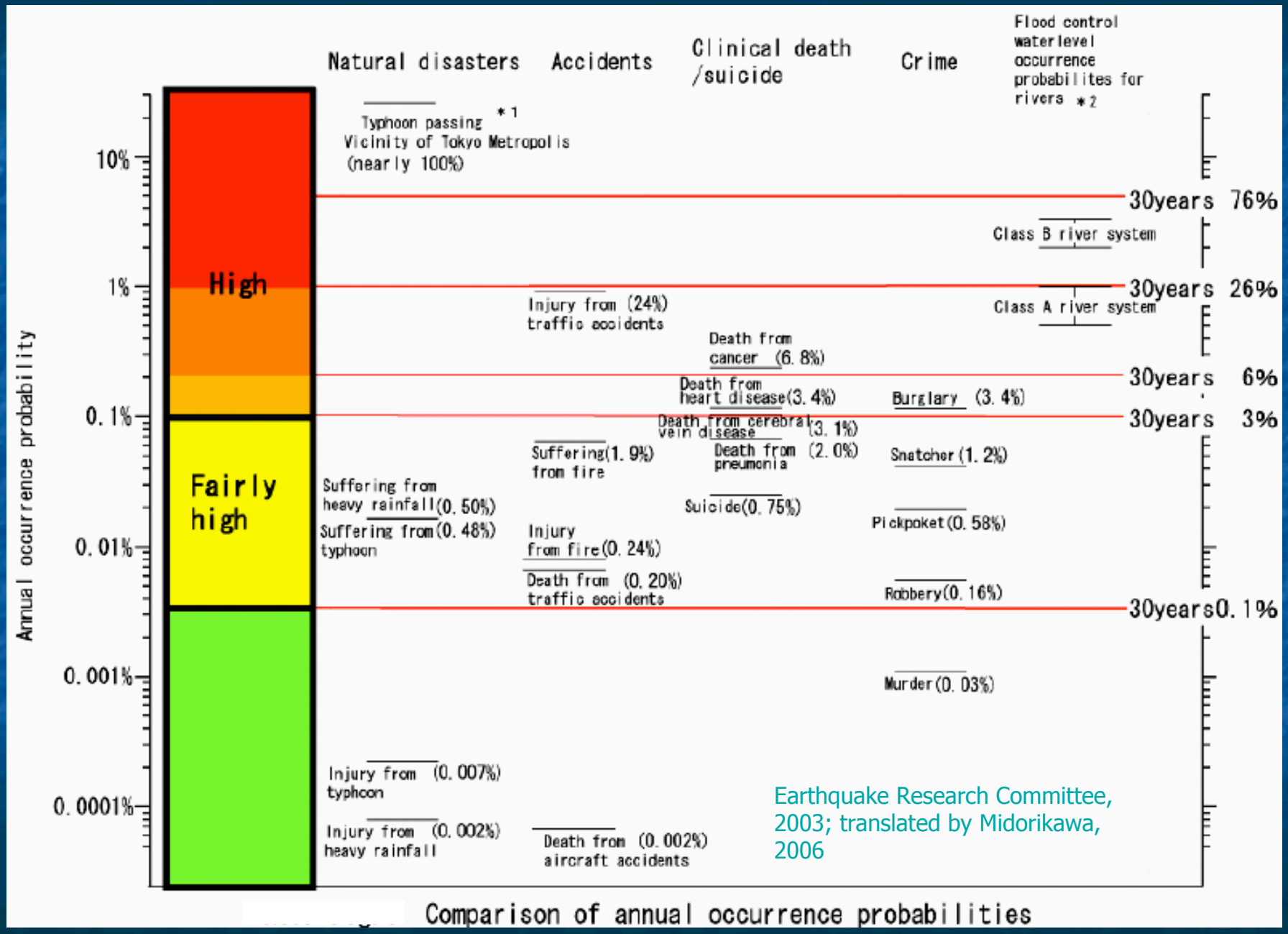
The 30-yr probability could have been evaluated as only 0.02-8%, if the estimate had been made just prior to the Kobe earthquake.

- High probability relative to other active fault zones: 3% or higher (30yr probability)
- Slightly high probability: 0.1-3%
- No comments: less than 0.1%

The largest probability is used when the range of probability is estimated.

Earthquake Research Committee, 2003

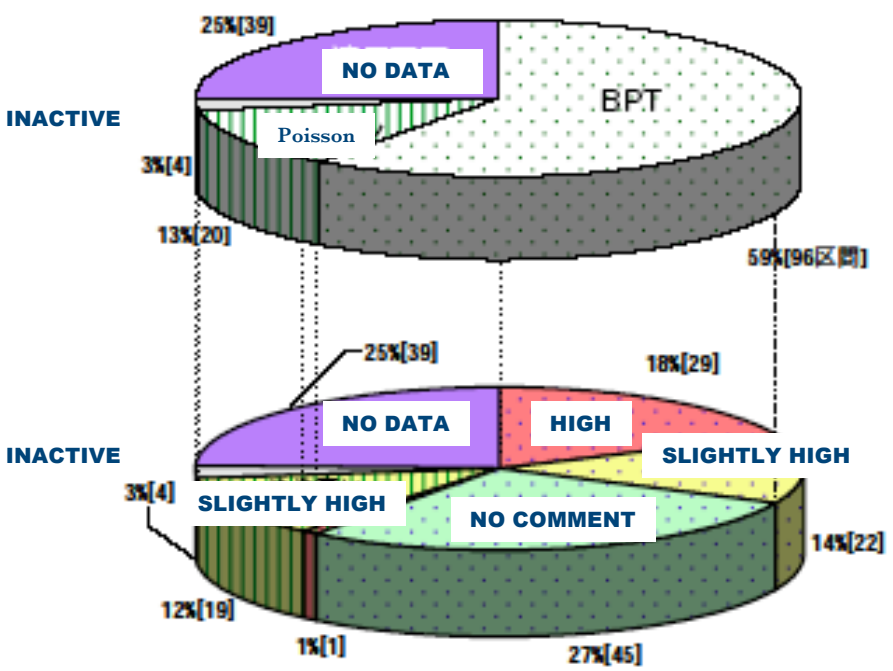
Help to understand meaning of probability level



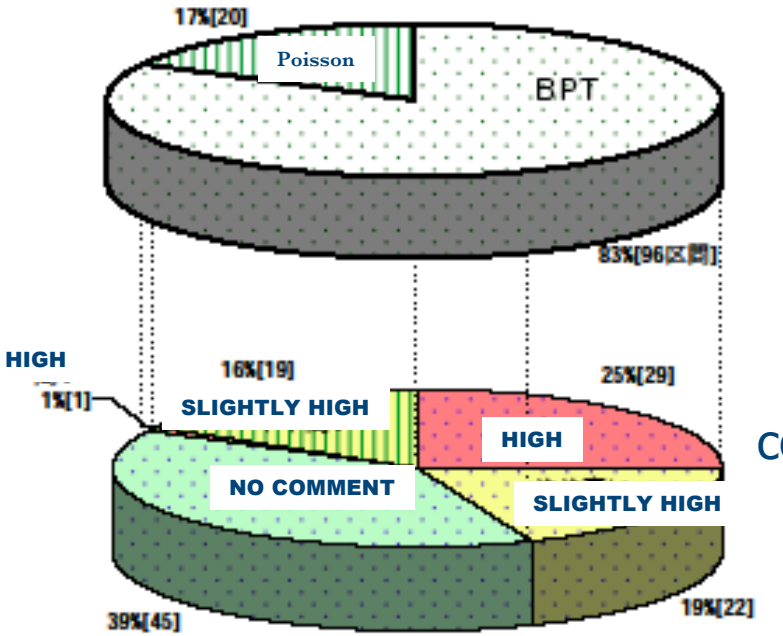
Earthquake Research Committee, 2003; translated by Midorikawa, 2006

