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SCA Joint Project Workshop “Natural Disasters”

Forecast, Prediction, and Hazard Assessments of Earthquakes

Kojiro Irikura
Aichi Institute of Technology

Earthquake Prediction and Forecast

Definitions

Earthquake:

a source (fault motion) that generates seismic waves

Ground motion:

ground shaking or seismic waves generated from earthquake source

Long-term forecast: years, decades or centuries

Short-term prediction: hours, days

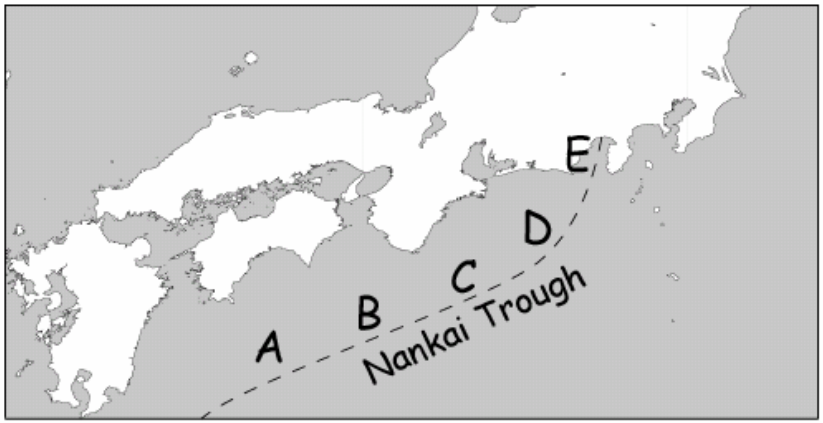
Three factors for successful forecast/prediction

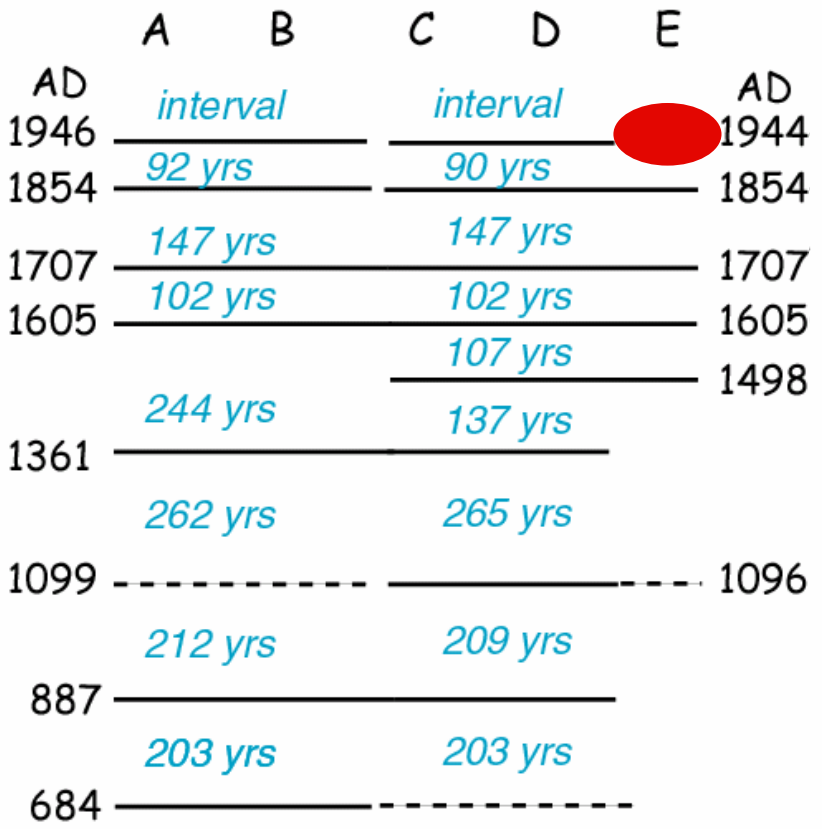
1. When (location)
2. Where (location)
3. How big (Magnitude)

Before 1995 Kobe Earthquake (Mw 6.9),

"Earthquake Prediction Program", one of national projects, played an important role in governmental policy and countermeasures for earthquake disaster mitigation.

Example:
Tokai Earthquake Prediction based on "Large-scale Earthquake Countermeasures Special Act (1978).





Recurrence of large earthquakes along Nankai trough

Tokai gap

Ishibashi (2002)

Tokai Earthquake Prediction

Tokai earthquake may be the only eq. to be predicted

Large-scale Earthquake Countermeasures Special Act (1978)

- Around-the-clock monitoring for precursors
- Prime Minister declares warning, based on experts judgement
- establishment of Earthquake Disaster Warning Headquarters

Within the designated area

Bullet trains, expressway suspended

Banks and post offices closed

Supermarkets, department stores closed

Hospitals closed for outpatients

Schools closed, students are sent back home

Tokai Earthquake Prediction

Policy Framework for Tokai Earthquake (2003)
by Central Disaster Management Council

Prediction → Hazard Reduction

Relaxation of limitation
Activity can be continued
in earthquake-resistant buildings

Different Level of Warning
depending on # of precursors

After the 1995 Kobe Earthquake, changed!

1. Know earthquakes

Promote basic researches and observations related to earthquakes.

