Recent destructive earthquakes and international collaboration for seismic hazard assessment

Ken XS Hao (郝　憲生)

Hiroyuki Fujiwara (藤原広行）

National Research Institute for Earth Science and Disaster Prevention

防災科学技術研究所

1976年7月28日唐山

The overlaid bodies beside street even on third –fourth days during hot summer. People can not breath on the air polluted.

I thought about 70% people dead in population over 100 million city.

日中共同研究･唐山地下構造探査

嶋 悦三（代表者）･工藤一嘉･柳沢馬住･瀬尾和大･纐纈一起･佐間野隆憲･星野務･郝憲生　等

廖振鵬（代表者）･袁一凡･王東強･陳慶彬･王自発　等

Bulletin of the Seismological Society of America, Vol. 84, No. 4, pp. 1018–1027, August 1994

Low Damage Anomaly of the 1976 Tangshan Earthquake: an Analysis Based on the Explosion Ground Motions

by Xian-Sheng Hao,[1] Kazuoh Seo, and Takanori Samano

Abstract During the 1976 Tangshan earthquake (M = 7.8), a low earthquake damage anomaly was reported in Yutian area. This low damage area has not been explained satisfactorily because of insufficient ground-motion records in this area. The Japan–China Joint Research Project conducted during 1987 to 1988 provides us with a unique opportunity to investigate this problem. In this study, the ground-motion data generated by explosions are used to explain the origin of the low earthquake damage anomaly. Four recording profiles are arranged for this purpose and each profile contains about 20 stations. The arrival times and waveform characteristics are different along profile B-B′. Wave trains with small amplitudes in the north are related to a thin sedimentary layer and an up-dip underground structure. In the south, the wave trains have longer coda waves that can be linked with a thicker sedimentary layer. Site effects on ground motions can be identified in the west of Yutian based on the small amplitudes observed during three explosions. The distributions of small amplitude also depend on the locations of explosions. This reveals that the path effects also contribute to the seismic ground motion. The regions with small peak velocities are

- 論文を米国地震学会論文集BSSAに取りまとめた。
- 唐山大地震の際の低震度異常の現象に着目し、発破の観測記録を用いた最大振幅の分布と、各地点のスペクトル比の評価を行い、基盤面の形状効果と地盤による増幅効果から成る相乗作用にあることが確認した。

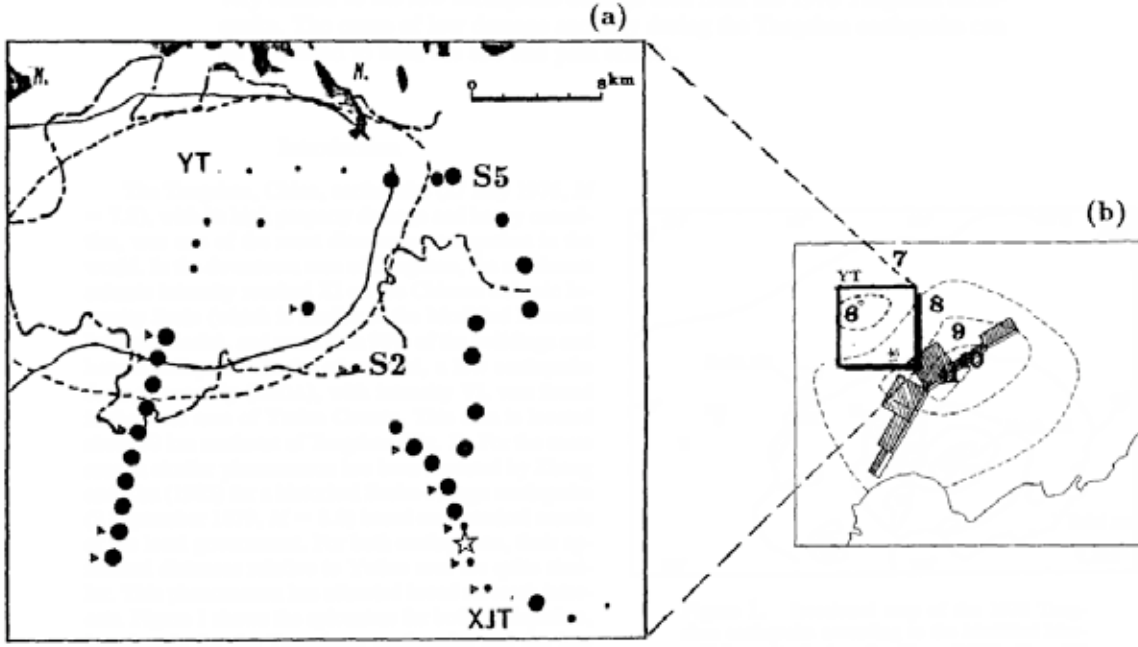


Figure 8. (a) Peak velocity distributions during shot 1. The location of the shot is indicated by a star. (b) LEDA during the 1976 Tangshan earthquake. Numbers denote the intensity. Width of the shaded area denotes the moment release on each subfault (after Xie, 1988).

32years passed since Tanshan EQ, people forgot it totally. . .

Nobody pay attention to Sichuan as like Kobe, M8 hit China again in Southwest.

What we had learnt from the Tangshan EQ ?

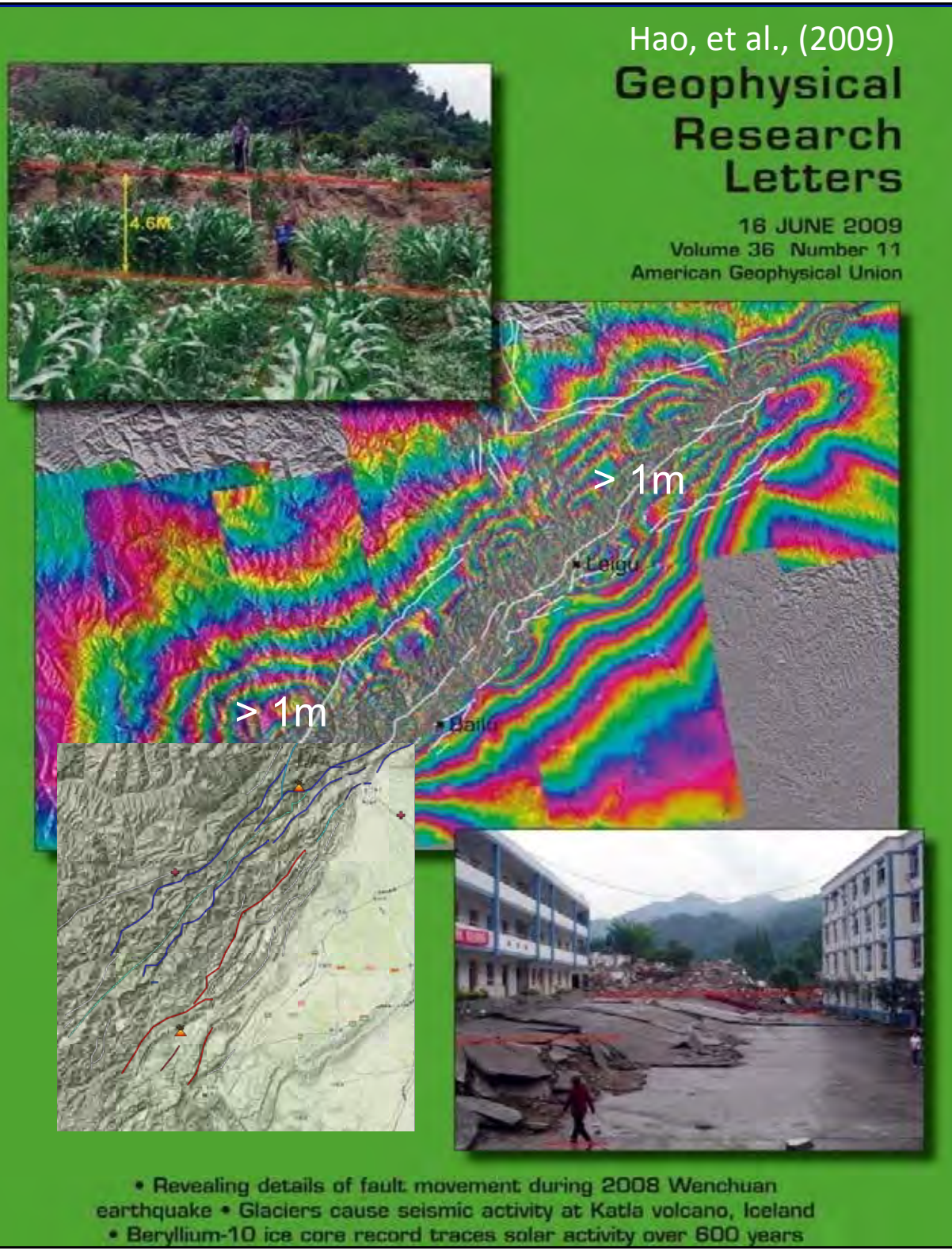
Fortunately, it occurred on the 2:28pm, even that the fatality reach 87,000 !

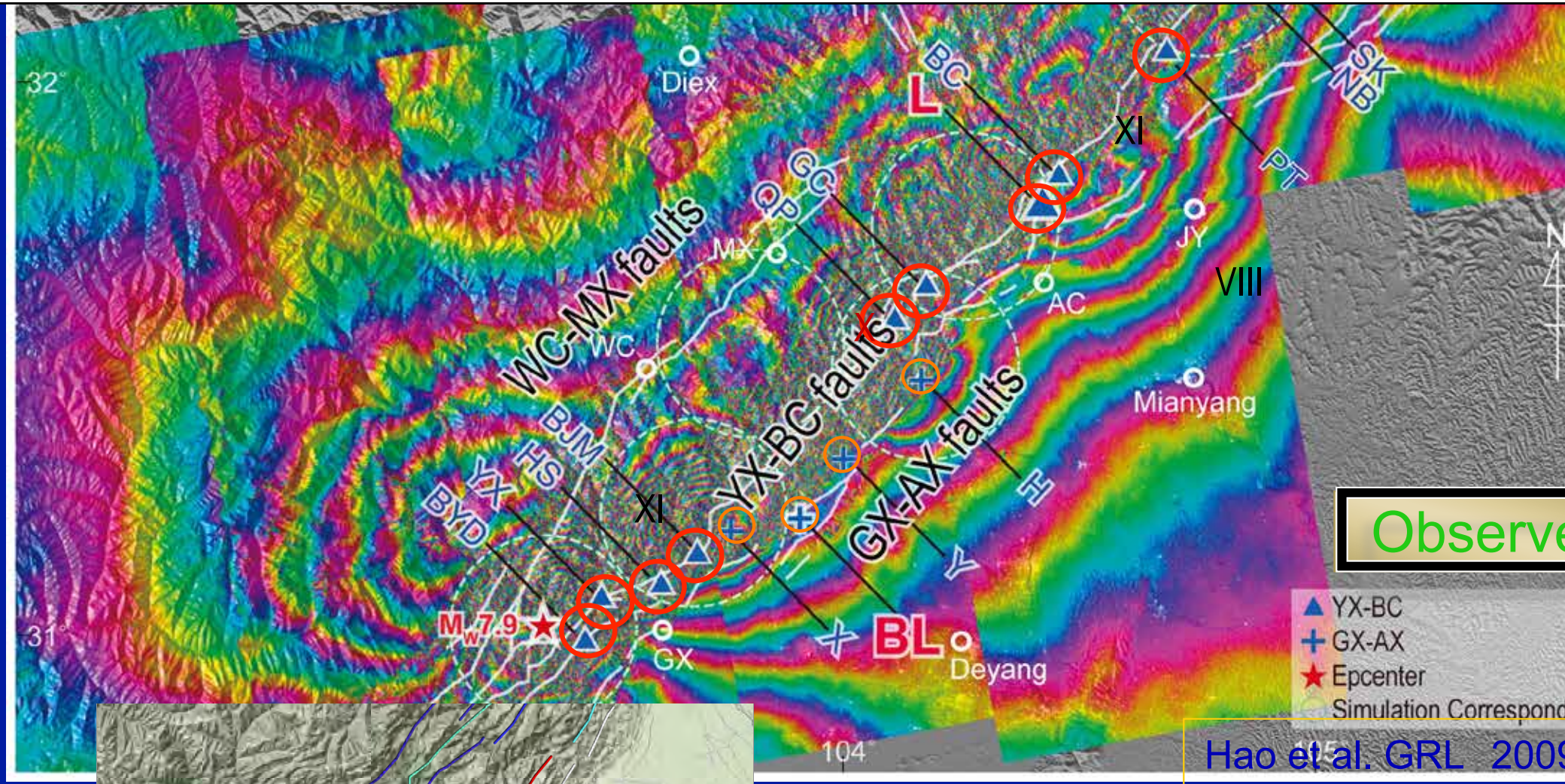
We visited Wenchuan Five time to investigate the coseismic faults and near-fault damage situation. Using the InSAR, first obtained the whole fault rupture image and crustal deformation.