Summary of earthquake forecasts for the 98 major active fault zones (159 faults/ fault segments)

159 faults/faults segments



116 cases with 30-yr probability



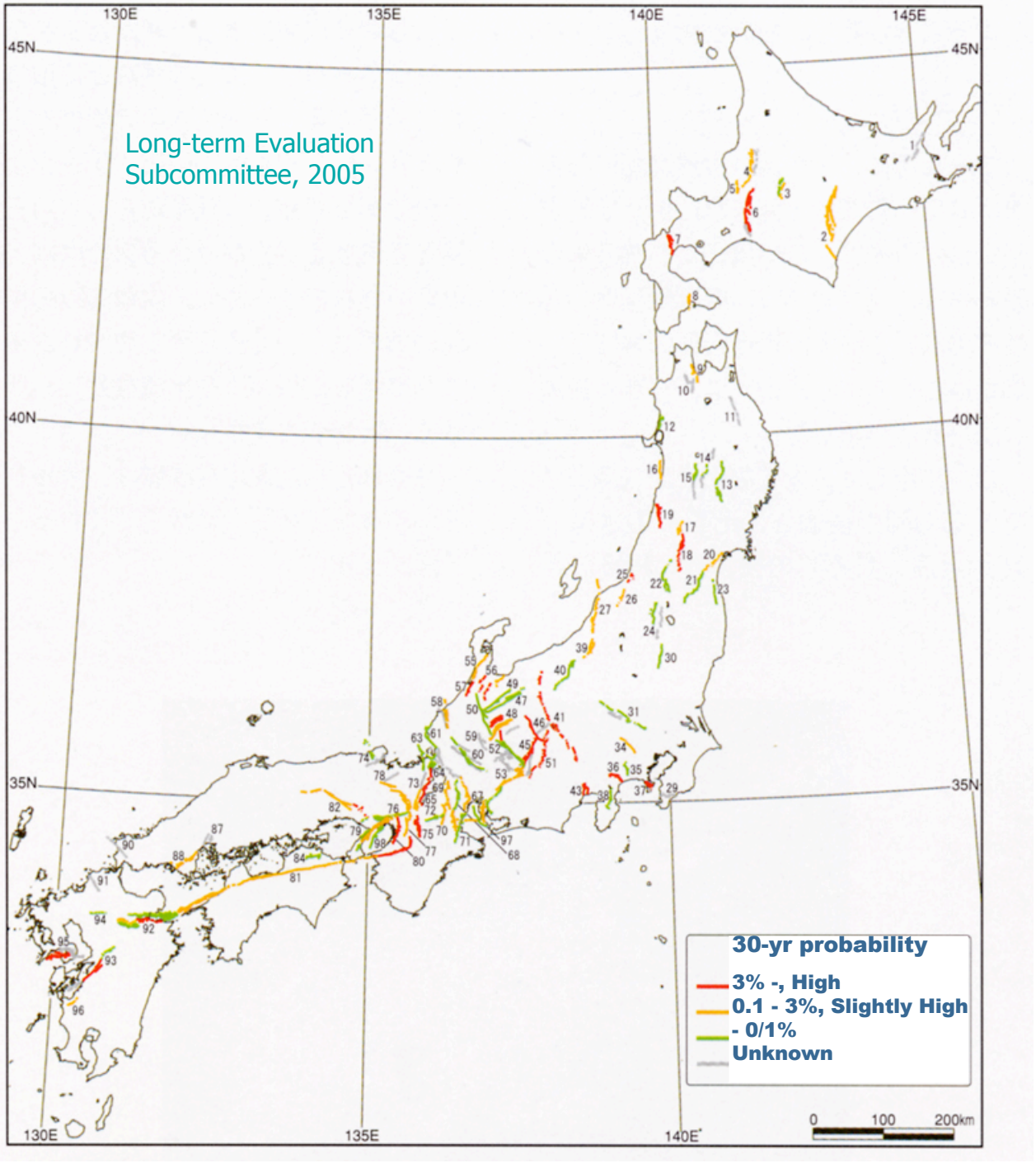
Model used

comment

Long-term Evaluation Subcommittee, 2005

30-yr probability

Long-term forecasts for the major 98 fault zones was made public by April 2005.