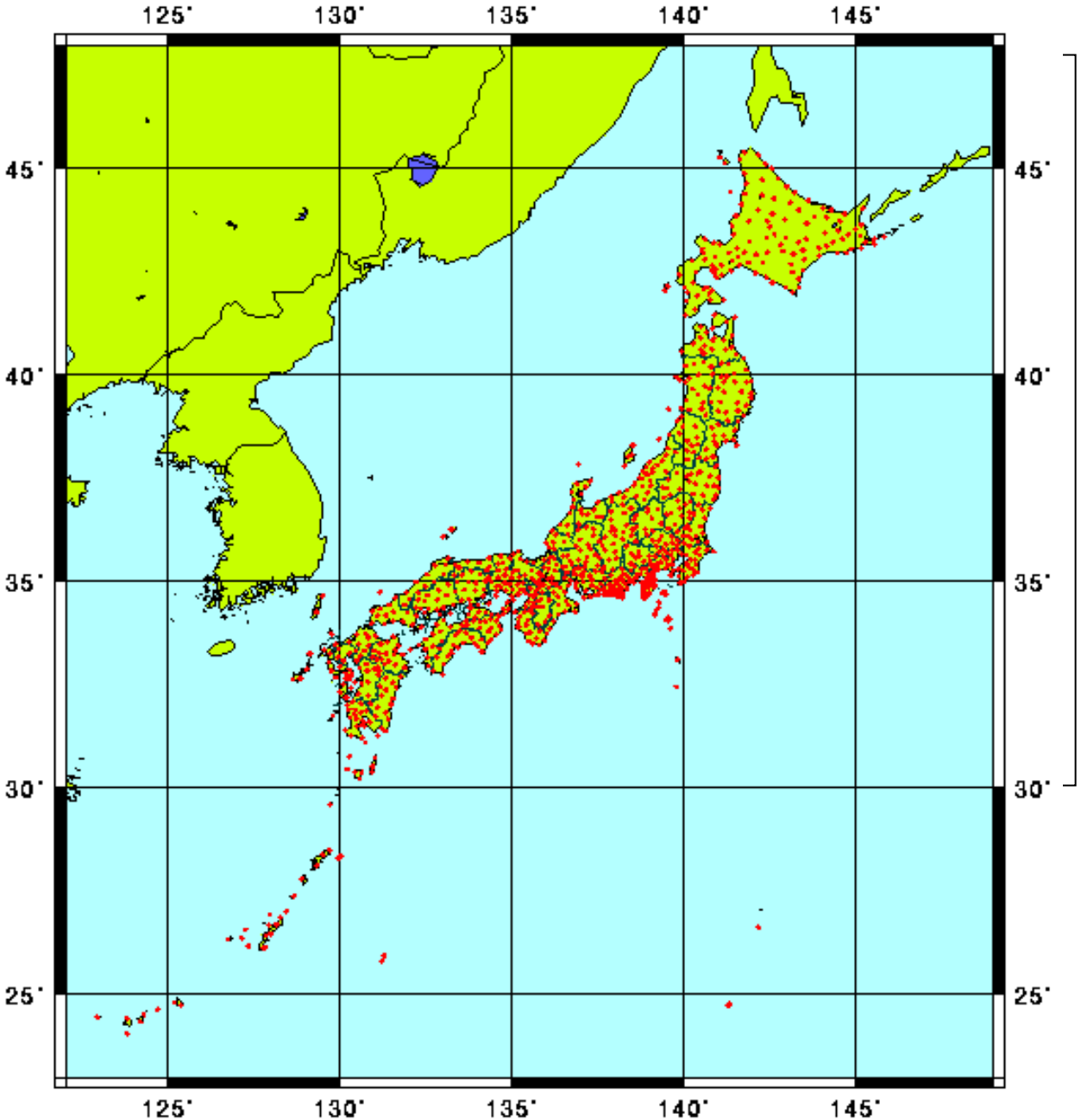
2. Prepare for earthquakes

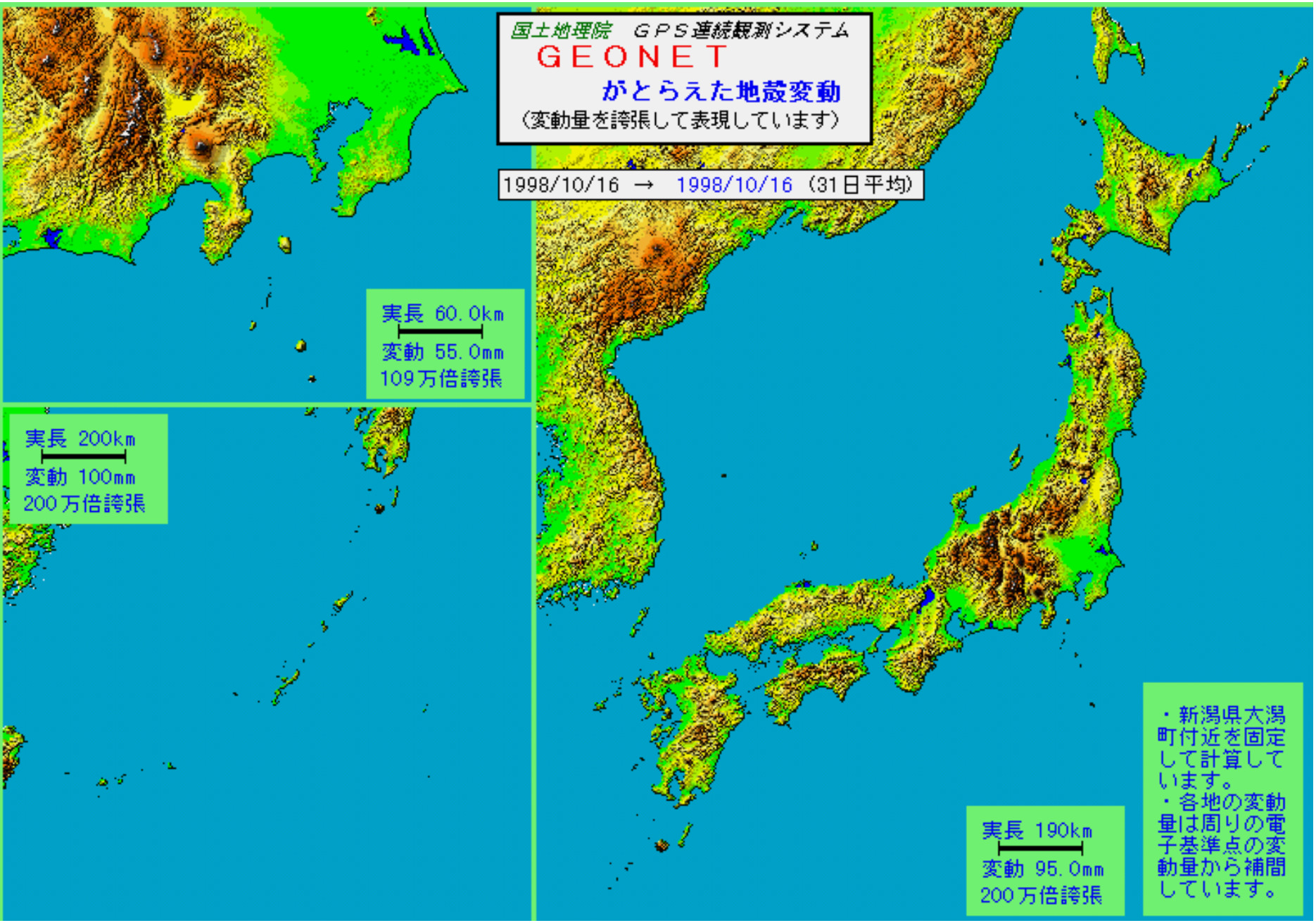
Promote earthquake engineering researches and cooperation between earthquake engineers , Earth scientists, and societal scientists for mitigating earthquake disasters and managing seismic risk.