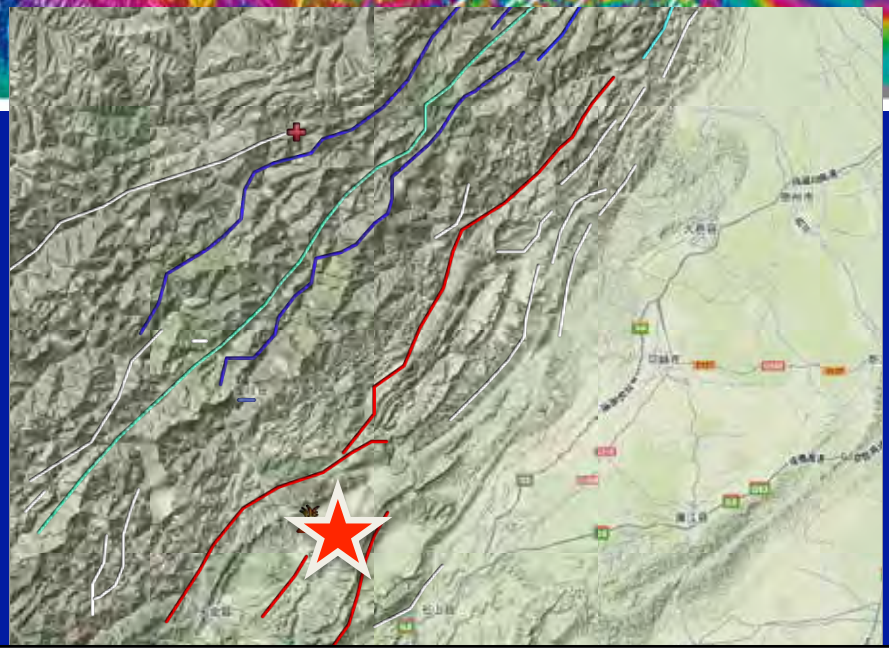
While researcher pay attention to the Northeastern, but M7 occurred at the SW.

That is the reality.

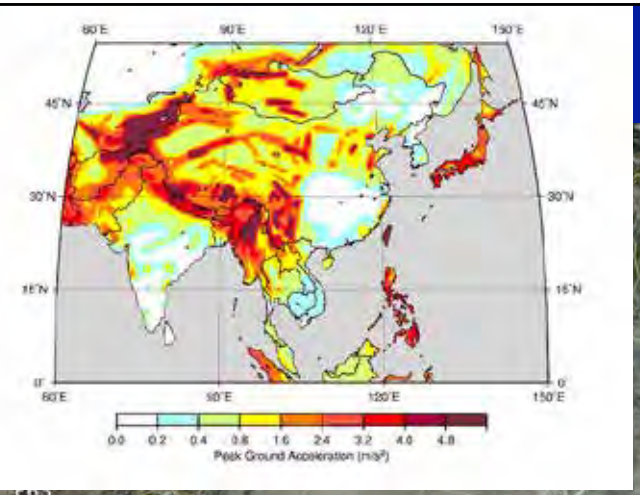
National Research Institute for Earth Science and Disaster Prevention







Hao et al. GRL 2009



Global Seismic Hazard Assessment Program (1999) – Asia

240,000 deaths 19,000 deaths 6,400 dea

1976 Tangshan *M* 7.8

1952 Pyeongyang, *M* 6.2

2011 Tohoku *M* 9.0

Worst-case scenario of Mega-earthquakes recorded

1995 Kobe *M* 7.3

2008 Wenchuan *M* 8.0

2013 YaAn-Lushan *M* 7.0

1999 Chi-Chi *M* 7.6

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US Dept of State Geographer
© 2012 Tele Atlas

Google earth

Major disaster EQs

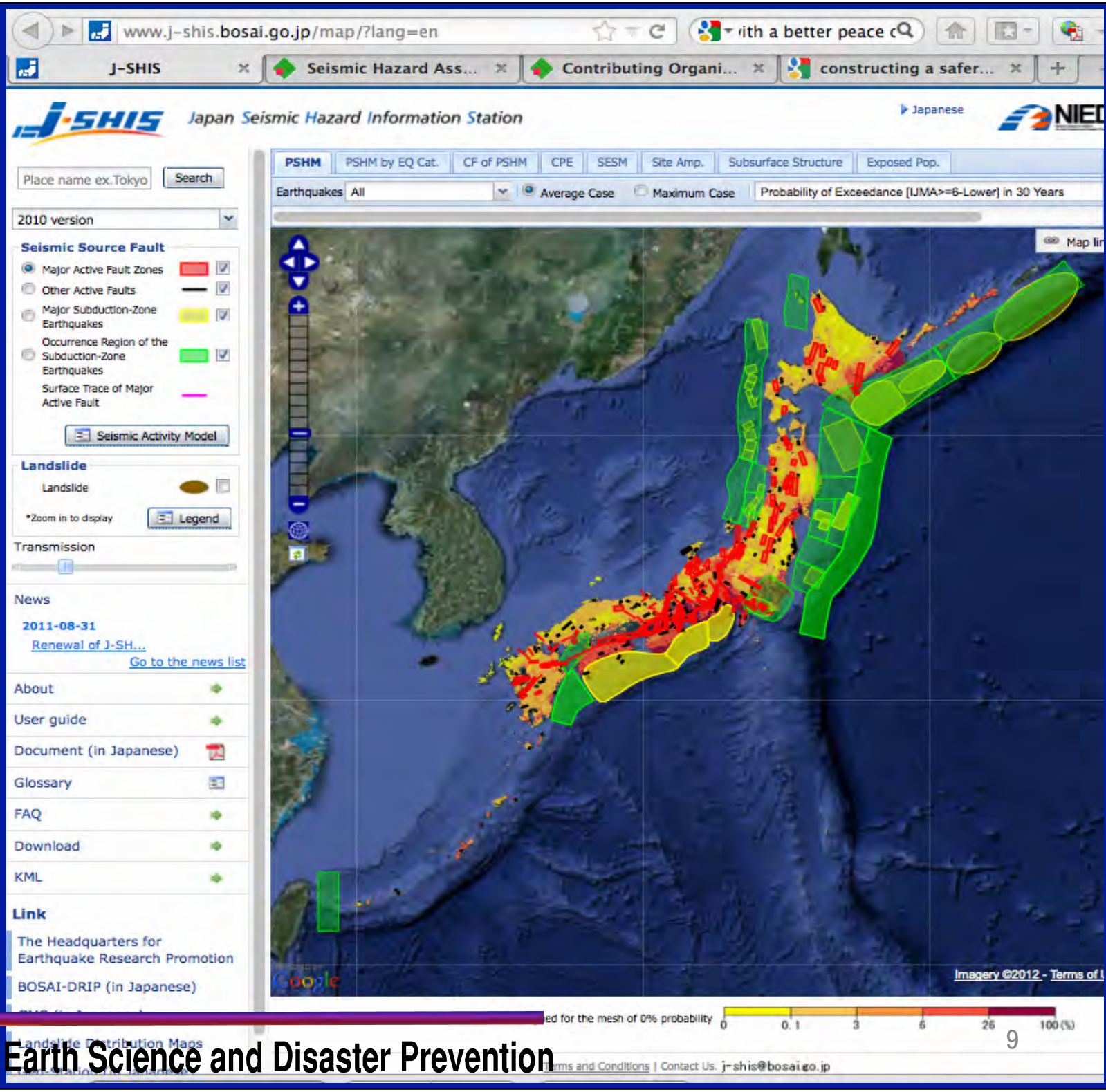
90,000 deaths 200 deaths 2,415 deaths

What lessons we have learnt from the Tohuku M9 earthquake.

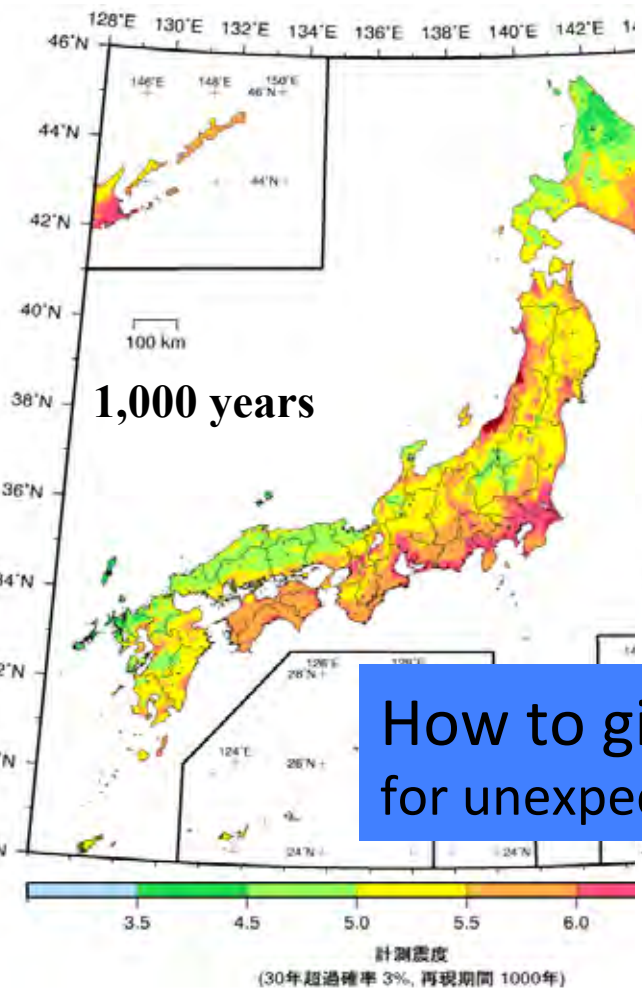
We did give the 90% prob. in PSHA map, but Under-estimated M.

