Should worst-case scenario of Mega-earthquake be considered in East Asian region, the lessons learnt from recently destructive earthquakes

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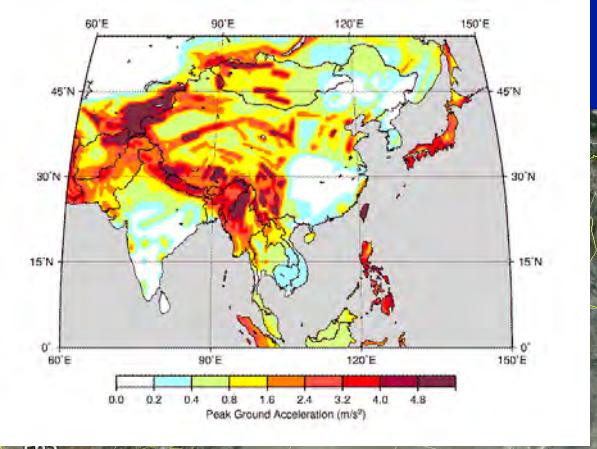
Global Seismic Hazard Assessment Program (1999) – Asia



Major earthquakes in East Asian region

Worst-case scenario of Mega-earthquakes recorded

1952 Pyeongyang, *M* 6.2 EQ North Korea

1976 Tangshan *M* 7.8 EQ China, 240,000 deaths

1995 Kobe *M* 7.3 EQ Japan, 6400 deaths
1999 Chi-Chi *M* 7.6 EQ Taiwan, 2,415 deaths
2008 Wenchuan *M* 8.0 EQ China, 90,000 deaths
2011 Tohoku *M* 9.0 EQ Japan,19,000 deaths

NEXT unexpected event ?

|

Where / How large / within a Long-term period

(The verdict and prison sentenced to Seven scientists and official for manslaughter in the **2009 L'Aquila earthquake** **<= Wrong targets!!** Back Off !!)

CJK Web site for communication →

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

Continuously Practice →

Trilateral cooperative program enabling knowledge data exchange

Supported by each individual counties

Goal →

National Research Institute for Earth Scien

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)

←NIED-TEM Website for communication

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 collapsed', and another 691,766 buildings partially damaged.

The oval tracks were moved 2.7m to S75W and uplifted 2.65m (left) by Chelungpu fault, buildings were destroyed (right top) in Guangfu Junior high school, and the Shigang dam was distorted and raised about 10 m (right bottom) during the 1999 Chi-Chi Earthquake.

Under the lessons learnt from the destructive earthquakes and the awareness of the unexpected earthquake possibly occur in the future, scientists on both sides have consensus of cooperative researches to share data, knowledge and information to mitigate the disasters.

The president of Committee of Taiwan Earthquake Model (TEM), Kuo-Fong Ma, and the director of Department of Socio-disaster research, NIED, Hiroyuki Fujiwara, agreed to hold the first workshop to share information on Probabilistic Seismic Hazard Assessment (PSHA).

NIED

TAIWAN Earthquake Model

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.

Japan Seismic Hazard Information Station J-SHIS

The first Workshop

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

First workshop of the TEM-NIED was hosted in NCU, Taoyuan, Taiwan in June 4-6, 2012. Not only the researches from Taiwan and Japan, many professionals from USA, Swiss also joined the workshop. Over 24 speakers have presented from the fields of PSHA, Seismic network observation, Geological structures, Earthquake Early Warning, GMPE, Scenario earthquake simulation, and other related. The highlight of the workshop was invited as a representative of regional programmes on the Global Earthquake Model (GEM) semi-annual meeting. Field trips to fault rupture, the 921 Earthquake Museum, and NCREE laboratory, consist of a very rich taste of the earthquake problems.

On the consequence of the fruitful communications and discussions, both sides agree that the annual workshop will be hold in alternative counties.

June 4th, 2012

Highlights

Hiroyuki Fujiwara,
Ken Xiansheng Hao (NIED)

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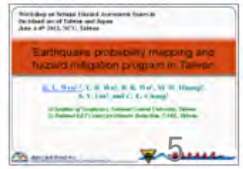
Seismic Hazard Assessment for Japan after the 2011 Great East Japan Earthquake

Hiroyuki Fujiwara (NIED)

PDF / 17.9MB Download

Earthquake probability mapping and hazard mitigation program in Taiwan

Kuo-Liang Wen (NCU)