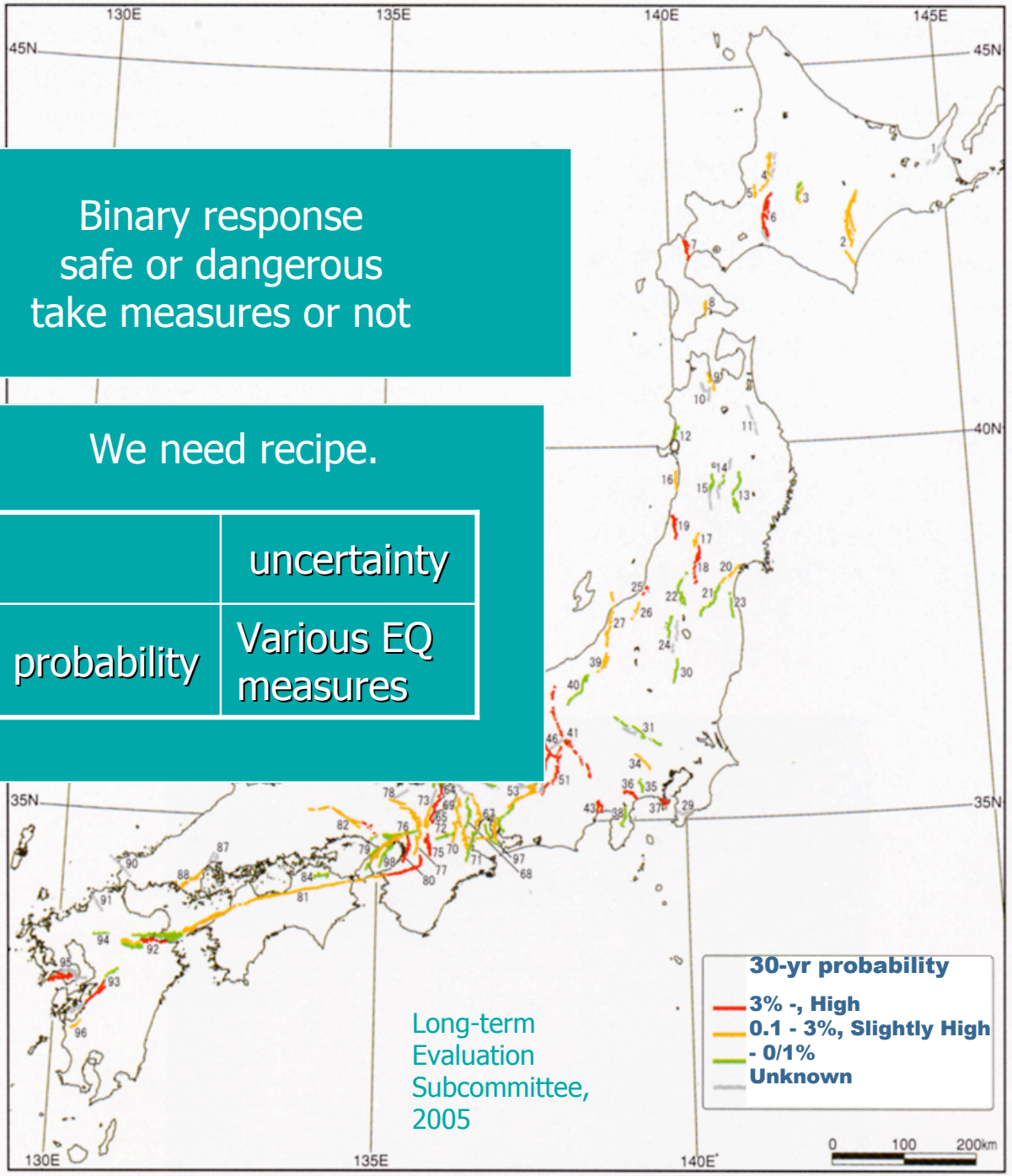
30-yr probability

Long-term forecasts for the major 98 fault zones was made public by April 2005.

Binary response
safe or dangerous
take measures or not

We need recipe.

	uncertainty
probability	Various EQ measures



Forecast summary of earthquakes along the oceanic trenches

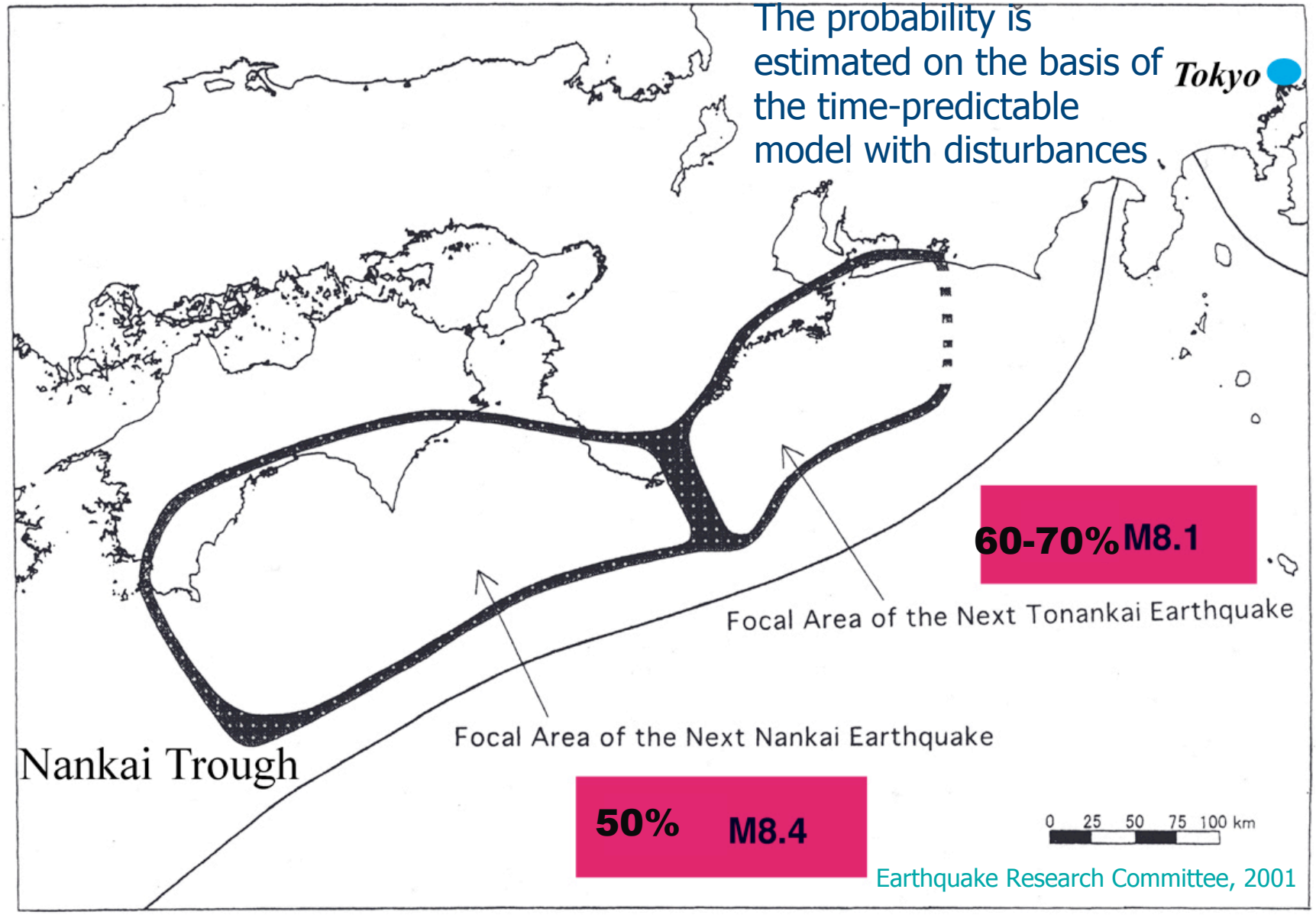
Identifiable source

Time-predictable with disturbances	2
Brownian Passage Time model	15
Poisson Process (unknown last event)	2