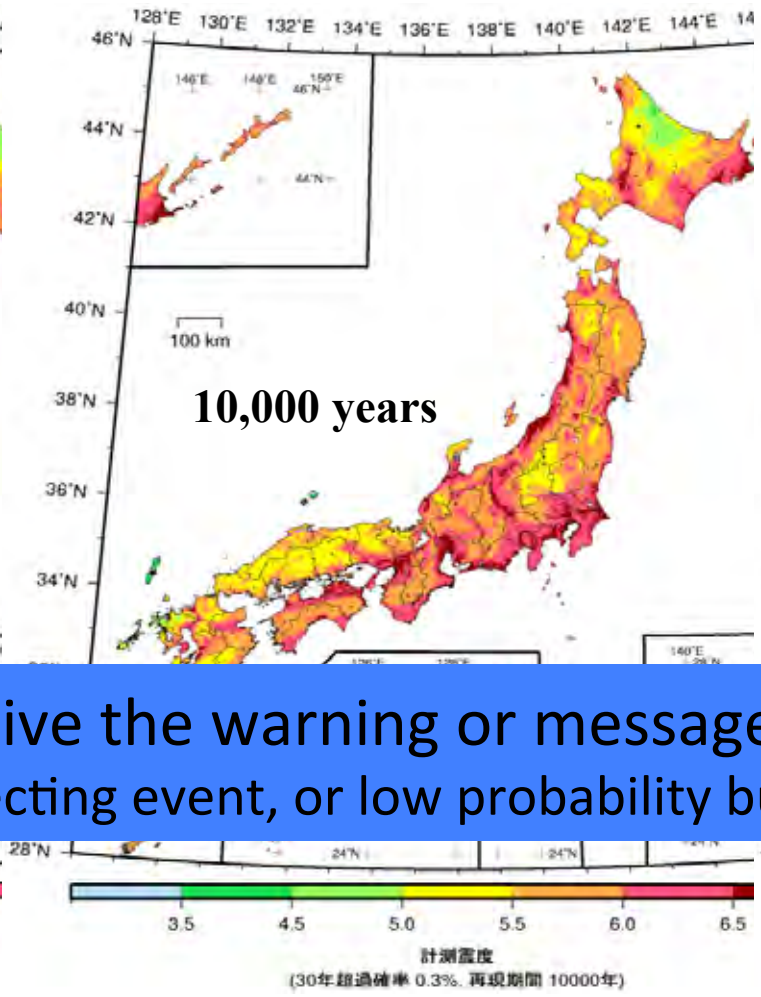
"The borderless world of Science" → enabling knowledge and data exchange each others.

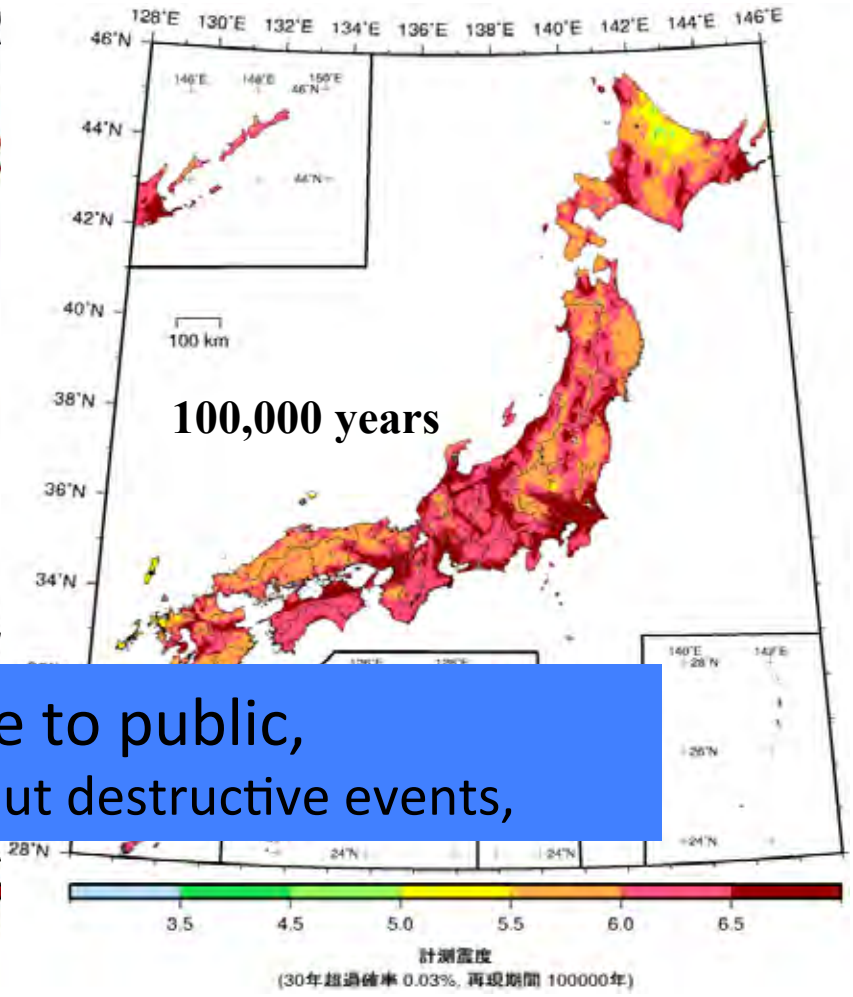
Subduction zones → Crossing border connect the world



Strong-motion maps considering low-probability earthquakes







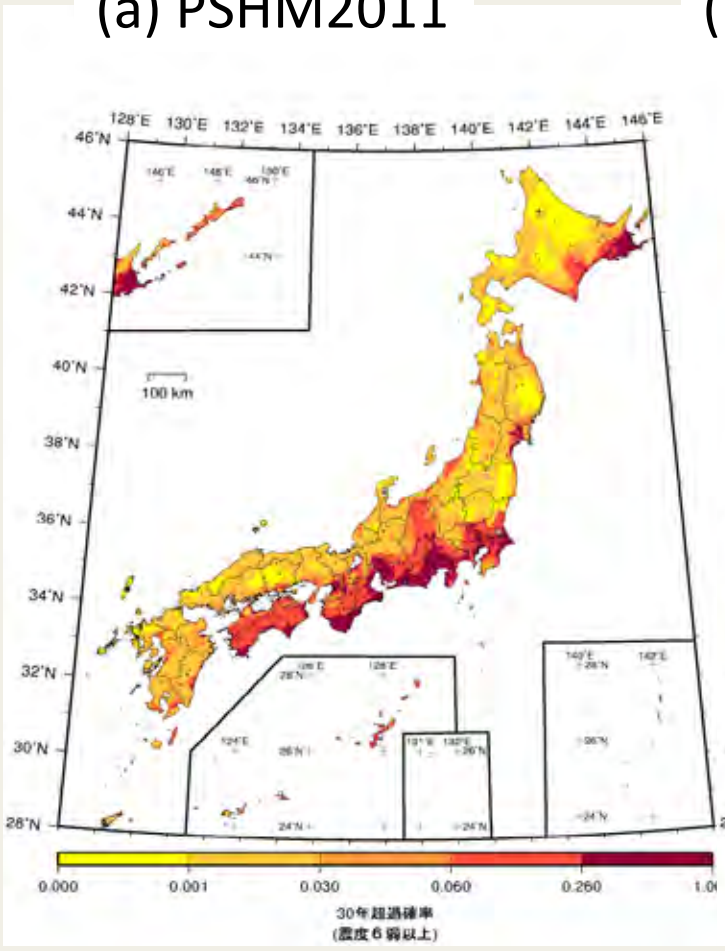
How to give the warning or message to public,
for unexpecting event, or low probability but destructive events,

Major earthquakes on active faults and subduction zone with low-probability, 10^{-4} ~ 10^{-5} .

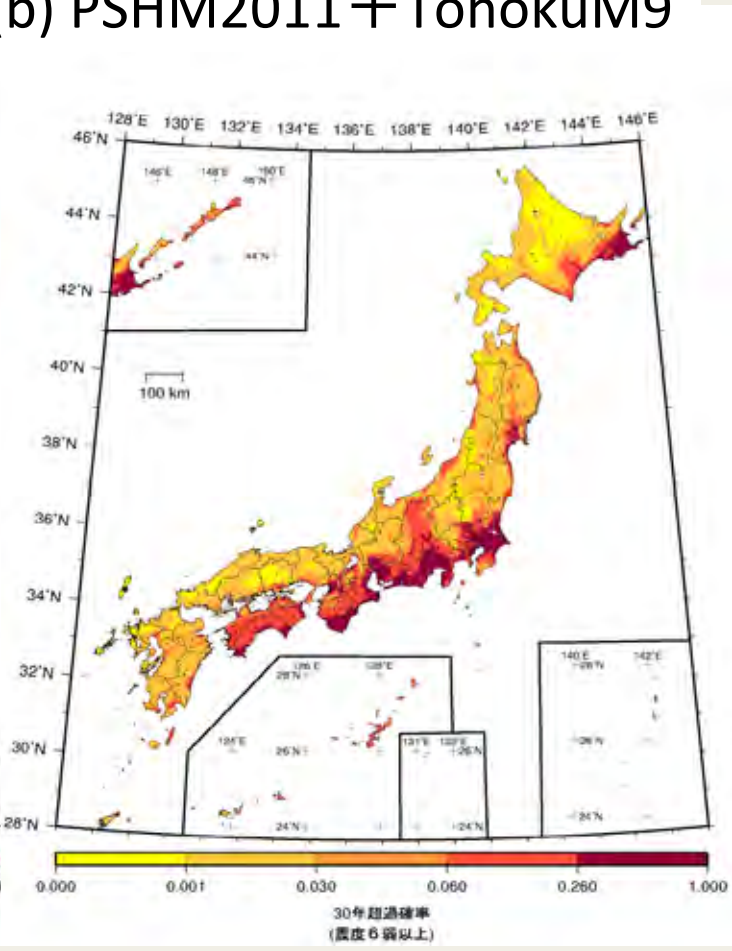
Regarding the PSHA for low probability, at presen it is insufficient to evaluate the uncertainty for low probability of M8-class earthquakes and it is necessary to improve techniques for them.

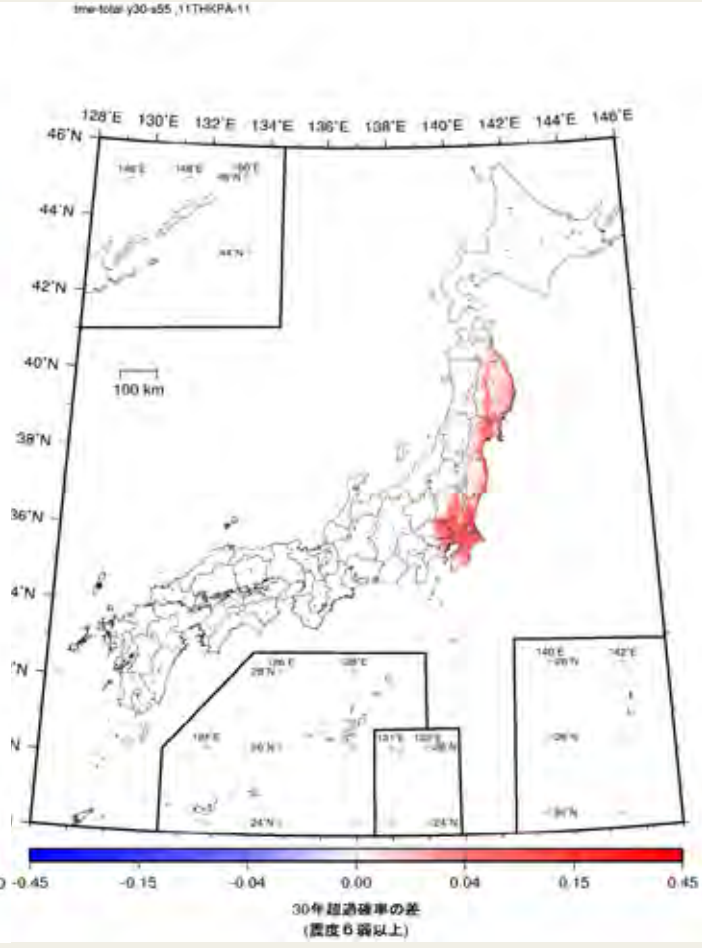
PSHMs considering the Tohoku type earthquake