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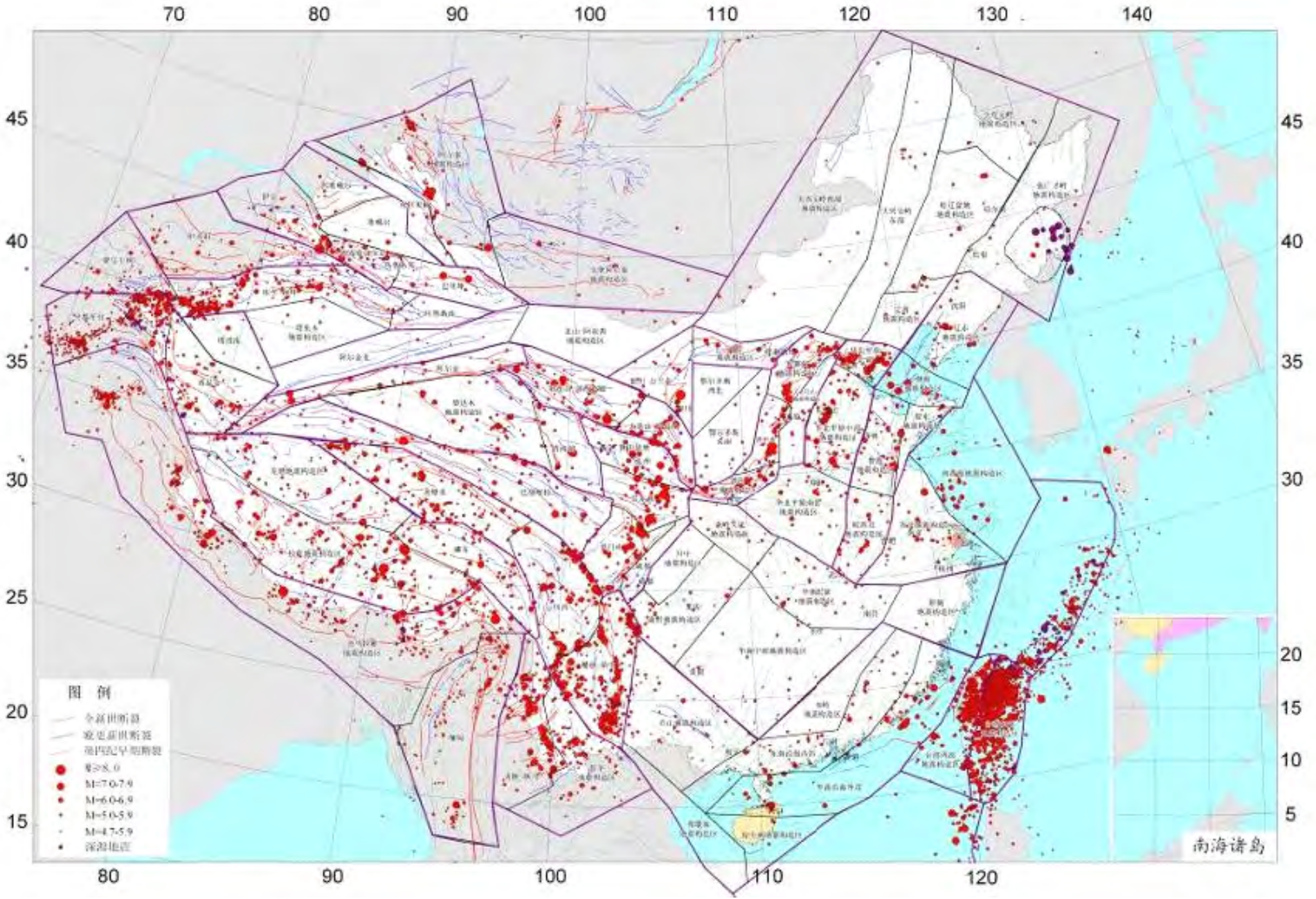
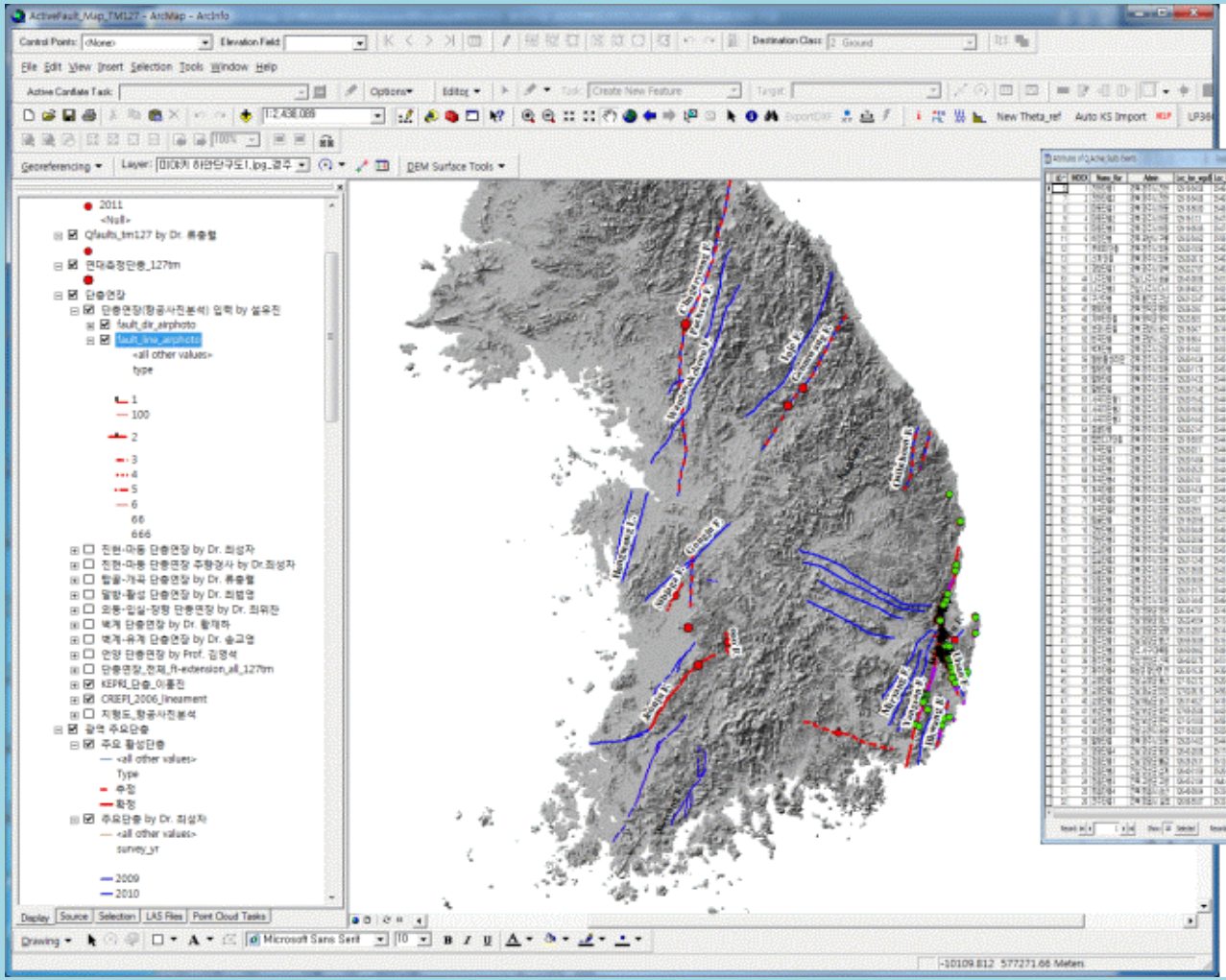
Seismotectonic zones in China and adjacent areas (X. Li, 2011)