Unidentifiable source

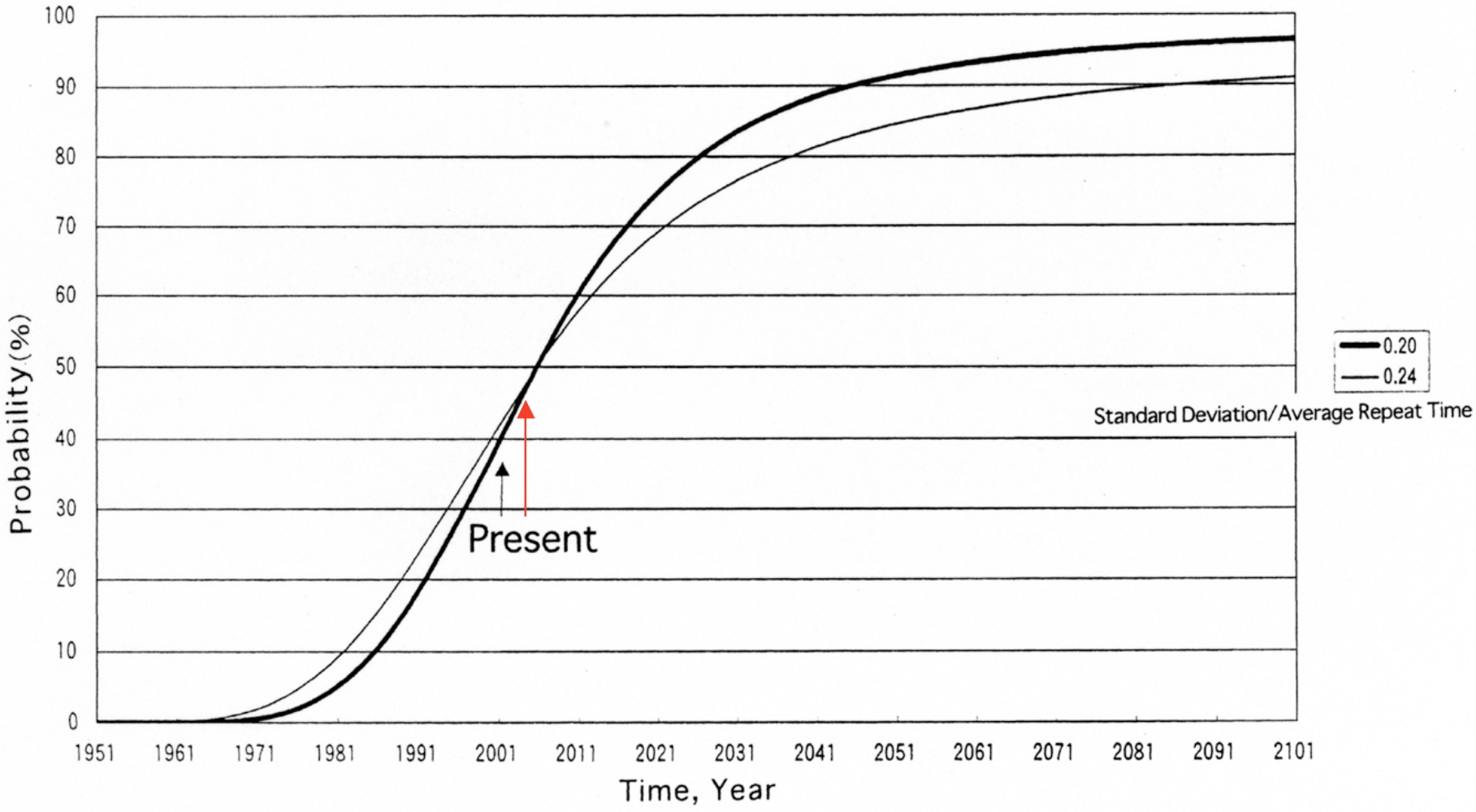
Poisson Process	14

30-yr Earthquake Occurrence Probability



Earthquake Research Committee, 2001

30-yr probability: Nankai Earthq



Earthquake Research Committee, 2001

Seismic Intensity: Nankai + Tonankai (Central Disaster Prevention Council, 2003)

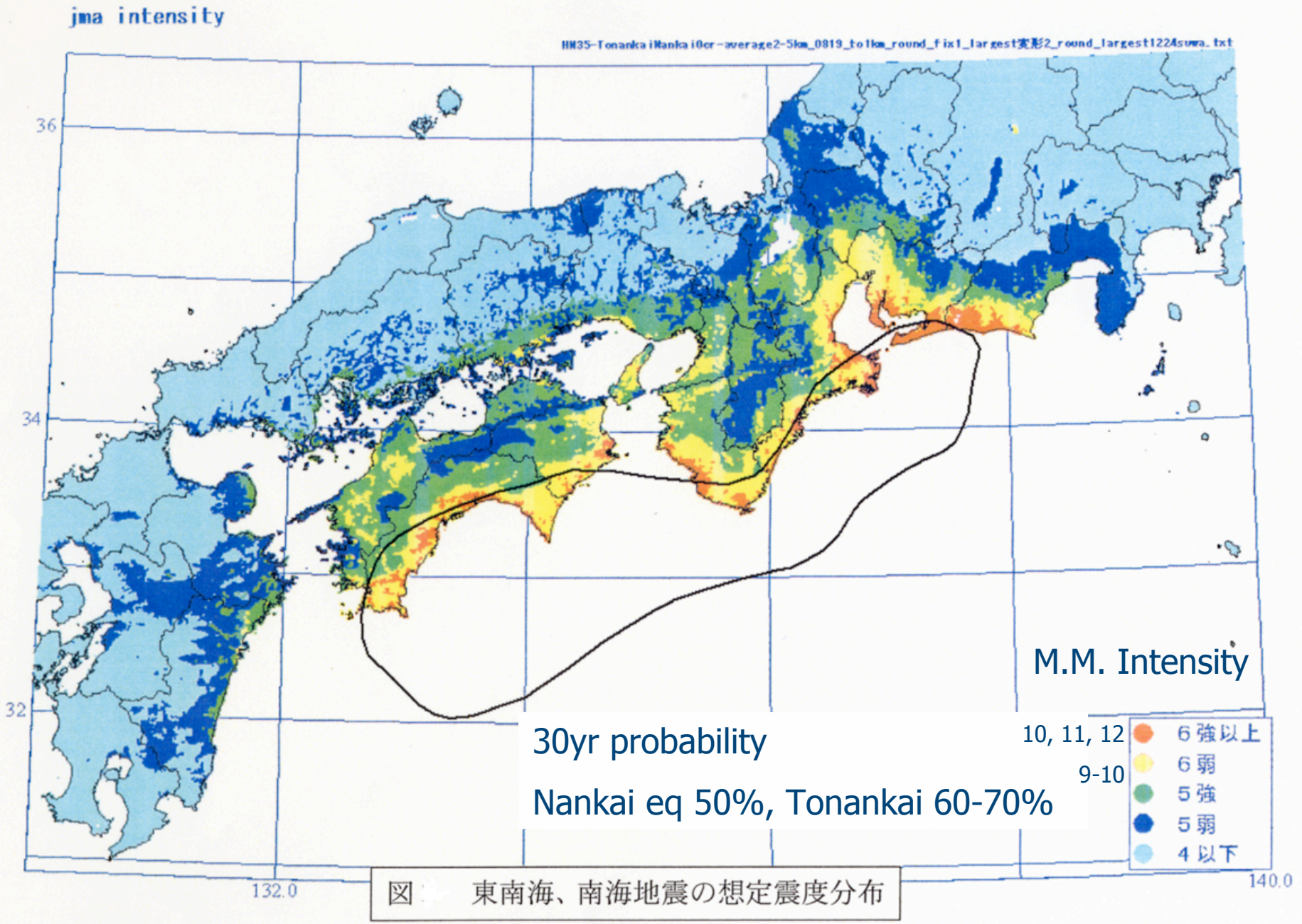
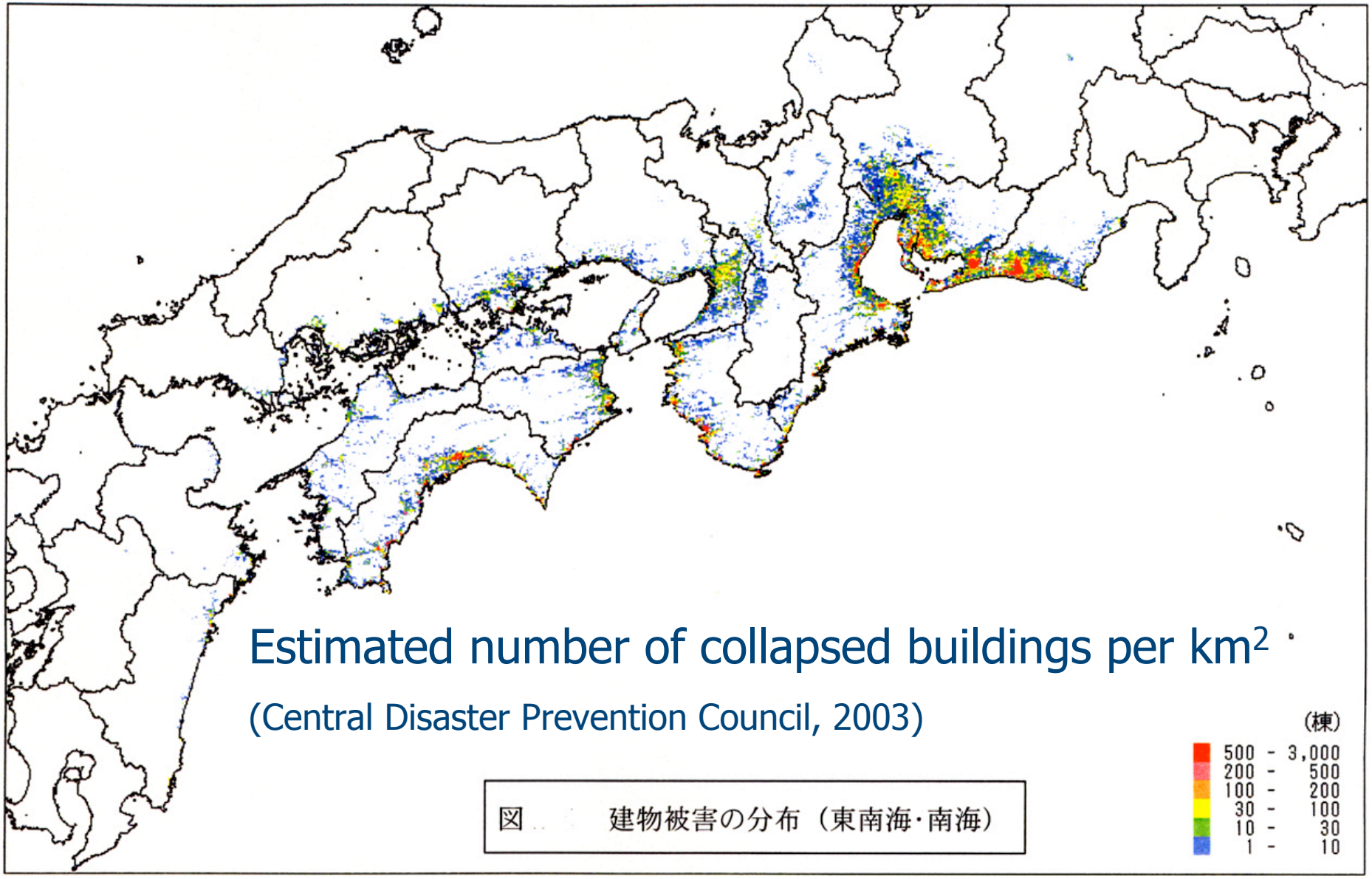