(a) PSHM2011



(b) PSHM2011＋TohokuM9

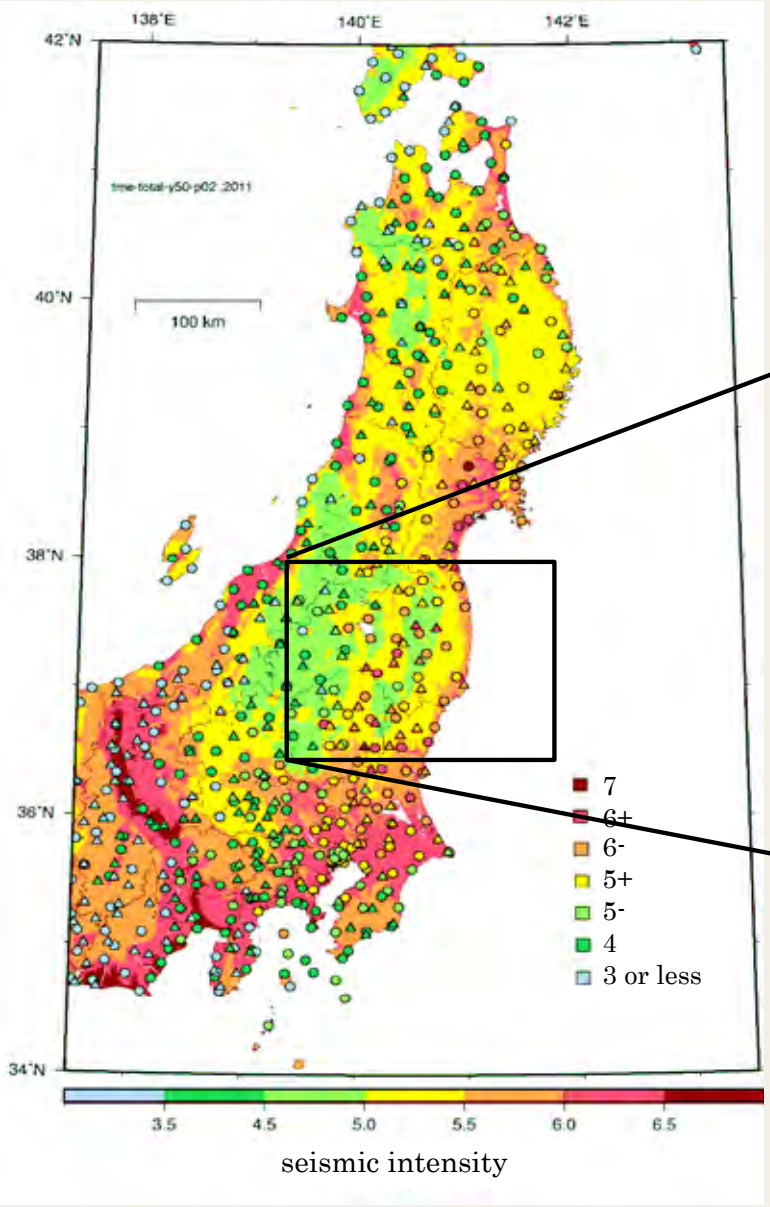


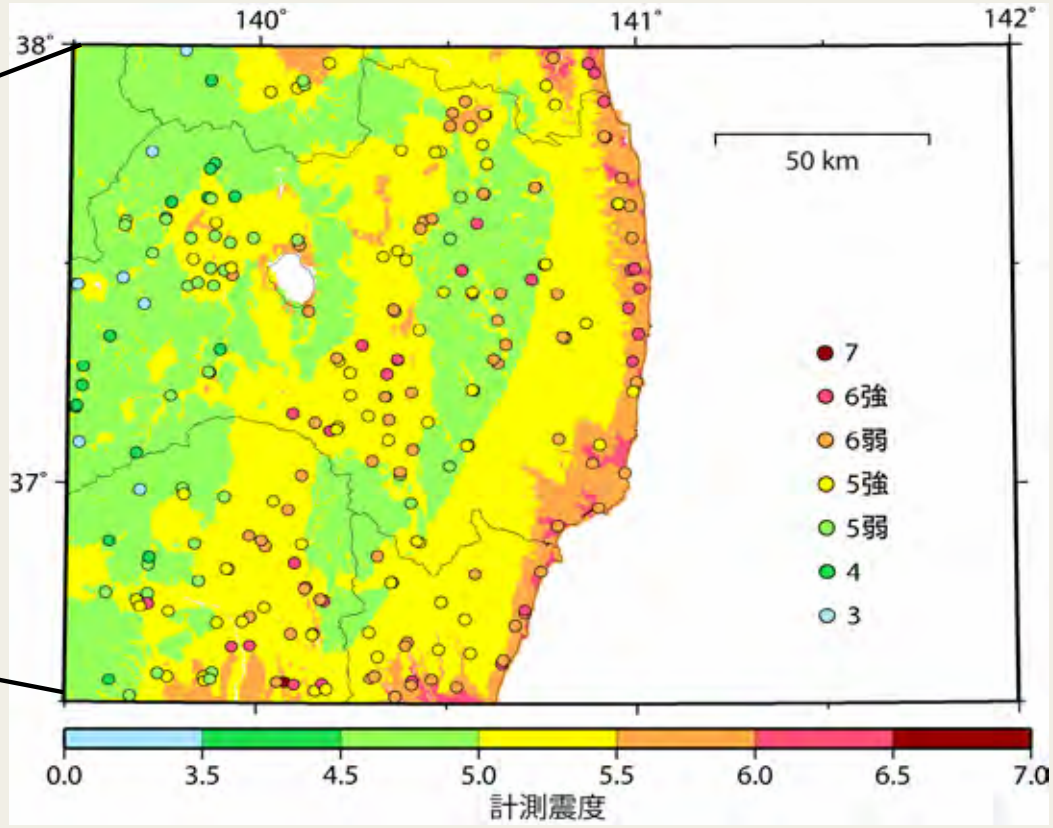


How to reduce the variation of uncertainty

- GMPE => PGA and PGV (now in PSHA, but, large variance in values)
- Requirement of a detail 3D velocity structure for modeling of high frequency.
- Fault Segment, geometry, mechanism
- PSHA => Simulation-based PSHA (Japan) to reduce the variation.
- Examination of recorded and PSHA predicted seismic intensity.

Comparison between the hazard maps and observed strong motions

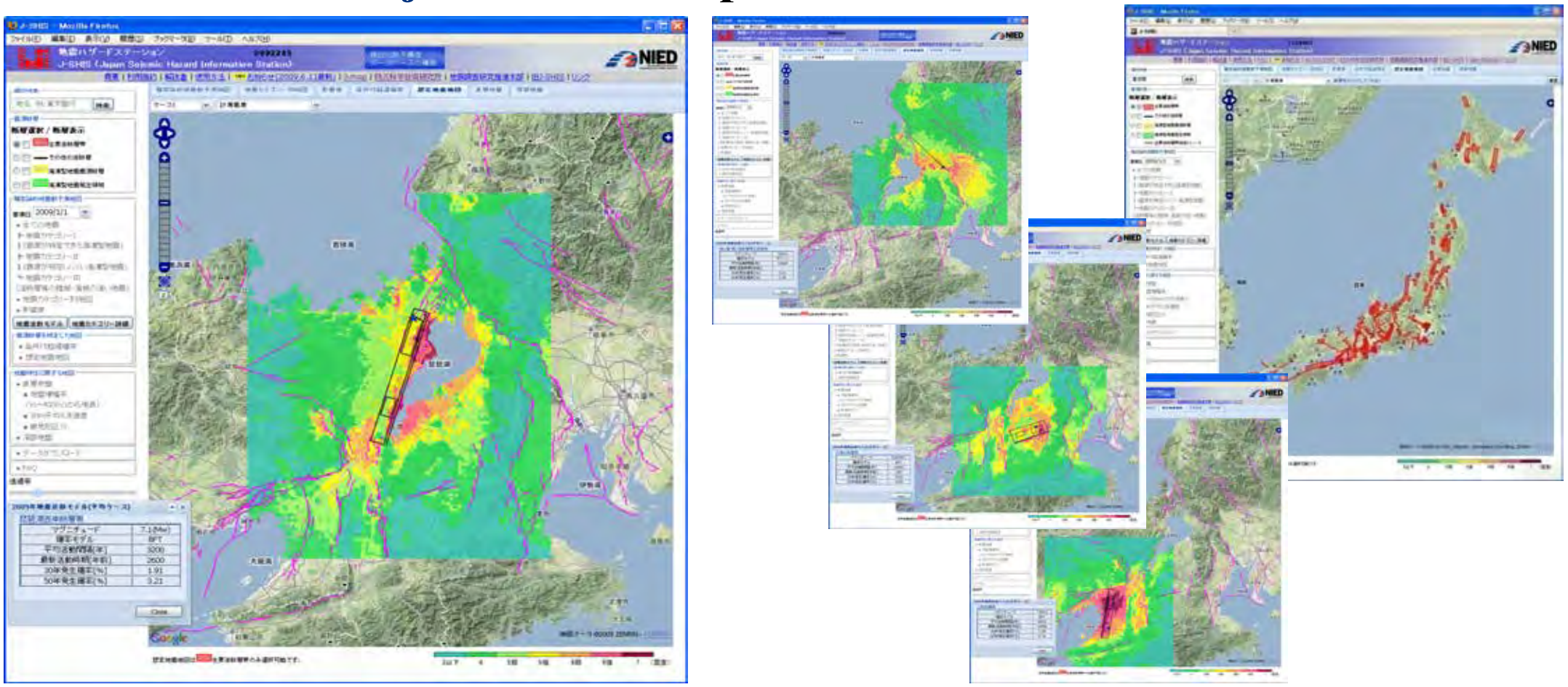




Seismic Intensity with 2% probability of exceedance in 50 year.

Scenario Earthquake Shaking Maps

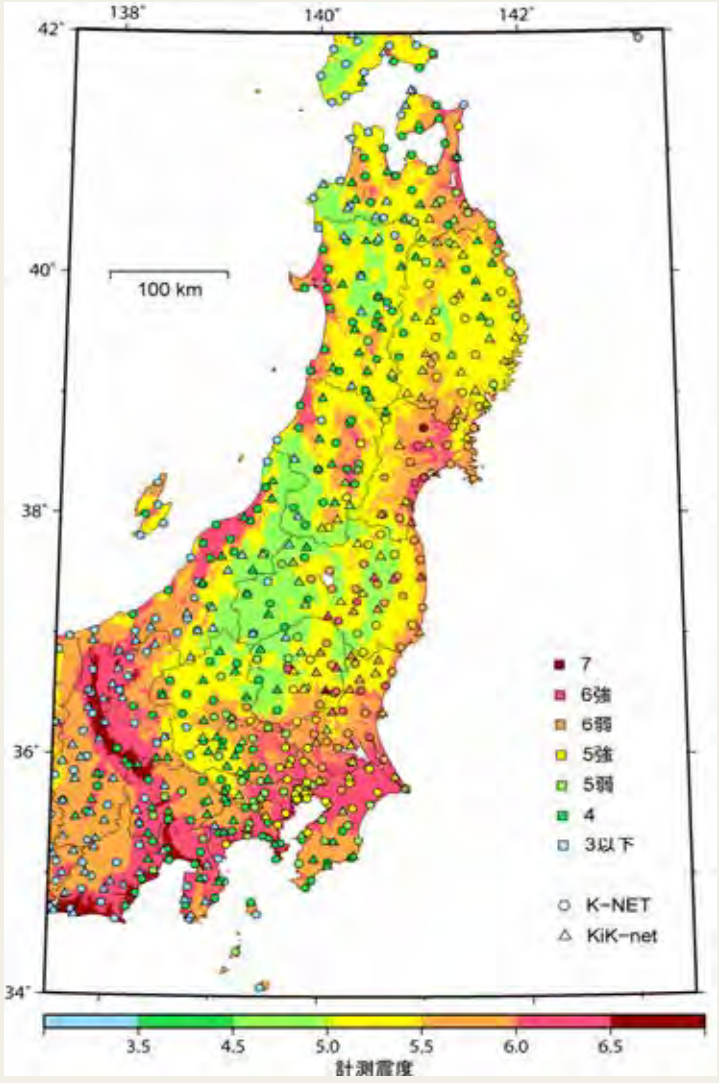
The shaking maps are evaluated for 490 scenario earthquakes of almost all of major faults in Japan.