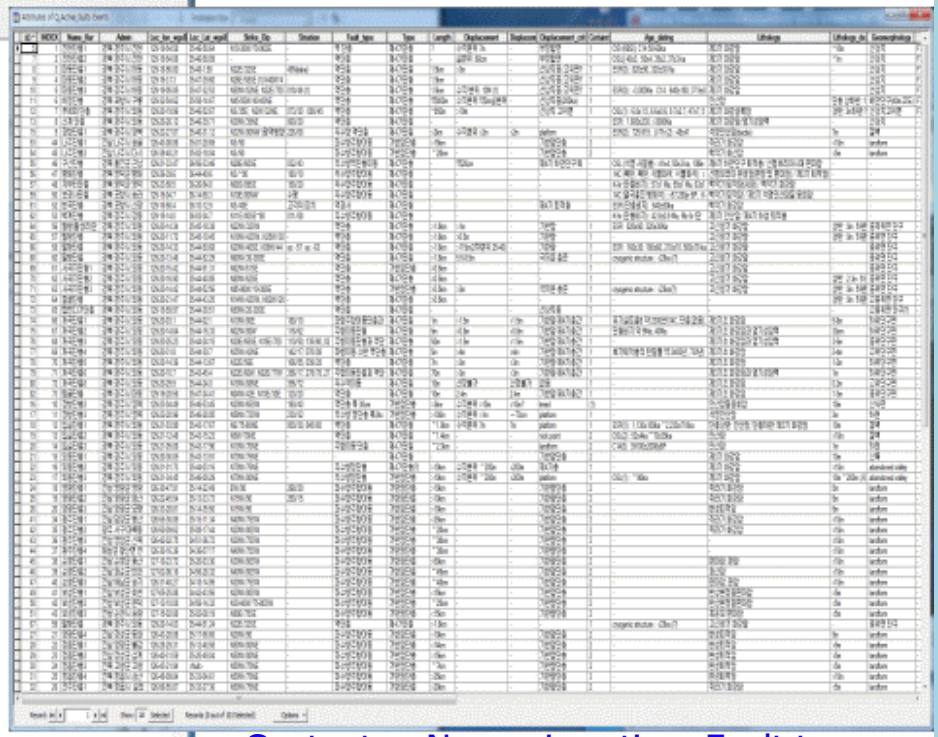


1. PSHM Methodology

(JEON, 2011)