→ Importance of Hazard and Risk Assessment

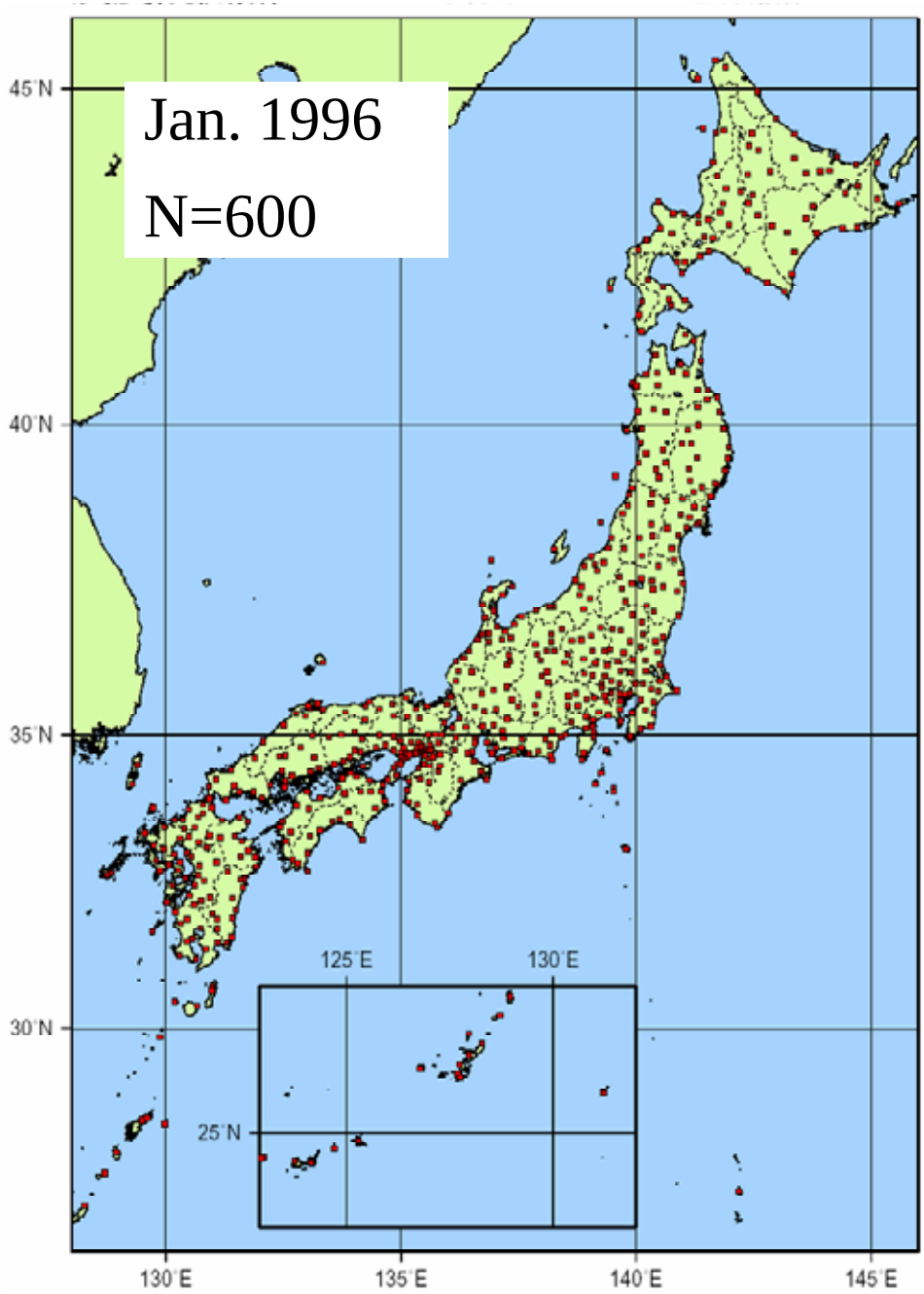
Role of the national government

GPS Observation Stations




国土地理院　ＧＰＳ連続観測システム
ＧＥＯＮＥＴ
がとらえた地殻変動
（変動量を誇張して表現しています）
1998/10/16 → 1998/10/16 （31日平均）
実長 60.0km
変動 55.0mm
109万倍誇張
実長 200km
変動 100mm
200万倍誇張
実長 190km
変動 95.0mm
200万倍誇張
・新潟県大潟町付近を固定して計算しています。
・各地の変動量は周りの電子基準点の変動量から補間しています。

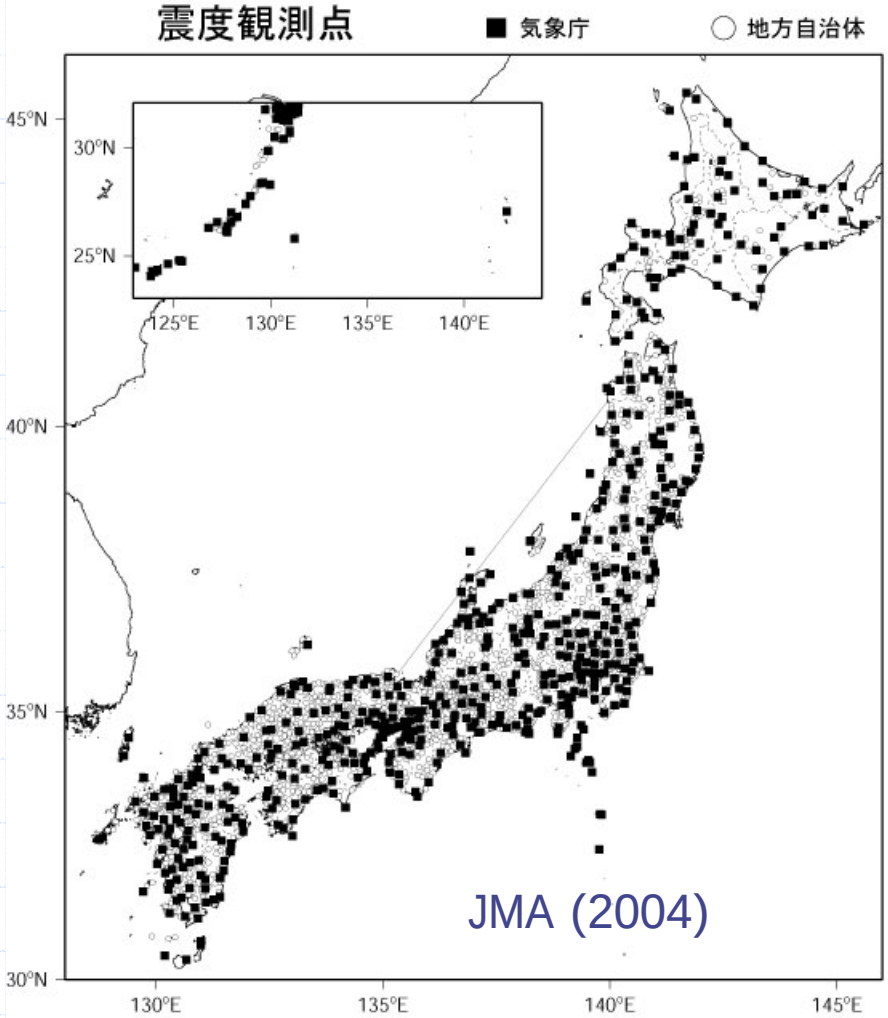
Transition of Observation Stations of Seismic Intensity 1/2