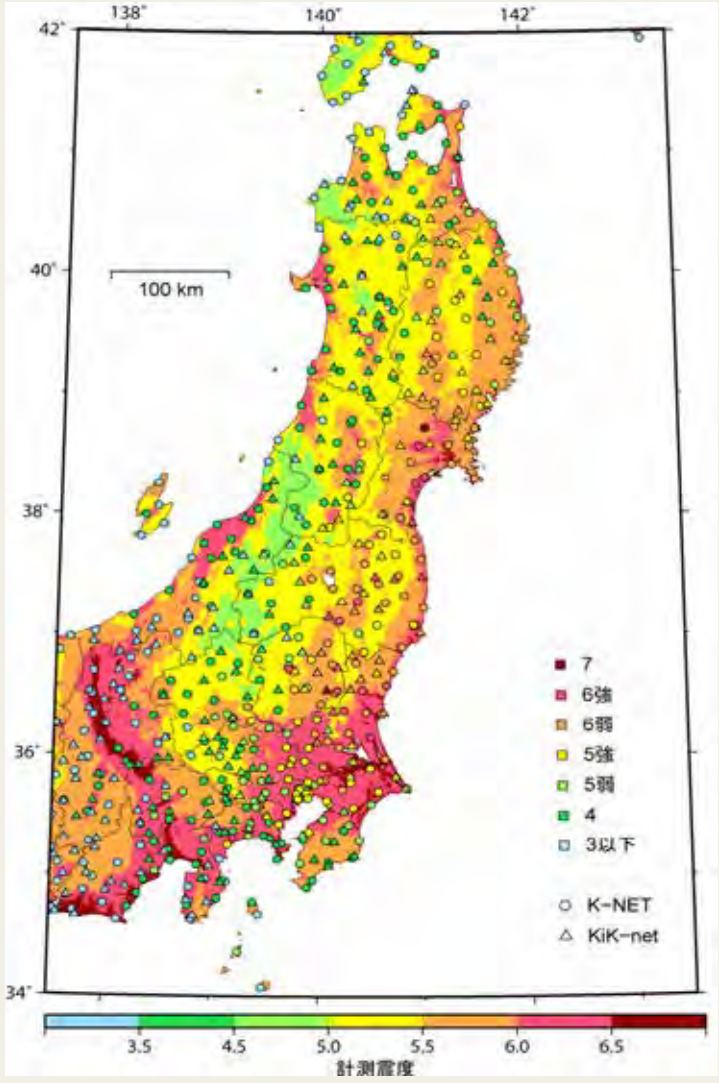
Selection of a specified scenario is essential to make a shaking map. The basic policy of the selection of a scenario earthquake is that we choose the most probable case.

For treatment of uncertainties, we assume several cases of source model and compare the results of them to show deviation of strong-motion evaluation due to uncertainties.

(a) PSHM2011



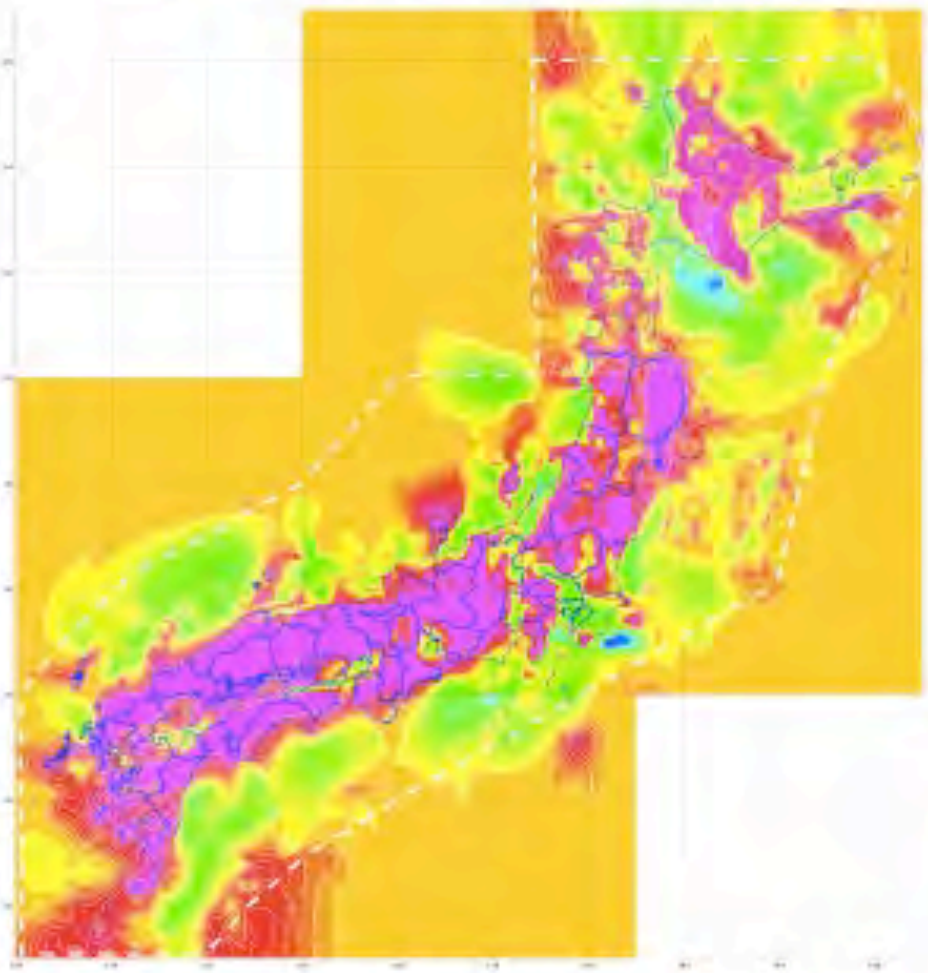
(b) PSHM2011＋TohokuM9



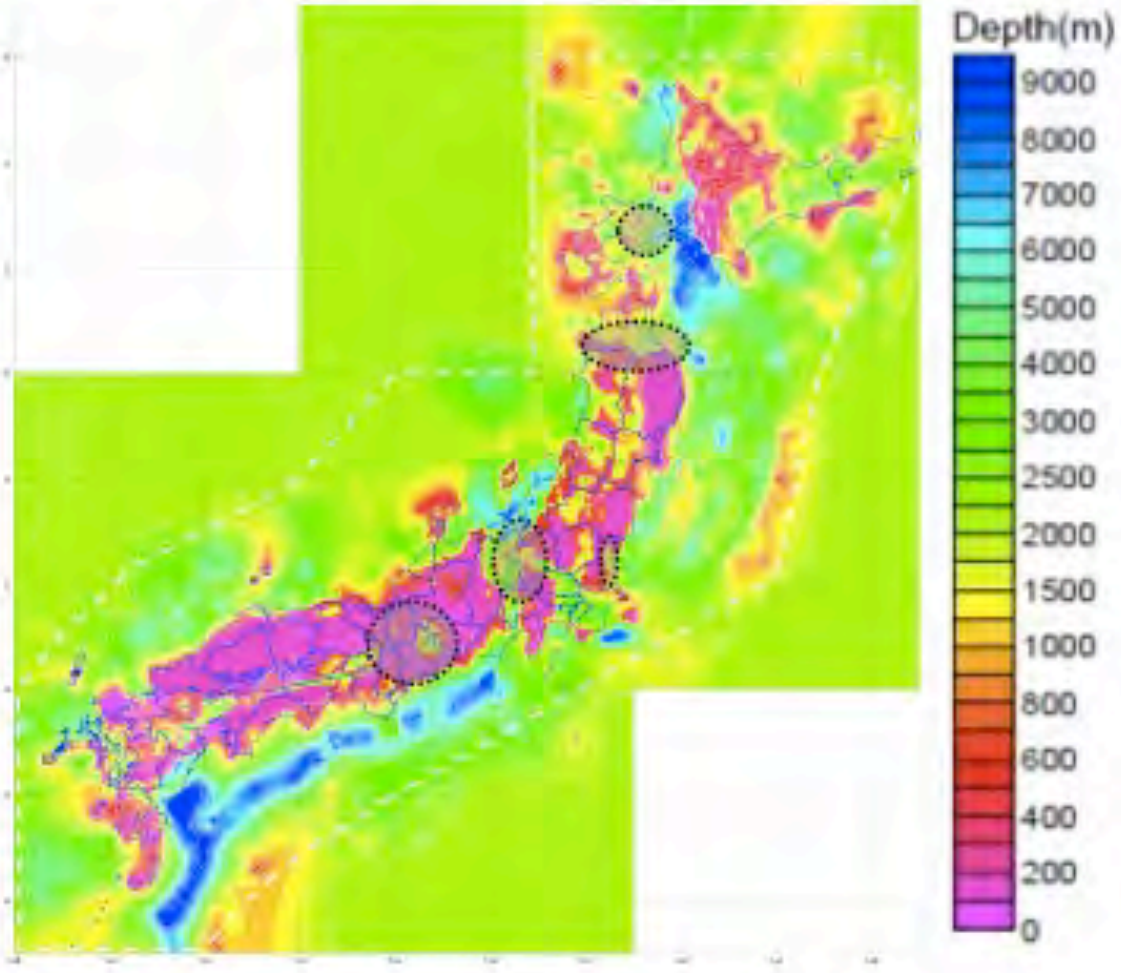
JMA seismic intensity: Exceedance probability of 2% within 50 years

1st-order velocity layered model(1)

Depth distribution of the upper surface of example layers



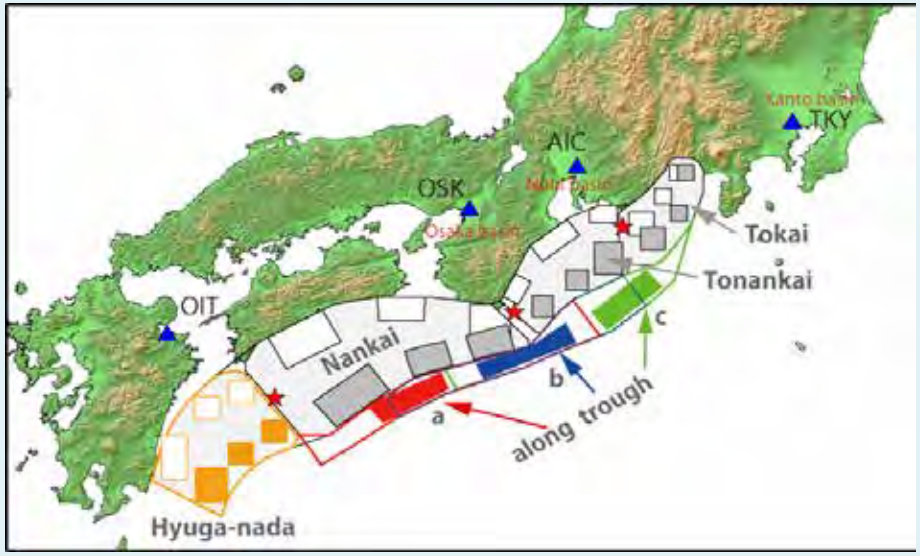
Upper surface of the layer *No.25*
(Vs = 2.1km/s)



Upper surface of the seismic bedrock
(Vs > 3.1km/s)

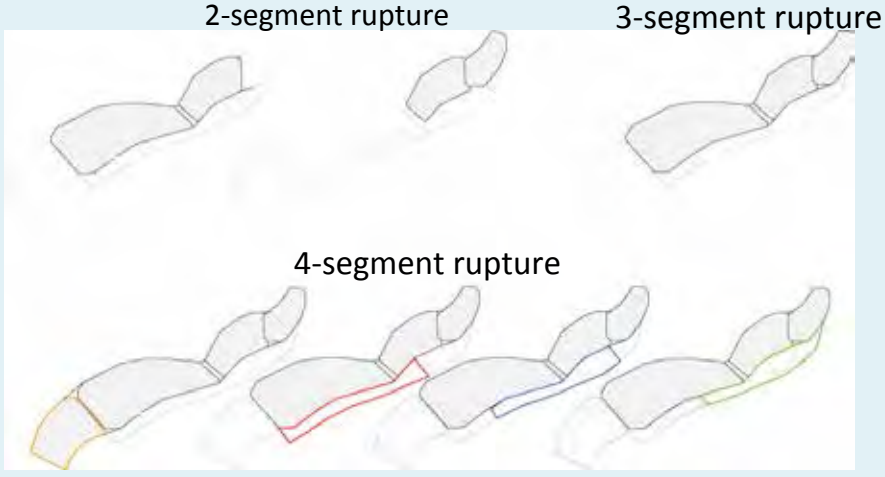
Characterized source model for the Nankai trough earthquakes