図　東南海、南海地震の想定震度分布



Estimated number of collapsed buildings per km^2

(Central Disaster Prevention Council, 2003)

図　　建物被害の分布（東南海・南海）

Historical damaging earthquakes: Identifiable and unidentifiable sources

- 98 major active fault zones: identifiable source
- 50% of inland damaging events which killed more than 50
- 70% of those which killed more than 1,000

- Other identifiable source
- Most off-shore earthquakes which killed more than 50

- Unidentifiable source
- Earthquakes occurring away from active faults
- Smaller off-shore earthquake
- Deep earthquakes

- Earthquakes on active fault other than the 98 major fault zones（Identifiable, but inaccurate forecast）

Statistics based on the past 200 year data

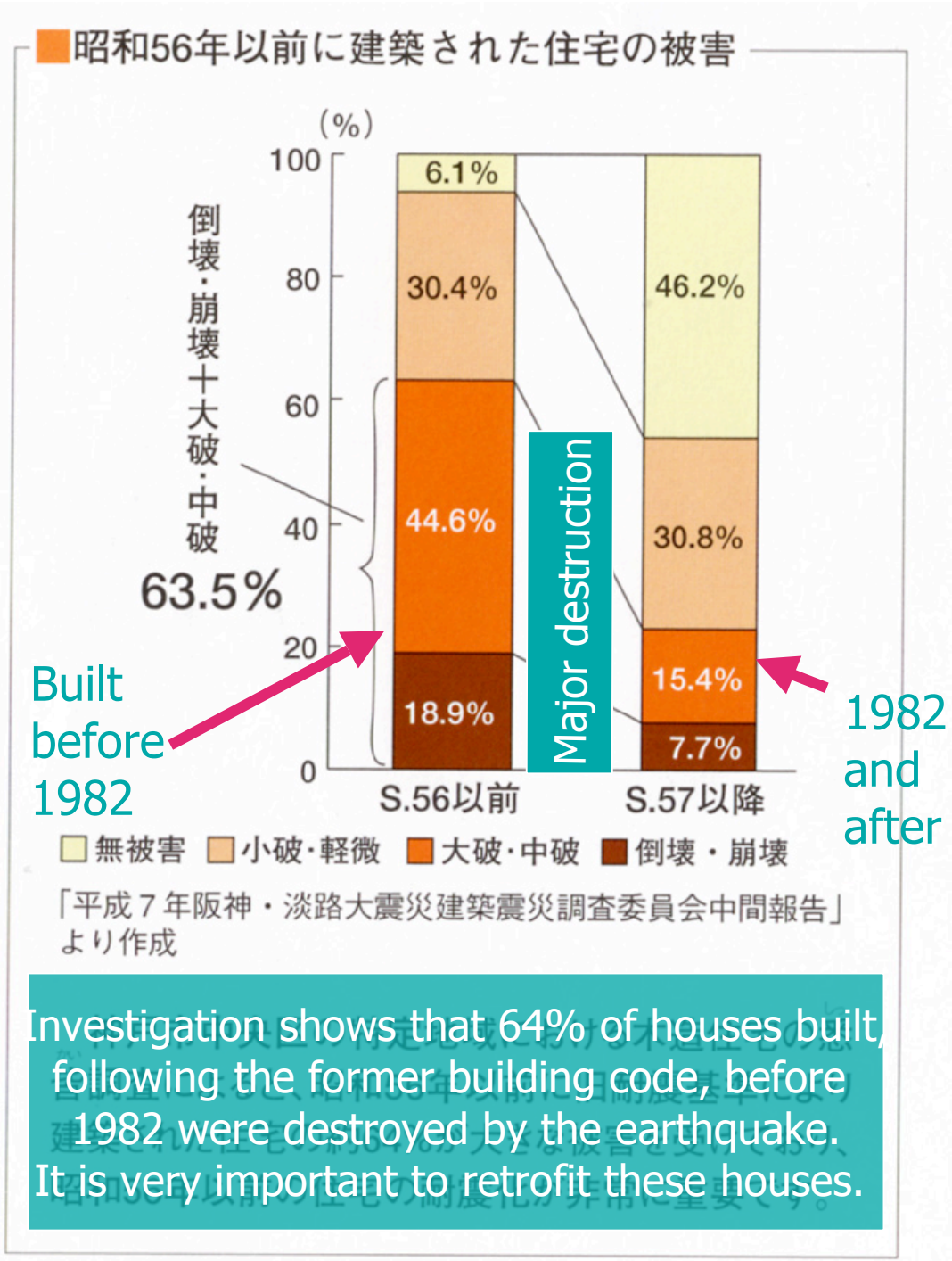
The 1995 Kobe earthquake

The present top issue is existing weak houses and buildings

Damaged houses

Most of the collapsed houses were built prior to the 1981 building code revision.