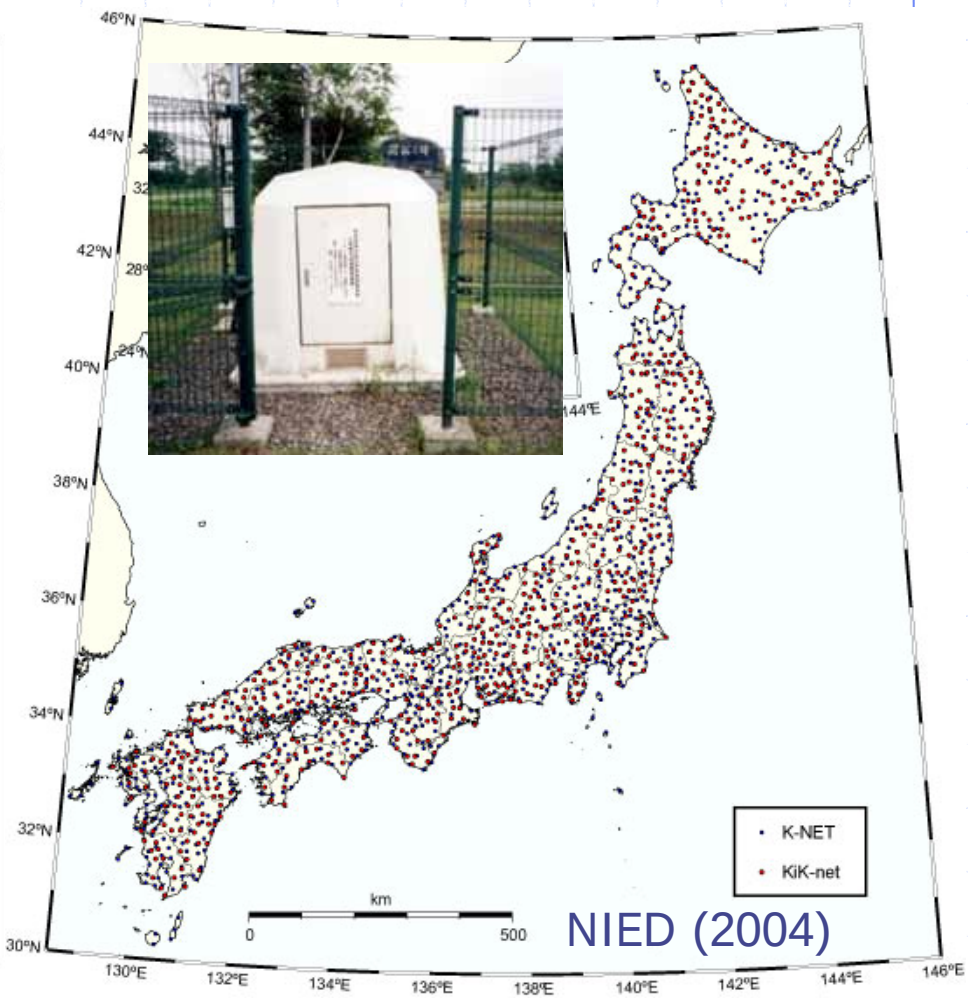
Seismic Network (after 1995 Kobe)

JMA: About 3500 stations

NIED: About 1800 stations

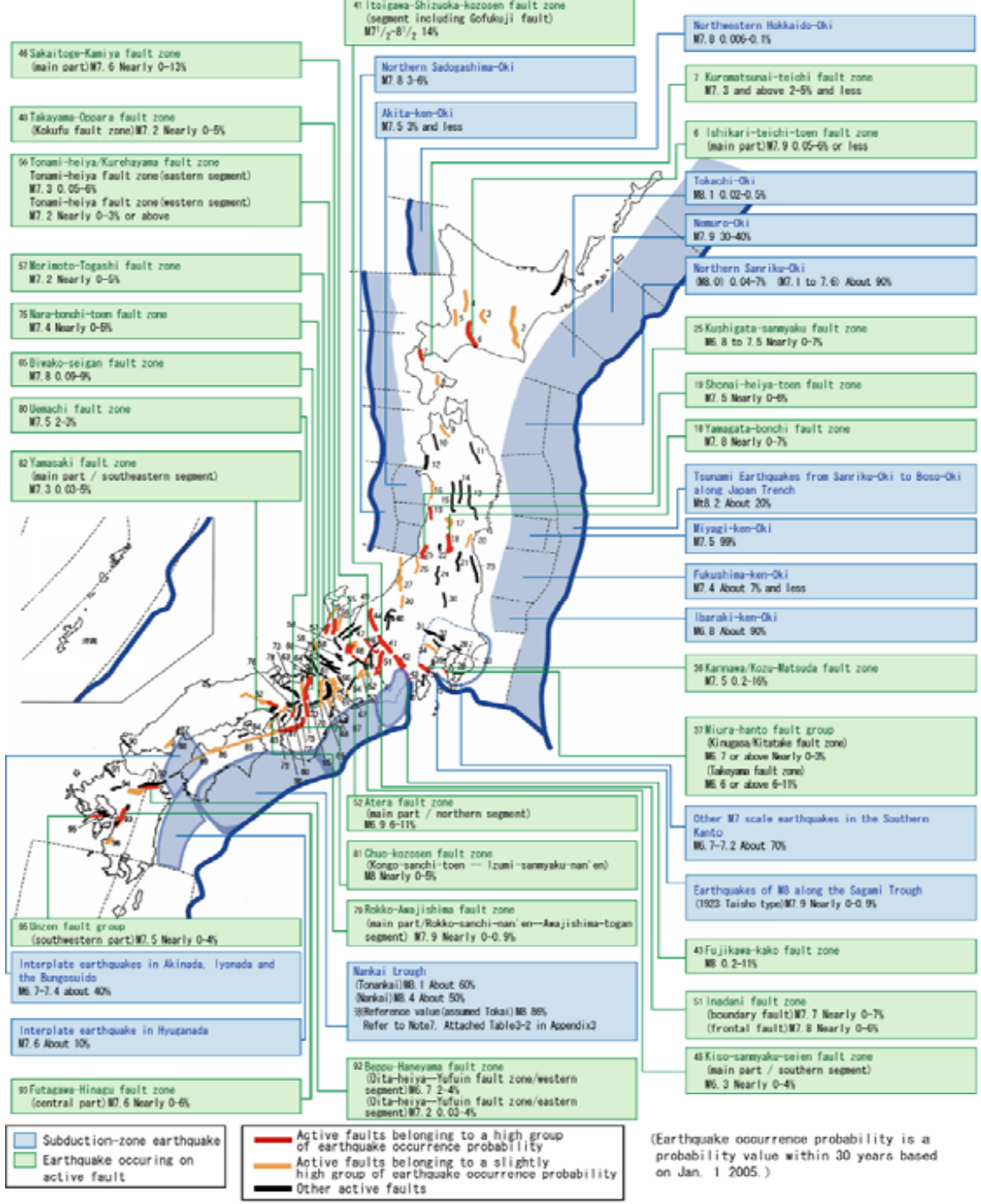


JMA (2004)