(Maeda, 2012)



- Source areas (14 cases x 3)
  - ◆ Single-segment earthquake
    - Nankai (ANNKI: Mw 8.5),
    - Tonankai (ATNKI: Mw 8.2),
    - Tokai (ATOKI: Mw 8.0),
    - Hyuga-nada (AHGND: Mw 8.3),
    - and along the trough (ATRGH: Mw 8.1) 3 cases (a, b, c).
      - 36 hours/ 1 scenario
      - 60000 steps (120 Hz)
      - Itanium 1.66GHz×256Core
      - Memory 130 GB
  - ◆ Multi-segment rupture simultaneously
    - 2-segment rupture
      - Nankai + Tonankai (ANNI1: Mw 8.7)
      - Tonankai + Tokai (ANNI2: Mw 8.4)
    - 3-segment rupture
      - Nankai + Tonankai + Tokai (ANNI3: Mw 8.8)
    - 4-segment rupture
      - 3-segment + along the trough (ANNI4: Mw 8.9)
      - 3-segment + Hyuga-nada (ANNI5: Mw 8.9)
  - Seismic moment are calculated using scaling model

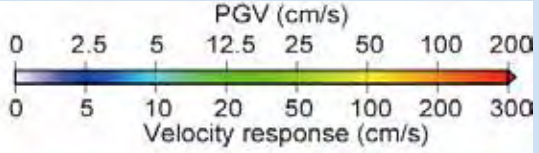
Multi-segment earthquakes

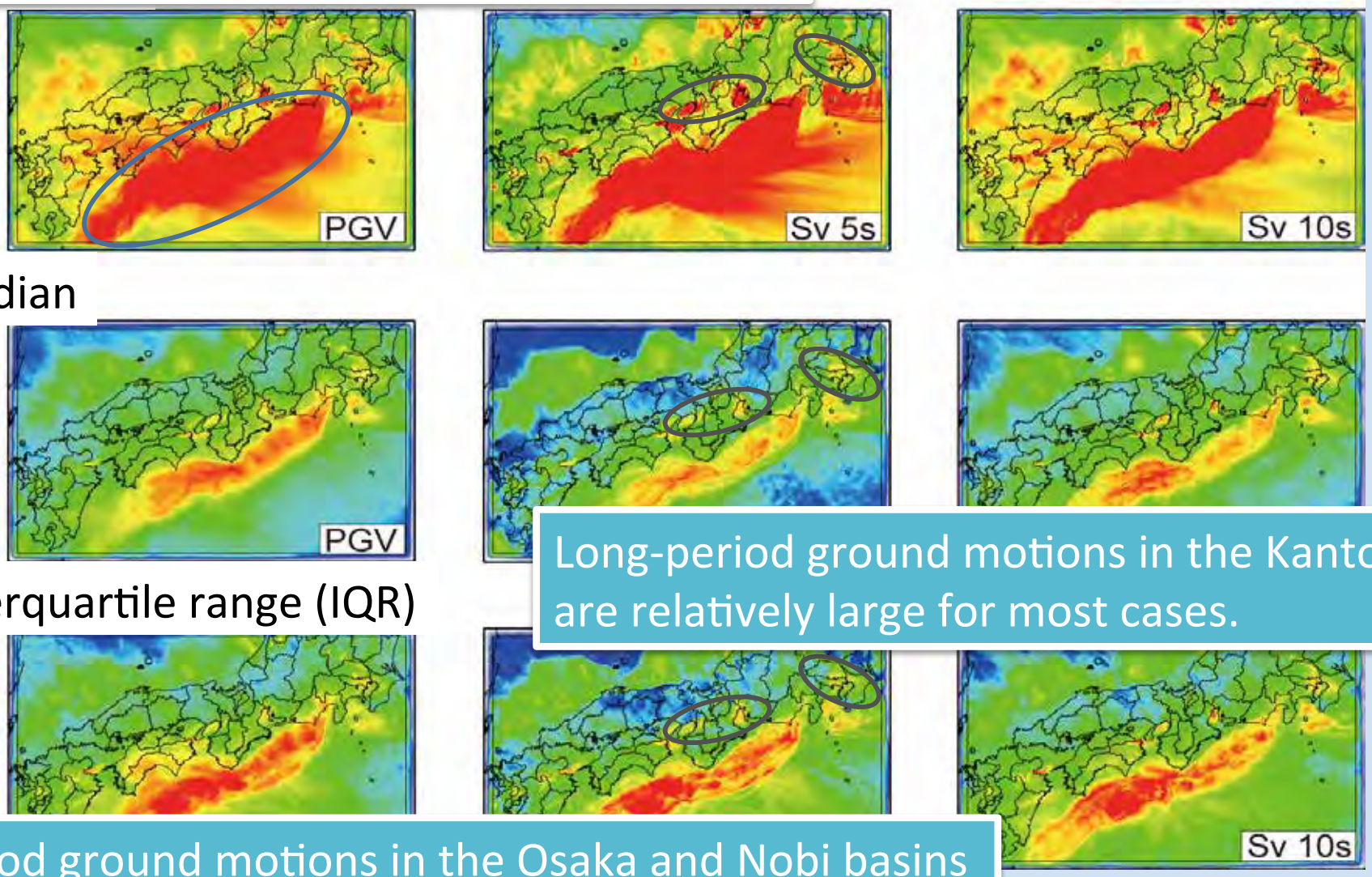


(Maeda, 2012)

Maps of Peak ground velocity (PGV) and Velocity response (Sv)

the sedimentary wedge greatly contributes to the generation of long-period ground motions





Long-period ground motions in the Kanto basin are relatively large for most cases.

Long-period ground motions in the Osaka and Nobi basins are greatly influenced by a few specific scenarios.

www.j-shis.bosai.go.jp/intl/cjk

International Cooperation →
Trilateral cooperative program
enabling knowledge data exchange

Approved and supported b
counties

→ SHA
for Next Generation PSH

J-SHIS | Seismic Hazard Asses... | Seismic Hazard Asses...

SEISMIC HAZARD ASSESSMENT FOR THE NEXT GENERATION MAP

Japan-China-Korea Cooperative Research Projects supported by JST-MOST-NRF

Over 90% of natural disasters have occurred in Asia and millions of people have lost their lives and homes by the recent earthquakes, tsunami and natural disasters. Earthquake prediction is not available in short-term, however, Probabilistic Seismic Hazard Assessment (PSHA)

Activities

1st Annual meeting
Hosted by HIT in Harbin, China on Nov 25-30, 2011.

2nd Annual meeting
Will be hosted by KIGAM in Korea, 2012.

3rd Annual meeting
Will be hosted by NIED in Japan, 2013.

Links

Japan Seismic Hazard Information Station J-SHIS

SEISMIC HAZARD ASSESSMENT FOR THE NEXT GENERATION MAP

Japan-China-Korea Cooperative Research Projects supported by JST-MOST-NRF

Photos





Constructing a safe and secure society

The 2nd Annual Meeting

The 2nd Annual Meeting of the Strategic Cooperative Program:
Seismic Hazard Assessment for the Next Generation Map, October 29-31, 2012, Jeju, Korea

Second annual meeting of the strategic project was hosted in Jeju Korea Oct 29-31, 2012, where in parallel with the East-Asia Earthquake Seminar 2012. We were so pleased to have special lectures from Professors Hiroo Kanamori,

Photos




NIED KIGAM

ting | The 3rd Annual Meeting | Links

Nationa

www.j-shis.bosai.go.jp/intl/tem

International Cooperation →
with TEM
enabling knowledge data exchange

National Research Institu

Probabilistic Seismic Hazard Assessment Issues in the island arc of Japan and Taiwan

Supported by the National Research Institute for Earth Science and Disaster Prevention, Japan (NIED) and
The Committee of Taiwan Earthquake Model (TEM)

Taiwan and Japan are located along stretch island arcs where four Plates of Pacific, Philippines, Eurasia, and North-American have complex conjunctions of subducting and overriding each other. Both countries have the highest level of seismic activities and suffered the destructive earthquakes recently. The 1999 Chi-Chi, Taiwan, Great Earthquake (Mw7.6) caused 2,415 deaths, 29 missing, and 11,305 severely wounded, with 51,711 buildings completely destroyed, 53,768 buildings severely damaged. The 2011 Great East Japan Earthquake (Mw9.0) caused 15,861 deaths, 6,107 injured, and 3,018 people missing across twenty prefectures, as well as 129,225 buildings totally collapsed, with a further 254,204 buildings 'half

Activities

The 1st Workshop
Hosted by TEM in NCU Taiwan on June 4-6, 2012.

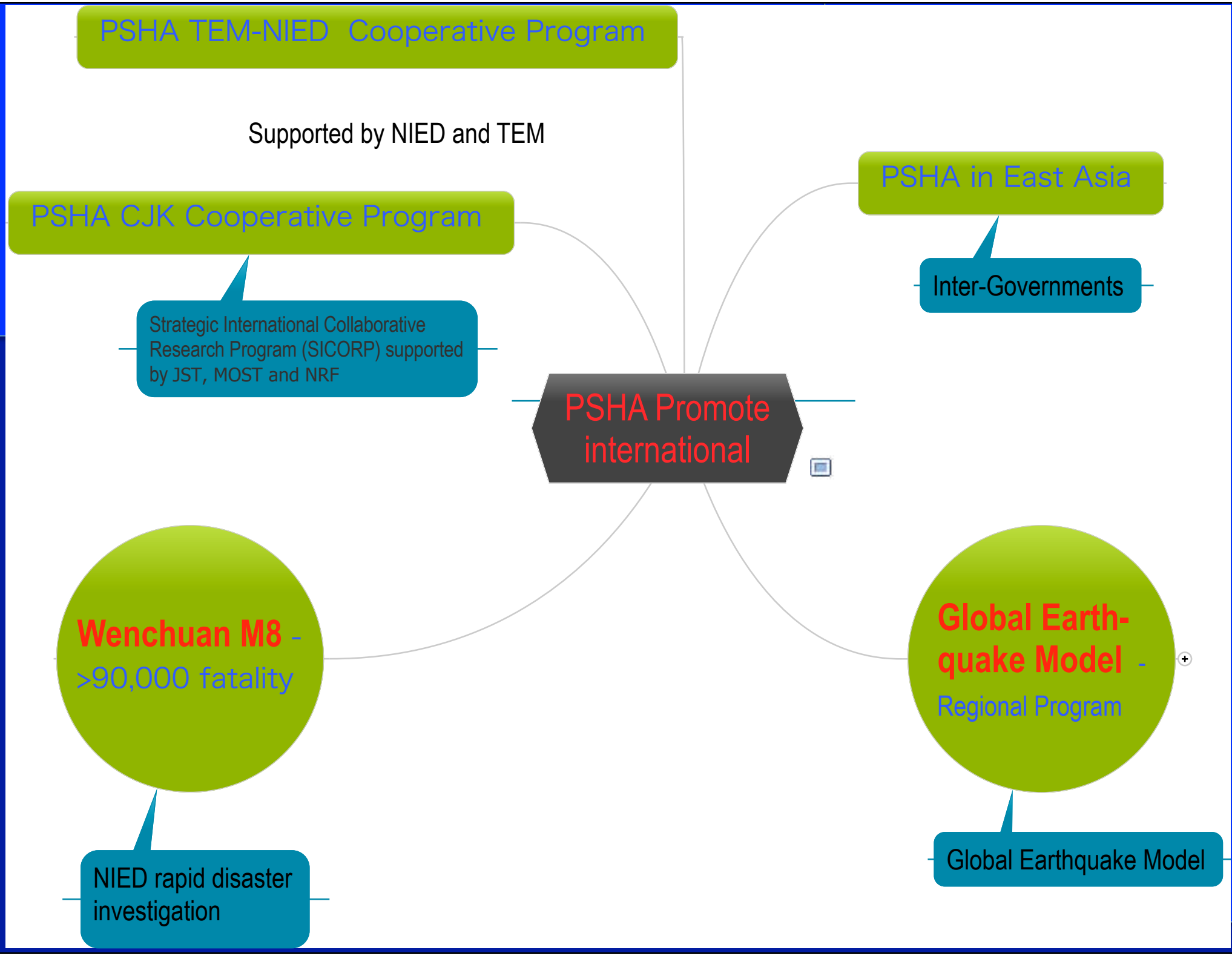
The 2nd Workshop
Will be hosted by NIED in Japan, 2013.