Central Disaster Prevention Council



Investigation shows that 64% of houses built following the former building code, before 1982 were destroyed by the earthquake. It is very important to retrofit these houses.

住宅の耐震化の状況

Ministry of land, construction, and transportation, 2004

		1998	2003	H10→H15
# of houses		44M	47M	+300万戸
	Unsafe	14M	11.5M	−250万戸
	(率)	32%	25%	
内訳	Wooden houses	2，350万戸	2，450万戸	+100万戸
	耐震性が不十分	1，200万戸	1，000万戸	−200万戸
	(率)	51%	41%	
	Apartment buildings	2，050万戸	2，250万戸	+200万戸
	耐震性が不十分	200万戸	150万戸	− 50万戸
	(率)	10%	7%	

GOAL:25% unsafe houses/buildings should be decreased to 10% within 10 years.

How can we reach the goal?

What would be the best incentive to make people retrofit or rebuild their dwellings?

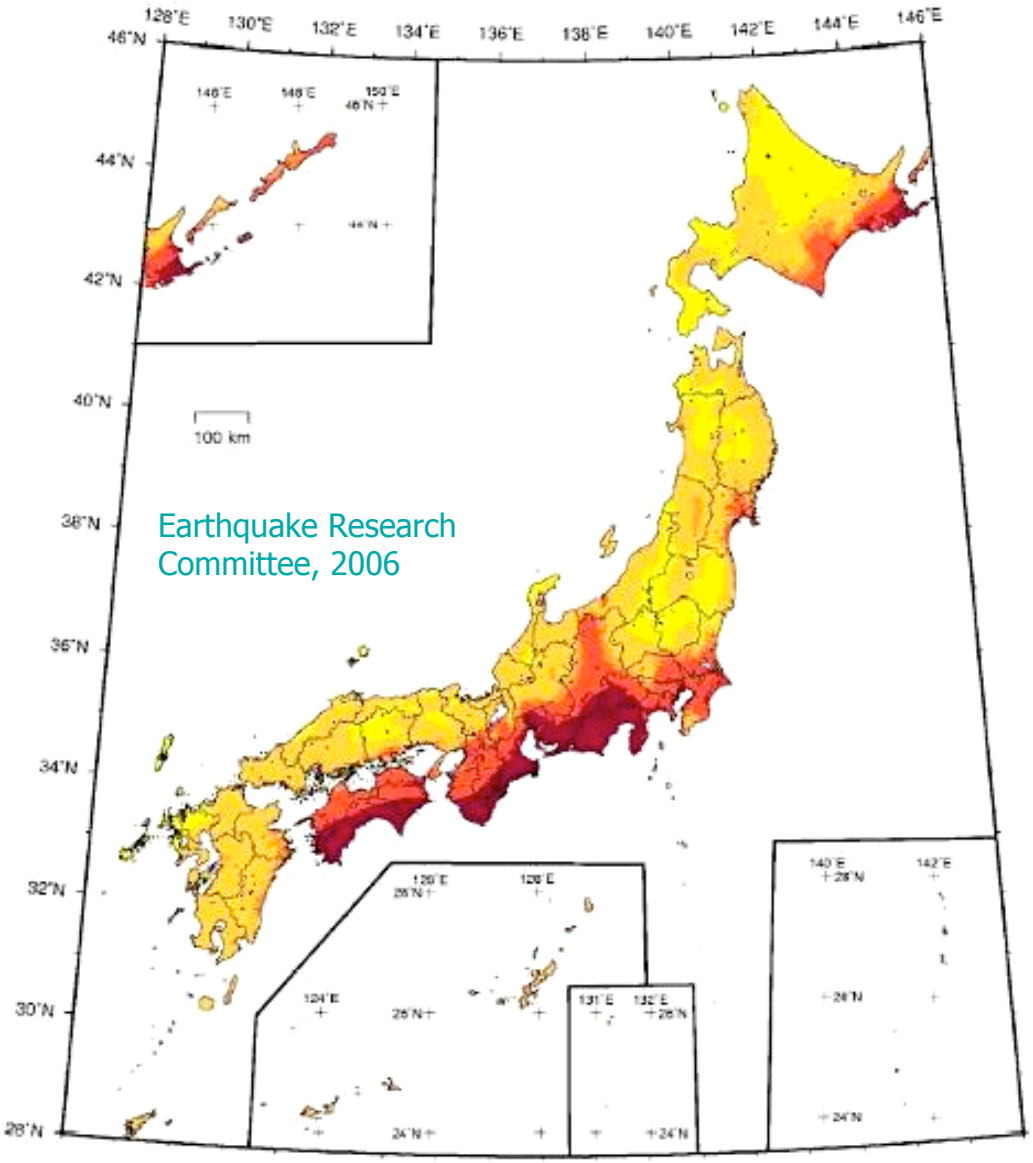
Example

Tax deduction for earthquake insurance premium starts from this fiscal year and two years later the present tax reduction for fire insurance (fire caused by earthquakes is not insured) premium will be abolished.

Which weak house/buildings should we choose for retrofit or rebuilding?

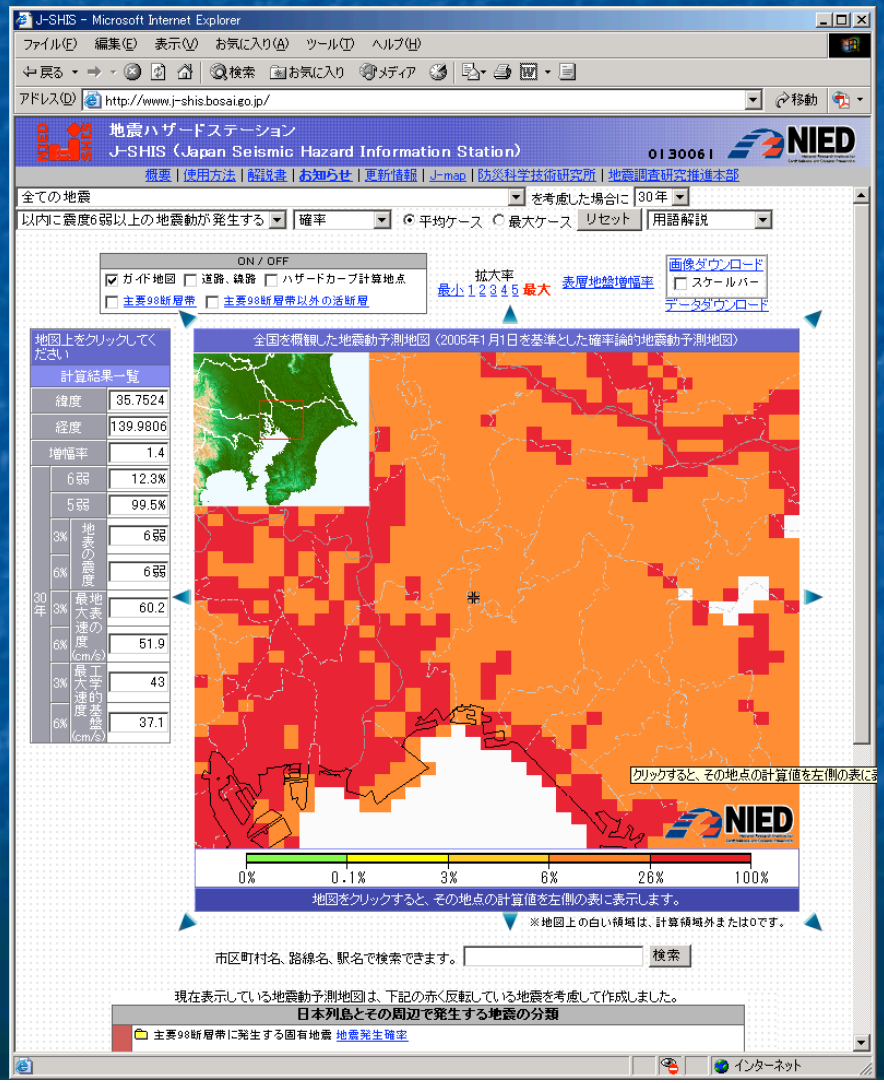
Probabilistic seismic hazard map answers this question.