NIED (2004)

Long-term Forecast based on Survey of Active-Faults over Japan

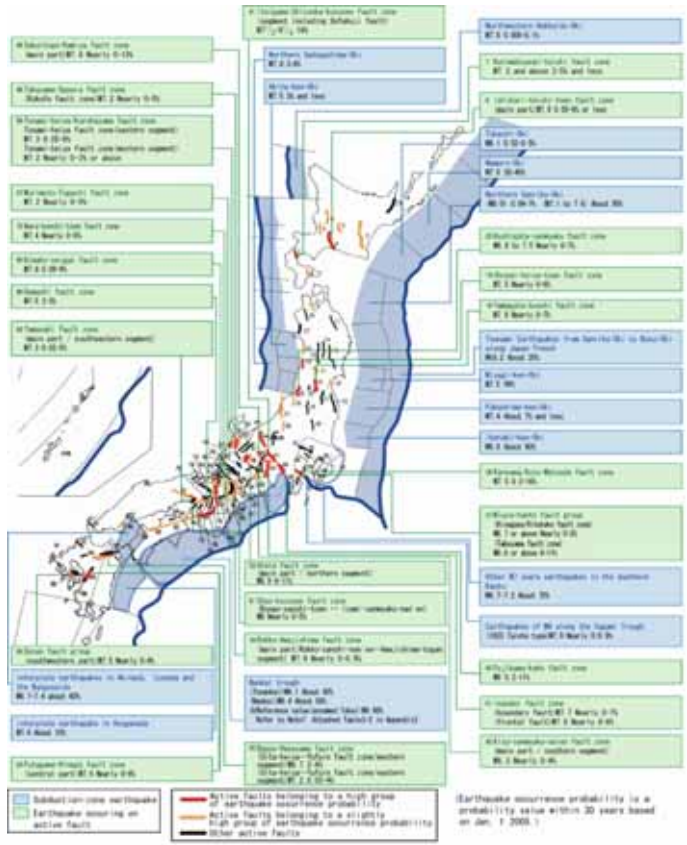


Long-term Forecast

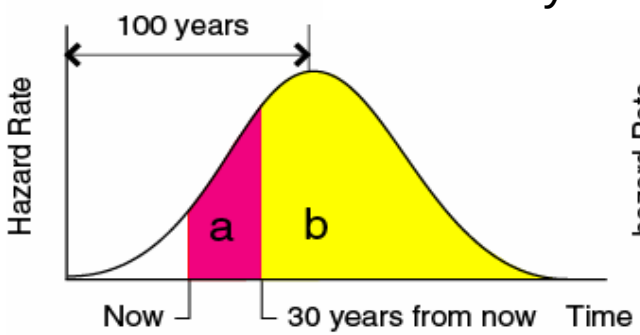
Japanese Govt. announcement

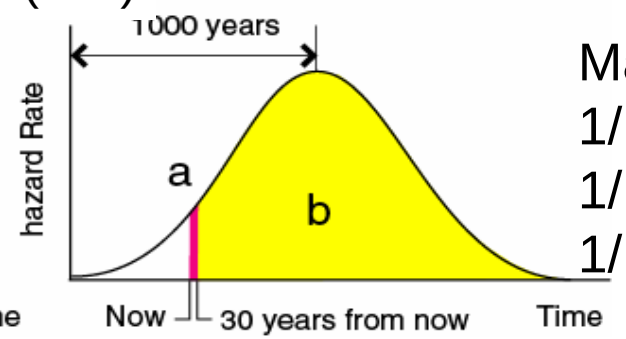
Next 30 years
- Miyagi-oki 99 %
- Nankai Trough 50-60 %
- ISTL (inland fault) 14%
- most active faults < 5%

Probability of Kobe eq. in 1995
0.02-8 %



Probability=a/(a+b)





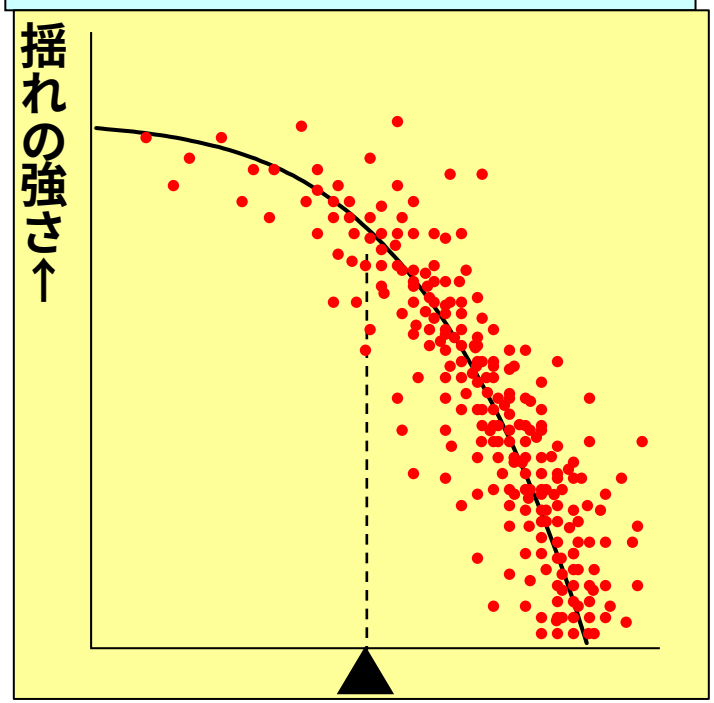
Max probability for 30 yrs
1/100 yr event ~ 90 %
1/1000 yr event ~ 20 %
1/10000 yr event ~ 2 %