Probabilistic Seismic Hazard Assessment Issues in the island arc of Japan and Taiwan

Supported by the National Research Institute for Earth Science and Disaster Prevention, Japan (NIED) and
The Committee of Taiwan Earthquake Model (TEM)

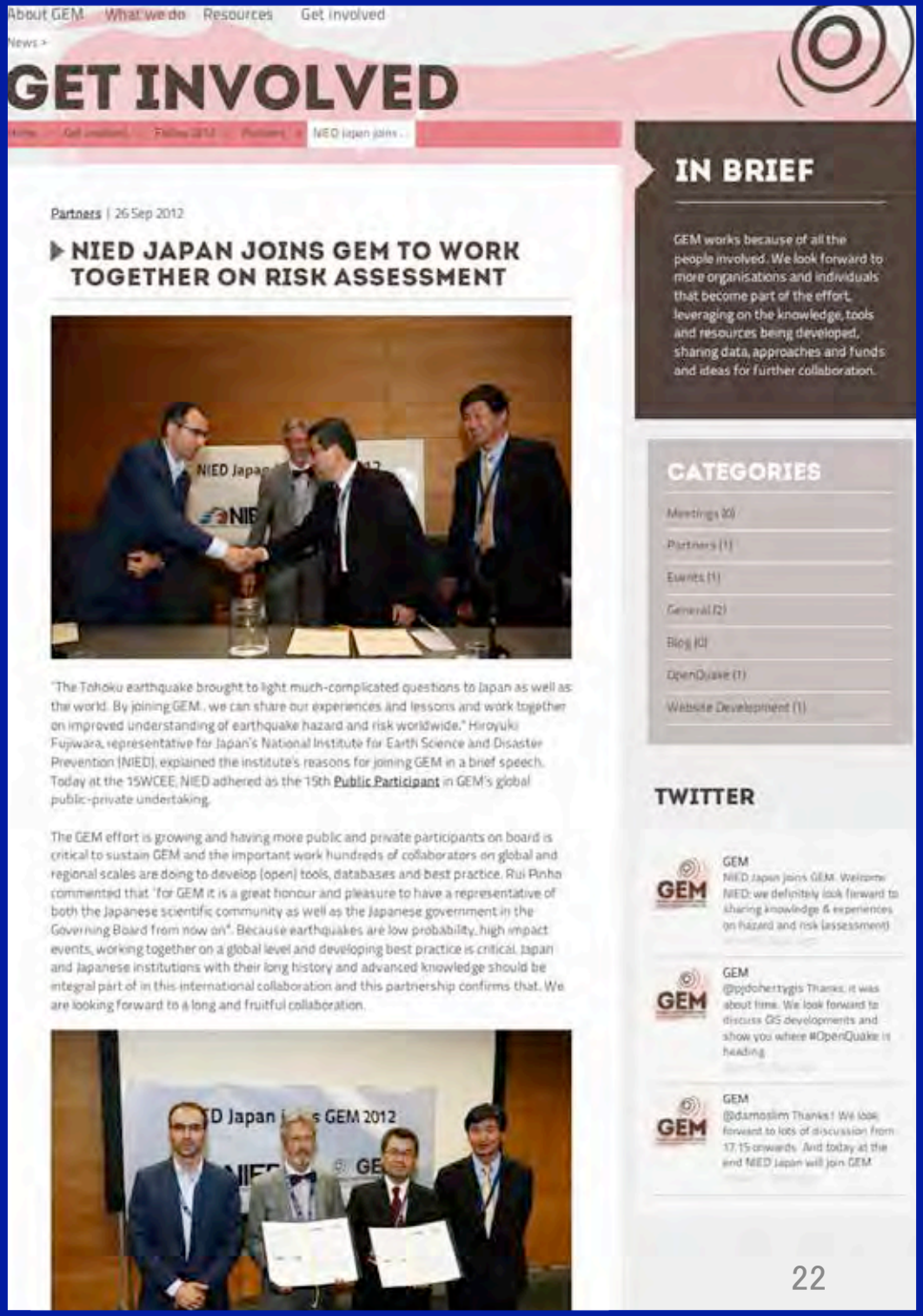
The first Workshop

Audience on the meeting at National Central University and professionals from Japan at NCREE, Taiwan


PSHA TEM-NIED Cooperative Program
Supported by NIED and TEM
PSHA CJK Cooperative Program
Strategic International Collaborative Research Program (SICORP) supported by JST, MOST and NRF
PSHA in East Asia
Inter-Governments
PSHA Promote international
Wenchuan M8 - >90,000 fatality
NIED rapid disaster investigation
Global Earth-quake Model - Regional Program
Global Earthquake Model

- The Tohoku earthquake brought to light much-complicated questions to Japan as well as the world. By joining GEM.. we can share our experiences and lessons and work together on improved understanding of earthquake hazard and risk worldwide.

- “for GEM it is a great honor and pleasure to have a representative of both the Japanese scientific community as well as the Japanese government in the Governing Board from now on”.



www.j-shis.bosai.go.jp/intl

International Cooperation
→ with GEM
enabling knowledge data exchange

Global Earthquake Model Foundation

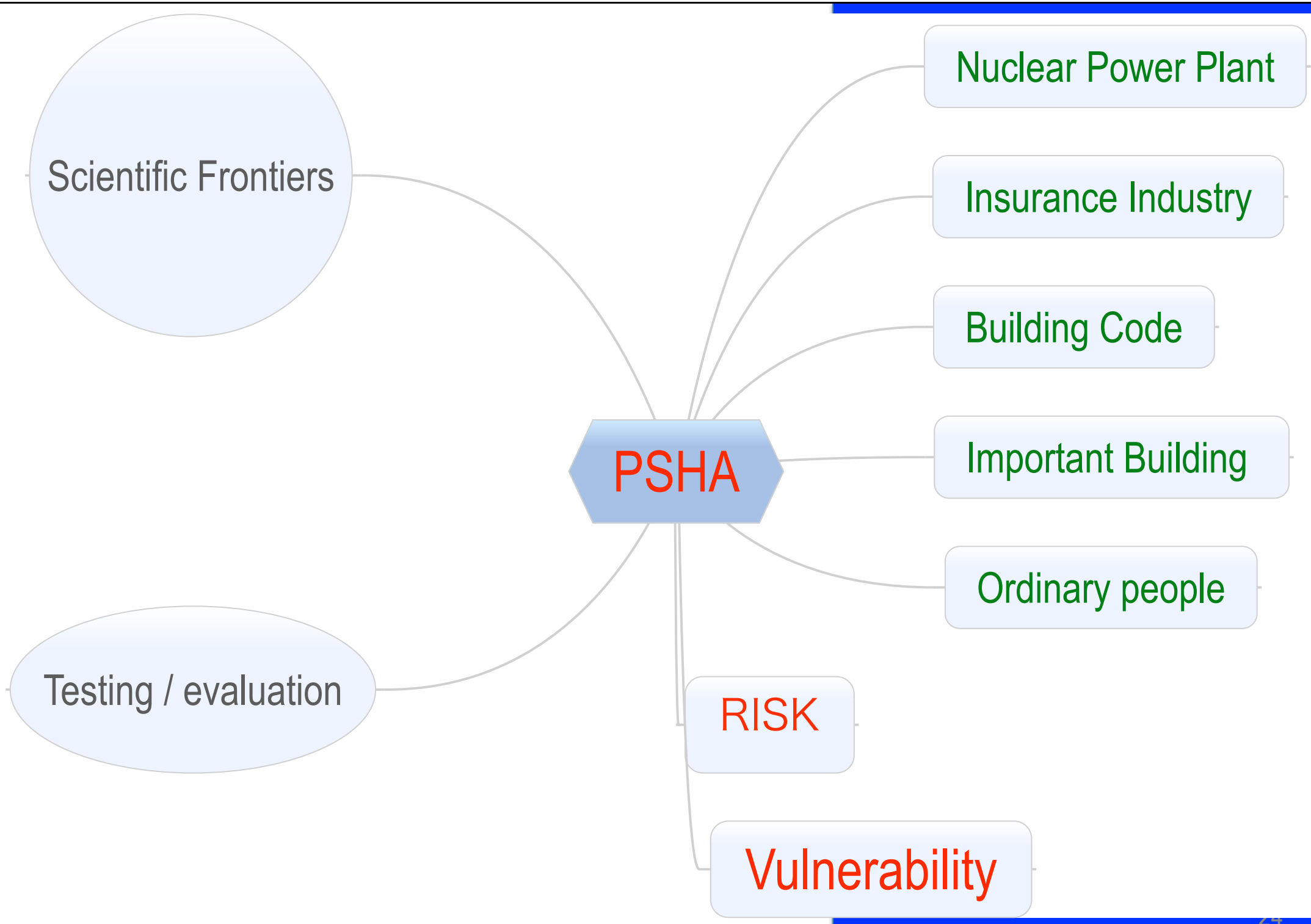
防災科研が国際NPO法人GEMに参画

国際的な地震ハザード評価・リスク評価手法開発の本格化

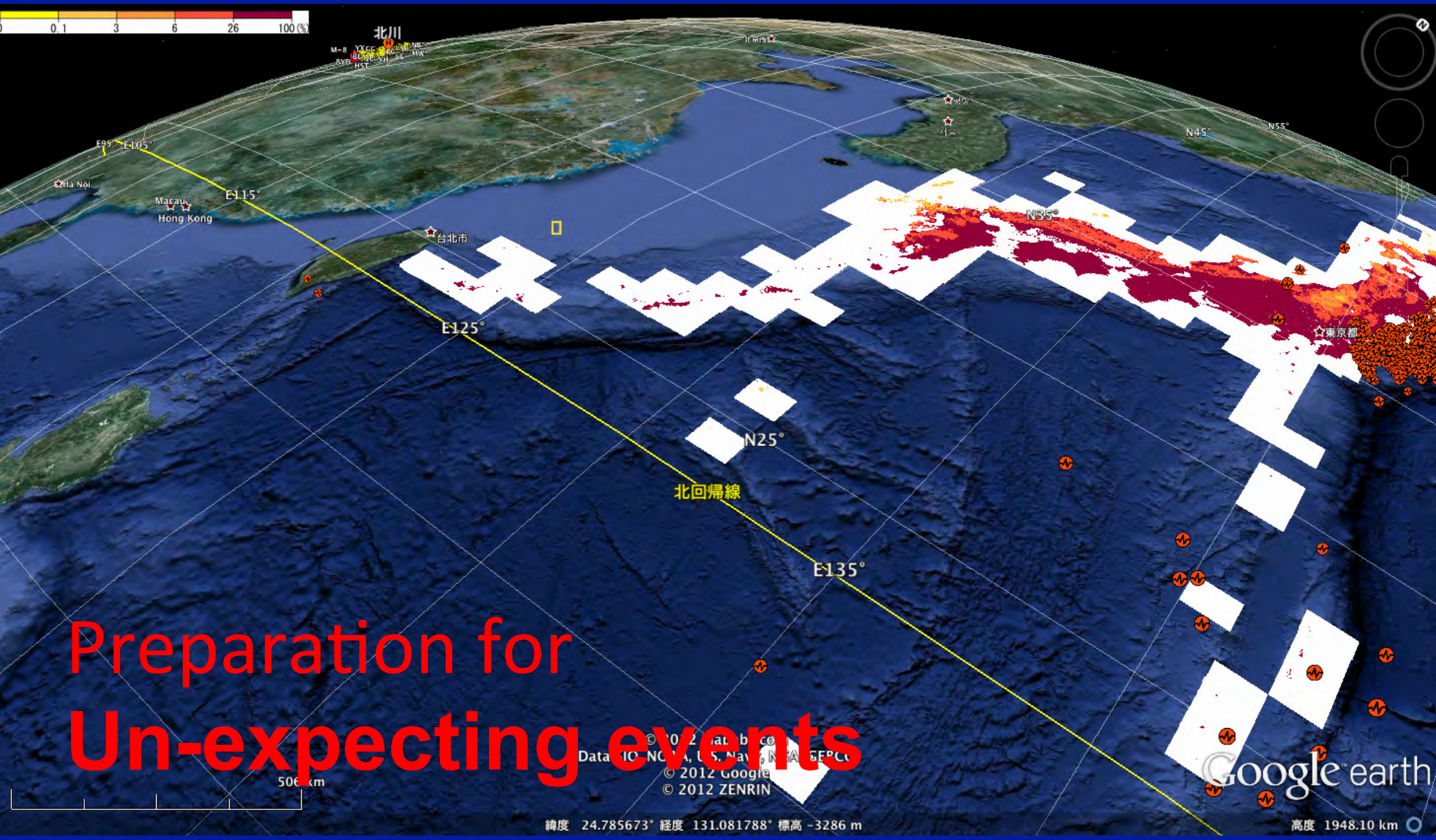
防災科学技術研究所（以下、防災科研）は、国際的な地震ハザード評価、リスク評価手法の開発や情報提供を行うGlobal Earthquake Model Foundation（以下GEM）の運営委員会メンバーとして参画しました。防災科研は政府に対し、我が国の地震ハザード評価手法などの開発および情報提供等を行っていますが、GEMがその開発技術を高く評価し、運営委員会メンバーとしての参加を要請されました。