The first national seismic hazard map is produced ten years after the Kobe eq. on the basis of long-term forecasts and empirical attenuation relationship.



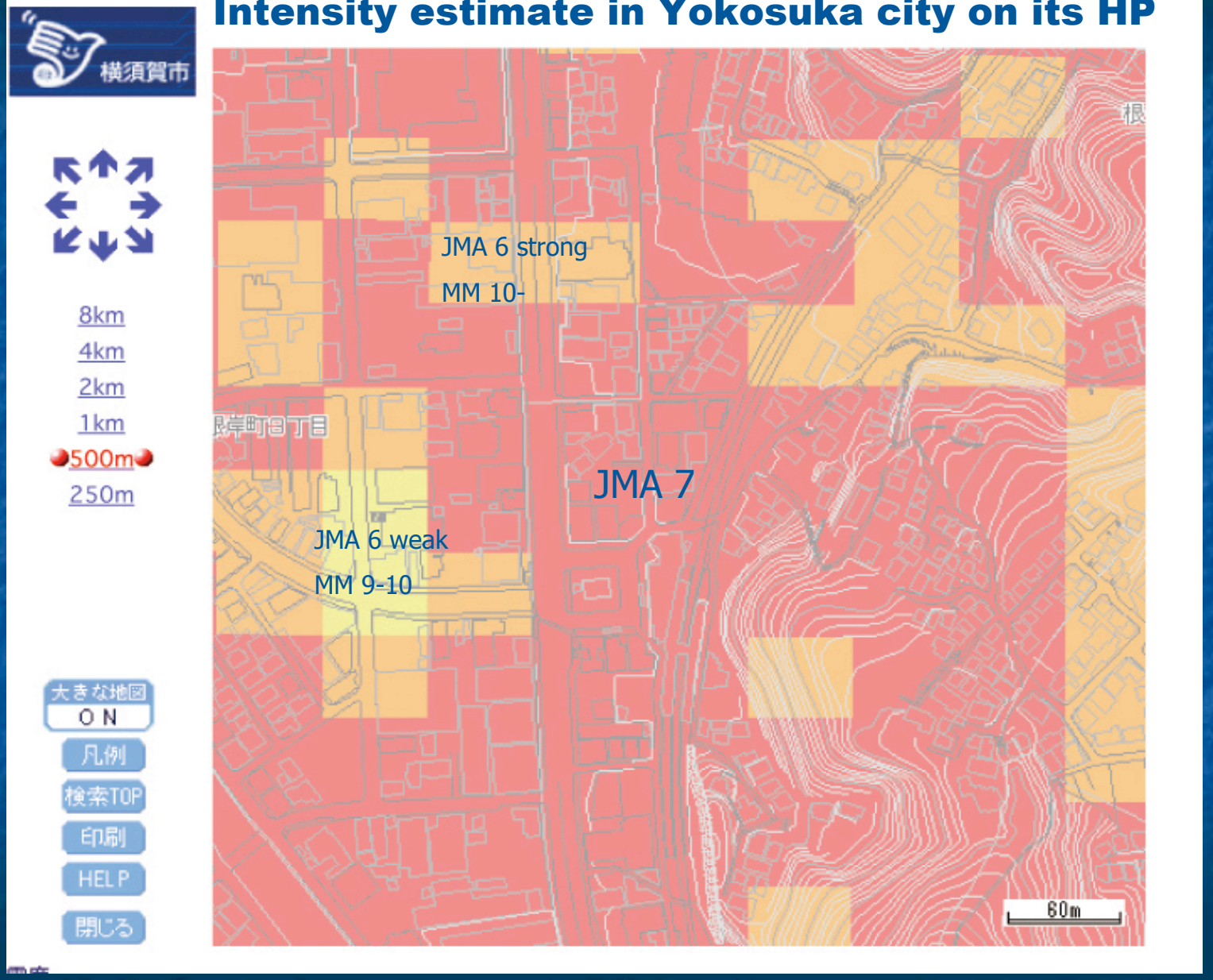
2006 Version
Probability of Ground Motion Equal to or Larger than JMA Intensity 6 weak (MM9-10) Occurring within 30 years

Japan Seismic Hazard Information Station
(J-SHIS)
http://www.j-shis.bosai.go.jp/j-shis/index_en.html