Probabilistic Seismic Hazard Map

Long-term Forecast

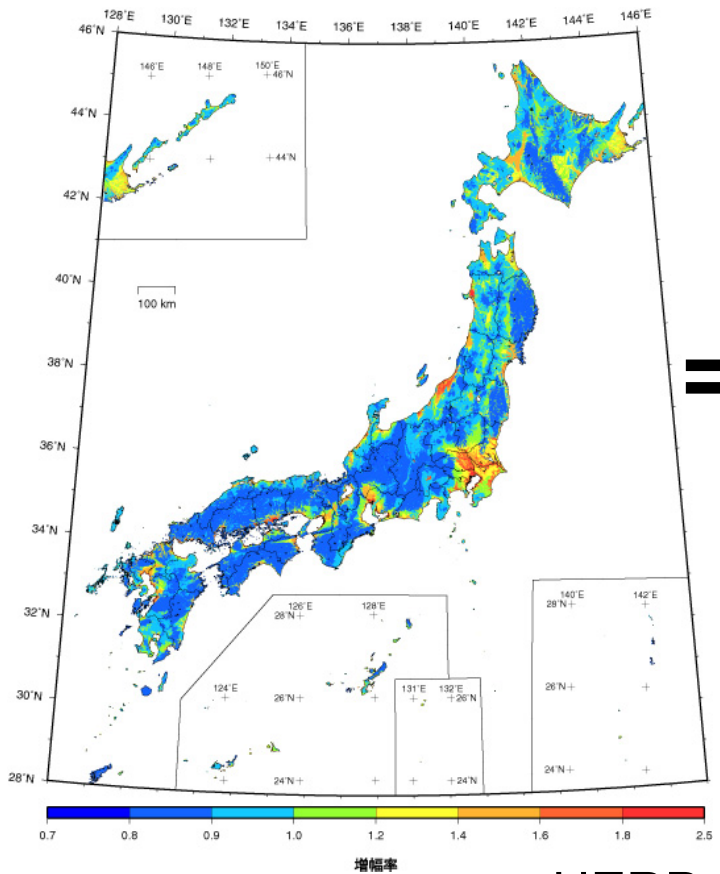
×

Ground motion – Distance Attenuation Relation



Surface Amplification

×

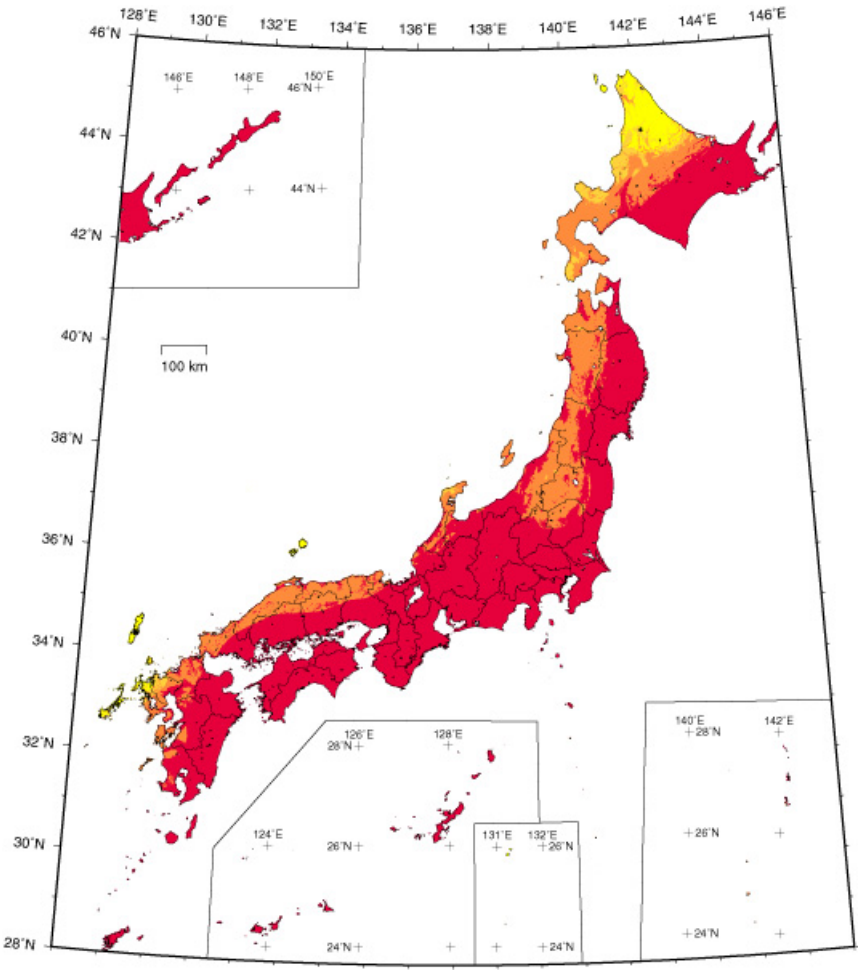


HERP

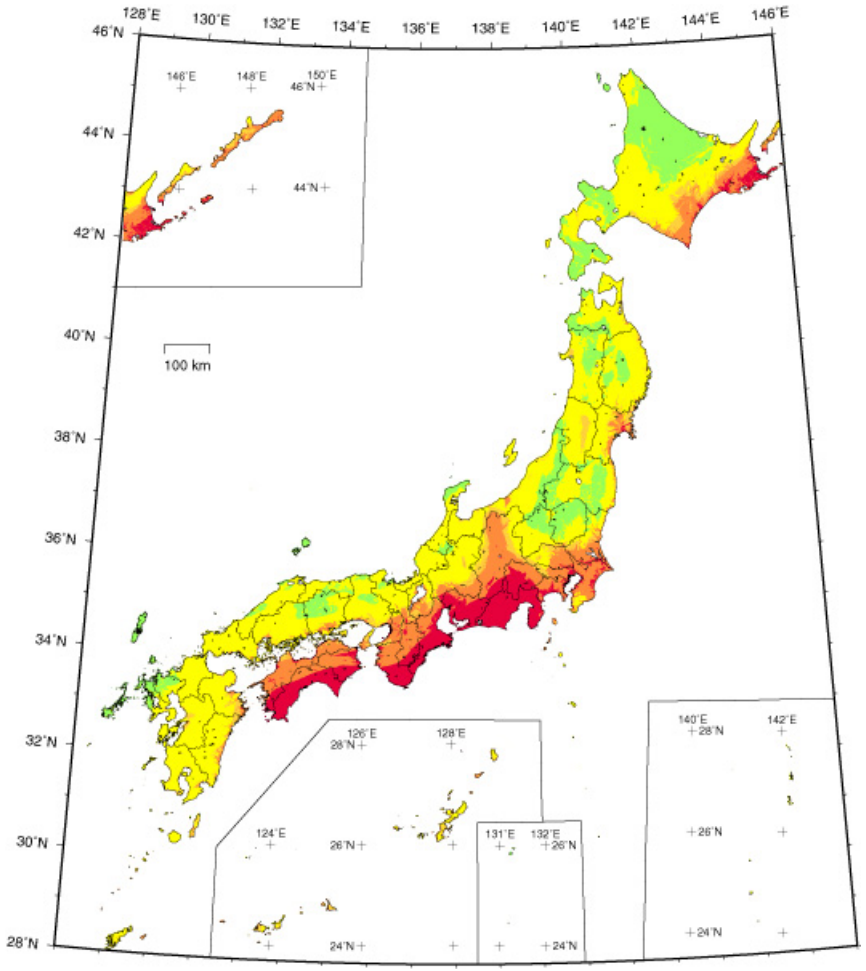
= PSHM

National Seismic Hazard Map