岡田義光理事長と GEM 側のサインが記された共同締結文書を持つ、（左から）Rui Pinho、Anselm Smolka（GEM）と藤原広行、はお憲生（防災科研）。

NIED 独立行政法人 防災科学技術研究所
〒305-0006 茨城県つくば市天王台3-1 Tel 029-851-1611


Scientific Frontiers
Testing / evaluation
PSHA
Nuclear Power Plant
Insurance Industry
Building Code
Important Building
Ordinary people
RISK
Vulnerability

East Asia Region



Preparation for
Un-expecting events

Thank you for your attention

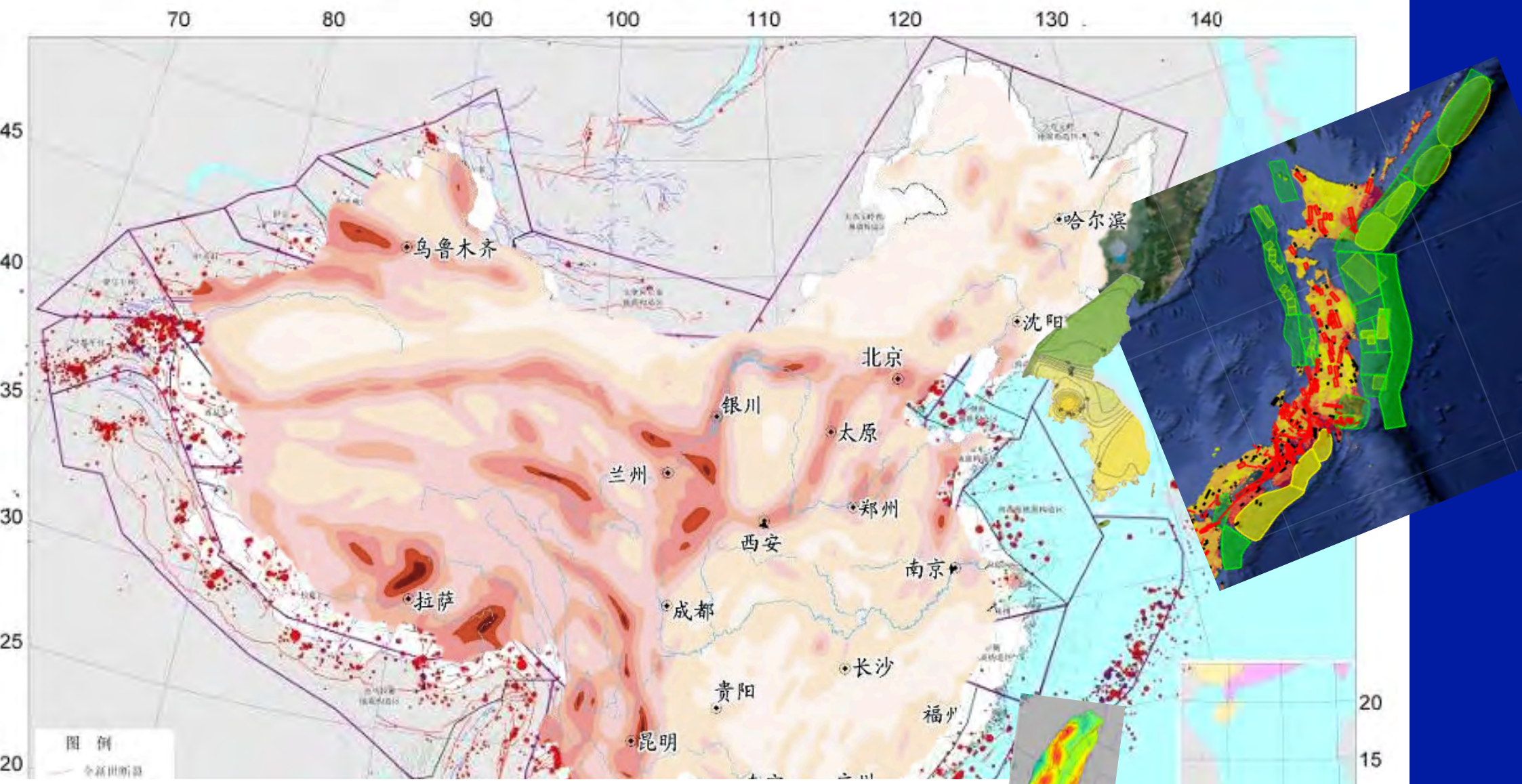
The Joint Symposium of Seismic Hazard Assessment

June 17-19, Sendai Japan

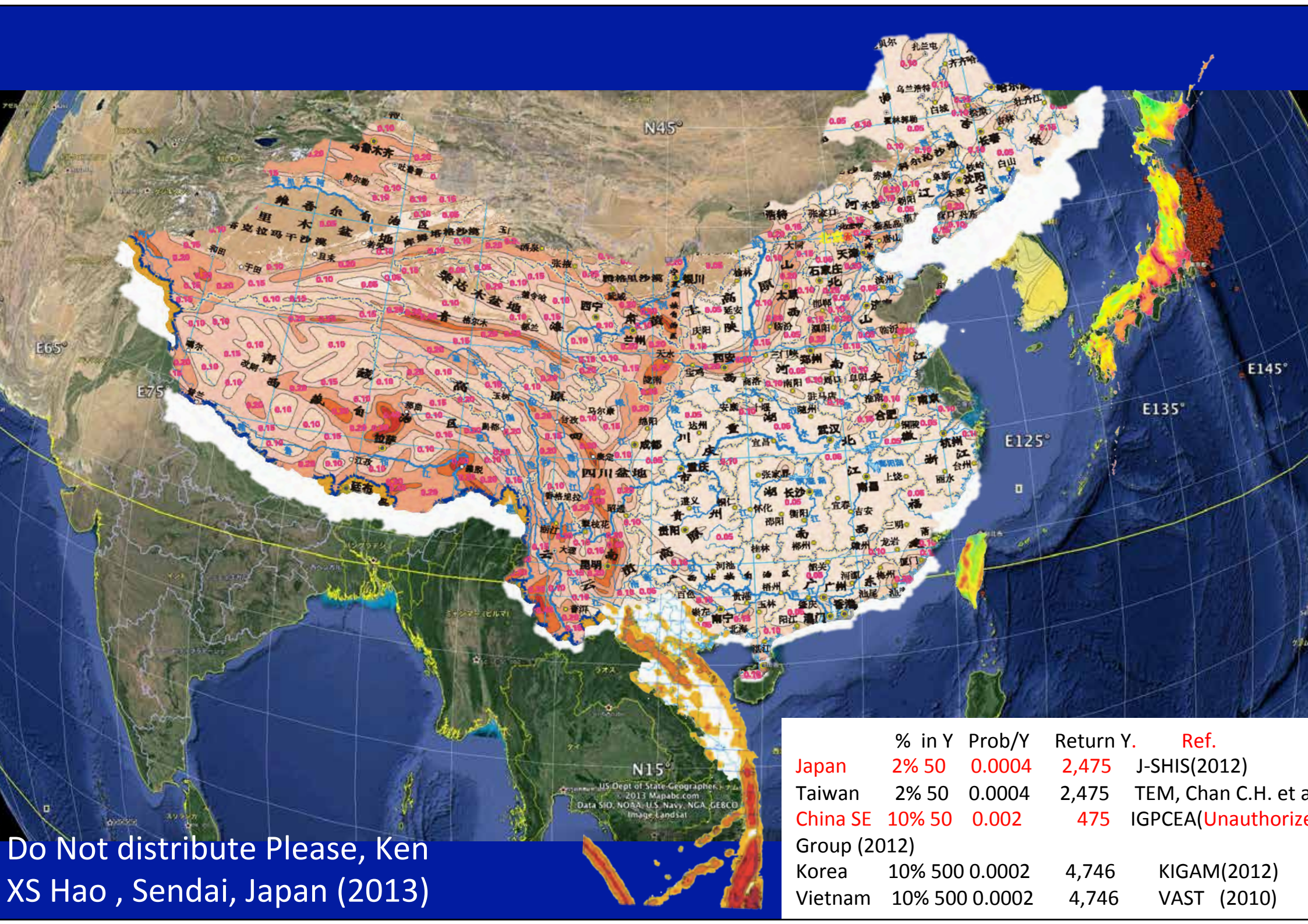
- The final year of CJK cooperative program (2010-2013)
- The TEM-NIED cooperative program (2012~)
- Is it possible to setting up a harmonized PSHA map in East Asia? How can?

PSHA image in East Asia Region

2012)



	% in Y	Prob/Y	Return Y.	Ref.
Japan	2% 50	0.0004	2,475	J-SHIS
Taiwan	2% 50	0.0004	2,475	TEM (Unauthorized), Chan C.H. et al.(2013)
China SE	2% 50	0.0004	2,475	IGPCEA(Unauthorized), CEA Working Group (2012)
Korea	10% 500	0.0002	4,746	KIGAM



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China SE	10% 50	0.002	475	IGPCEA(Unauthorize
Group (2012)				
Korea	10% 500	0.0002	4,746	KIGAM(2012)
Vietnam	10% 500	0.0002	4,746	VAST (2010)

Do Not distribute Please, Ken
XS Hao , Sendai, Japan (2013)

- Personal idea:
- Just set up a common base to discuss the problems and extend to next step.
- If some of you have interests about this idea, we may first put the digital data (KML, shape file) together, then, plan to do next step.
- An umbrella to cover all of programs in East Asia, GEM Regional Program could be a best choice for all of courtiers and economic regions.
- Thank for your attention.

- Chan C.H. et al.(2013), Probabilistic seismic hazard assessment for Taiwan: Application of OpenQuake
- China Earthquake Administration Working Group (2012), Chief editor by Gao Mentan.
- Jeon JS (2013), Current status of probabilistic seismic hazard map in Korea
- PGA map for Anti-seismic design and Building code TCXD-VN 375 2006 of Vietnam, 2003.
- J-SHIS (2012), J-SHIS