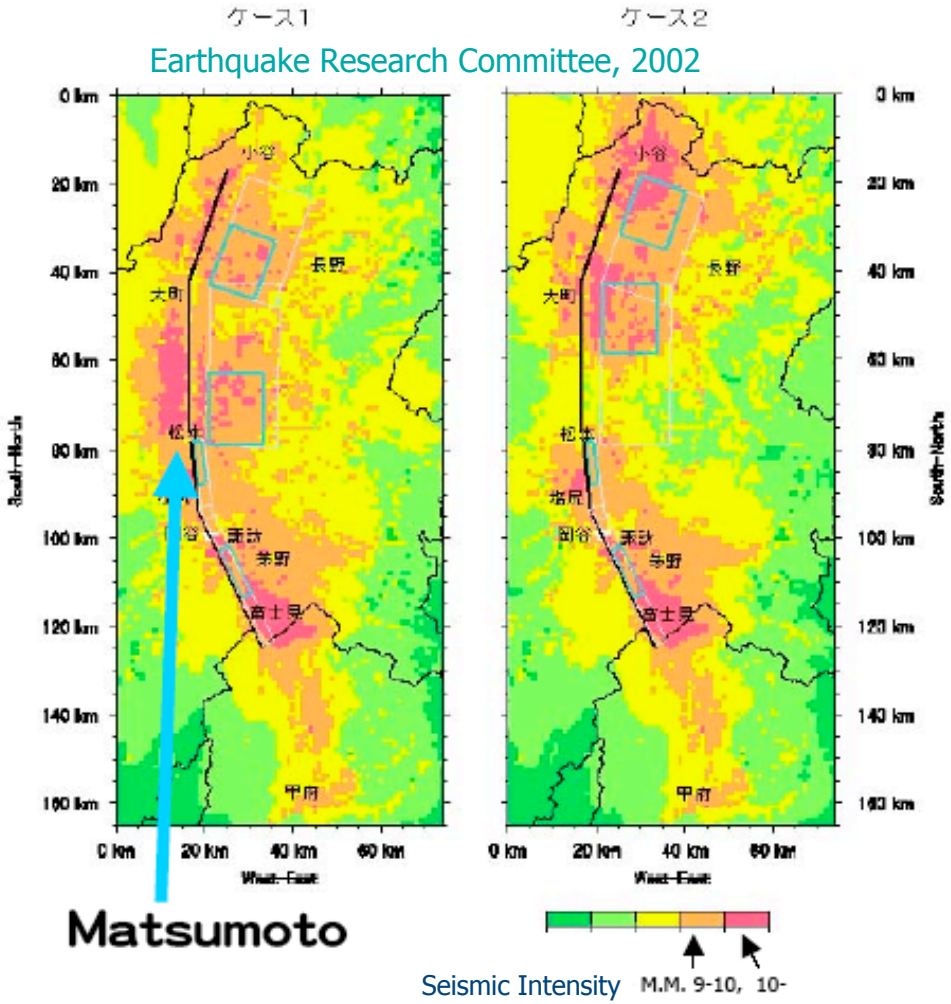


Shake map for M7.2 Miura Peninsula Fault Zone EQ

Intensity estimate in Yokosuka city on its HP

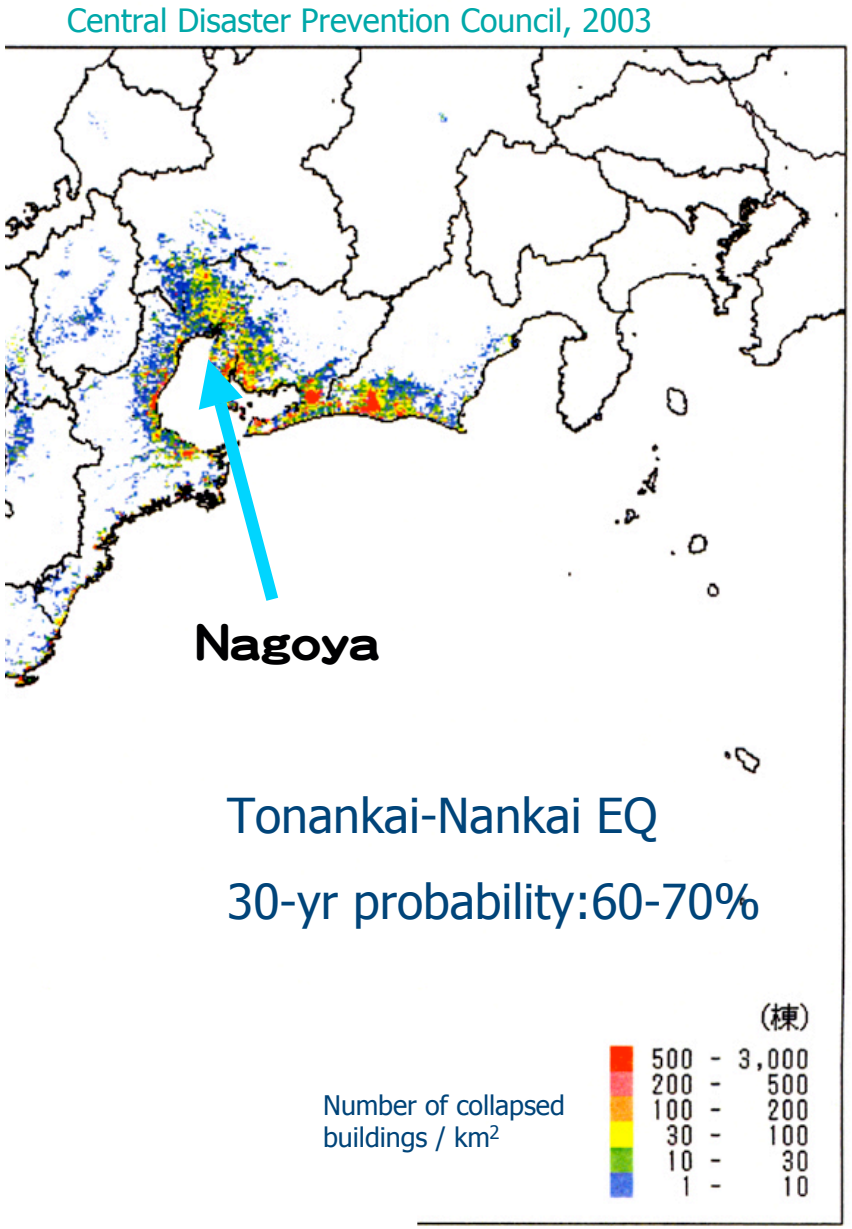


http://www2.wagamachi-guide.com/yokosuka/apps/search/asp?GetChkFlg=miura



Itoigawa-Shizuoka
Tectonic Line fault zone

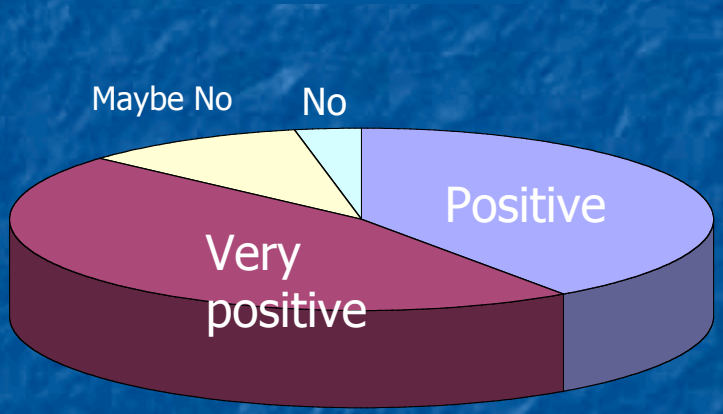
30-yr probability:14%



Tonankai-Nankai EQ

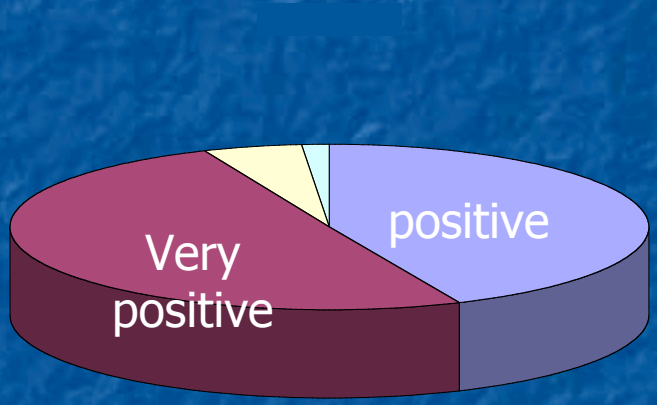
30-yr probability:60-70%

Do you feel the necessity of earthquake measures?



Matsumoto

(Fault EQ 14% in 30yrs)



Nagoya

(Subduction EQ 60-70% in 30yrs)

Headquarters for Earthquake Research Promotion, 2006

General comments may not be sufficiently persuasive to make people prepare for earthquake disasters.

One way is to make statements very specific. If you are told that your house will collapse when a ceratain earthquake hits, you would start to think about it.

long-term earthquake forecasts, realizable at the present level of our knowledge, are helpful and the first step towards our goal.

Retrofit Construction of ERI building

February 2007