Probability for Intensity > 5 – in the next 30 yrs

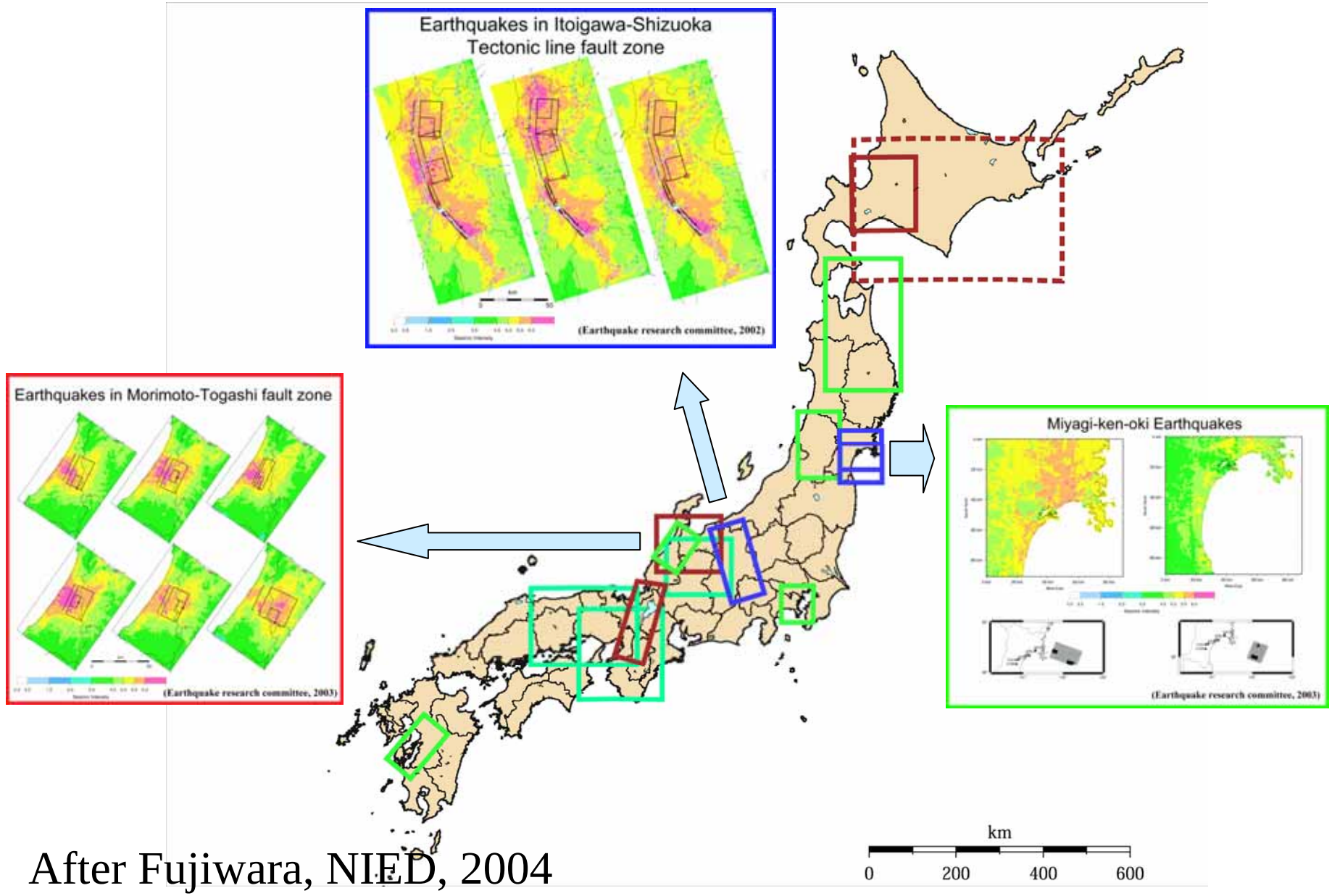


Probability for Intensity > 6 in the next 30 yrs



HERP

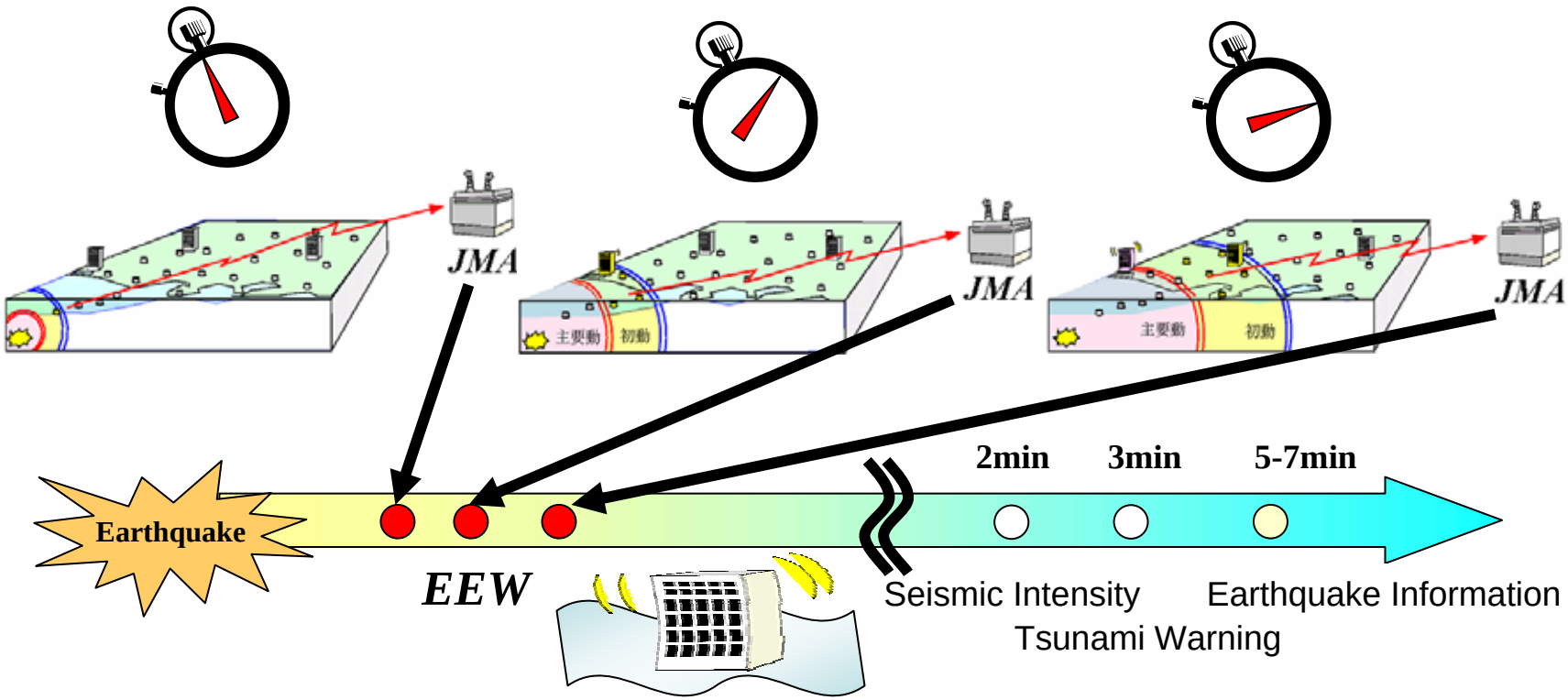
Deterministic Seismic Hazard Map



After Fujiwara, NIED, 2004

Earthquake Early Warning Systems
(Hypocenter,Magnitude,Seismic Intensity)

1. Hypocenter estimation
   1) Single station method 2) Network method
2. Magnitude estimation
3. Seismic intensity estimation

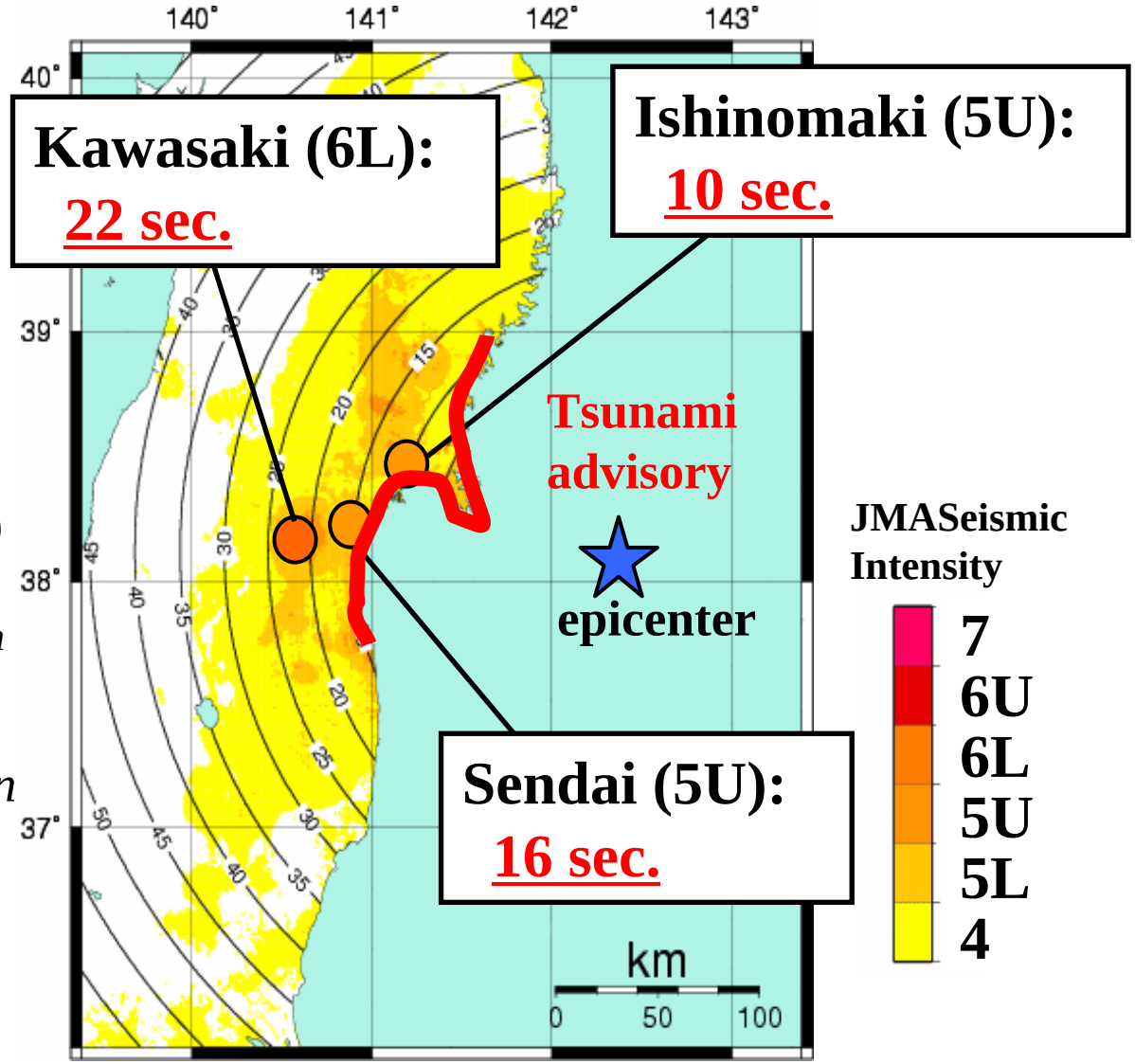


Example
M7.2(August 16, 2005 Off Miyagi Pref.)

11:46:26 Origin Time
11:46:41 First Detection
11:46:45 1st EEW
Hypocenter,Magnitude,and Seismic Intensity
11:46:45 2nd EEW
updated EEW

……..
11:47:51 Final EEW(8th)

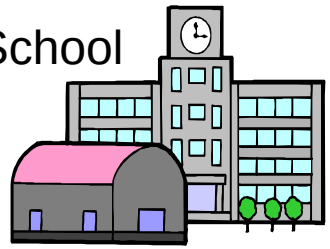
11:48 *Seismic Intensity Information*
11:50 ***Tsunami Advisory***
11:54 *Earthquake Information*
12:12 *13cm tsunami height (at Ayukawa)*
13:15 ***Tsunami Cancellation***



Supporting System for School Children and Teachers to Avoid Earthquake Disasters

Early Warning Information

School

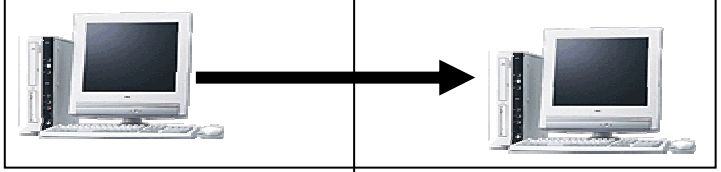


School Room

NIED

Distributing Equipment

Display System



Instruction from Teachers to School Children to Refuge／Practice

Expected Outcome

1. Establishment of Infrastructure to utilize Early Warning Information
2. Security of School Children from Earthquake

Summary

Short-term earthquake prediction is still difficult, but long-term forecast, probabilistic ground-motion prediction, and earthquake early warning has become operational in the last decade.

Hazard assessments (probabilistic and deterministic) for future earthquakes and earthquake risk assessments for mega-cities and critical facilities have been developed.

As the most advanced countries in the region for seismological and disaster prevention, Japan is expected to export such advanced technologies to Asian countries.