Active Faults D/B





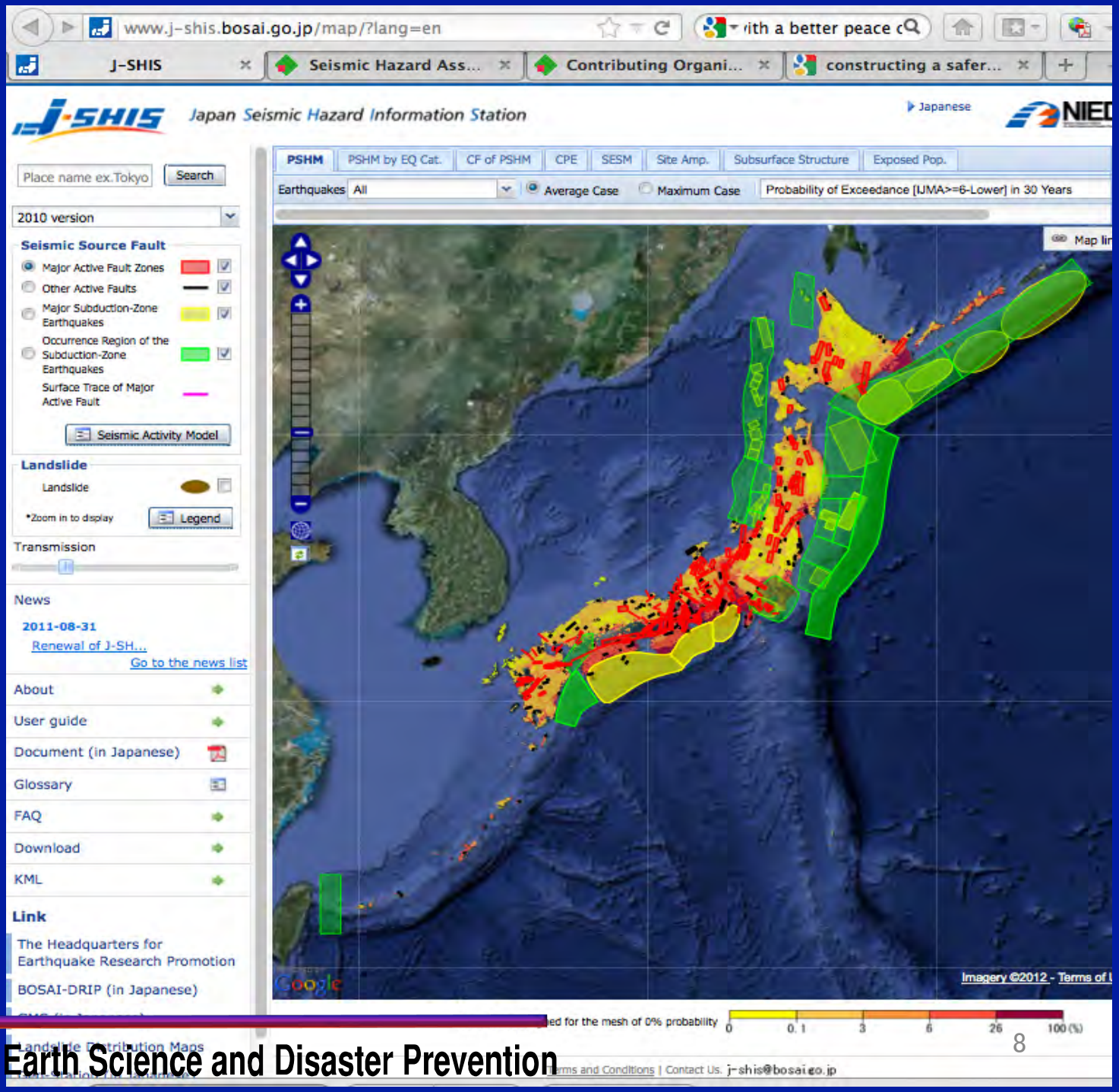
Contents : Name, Location, Fault type, Strike/Dip, Length, Displacement, Age dating, Lithology, etc

What lessons we have learnt from the Tohuku M9 earthquake.

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

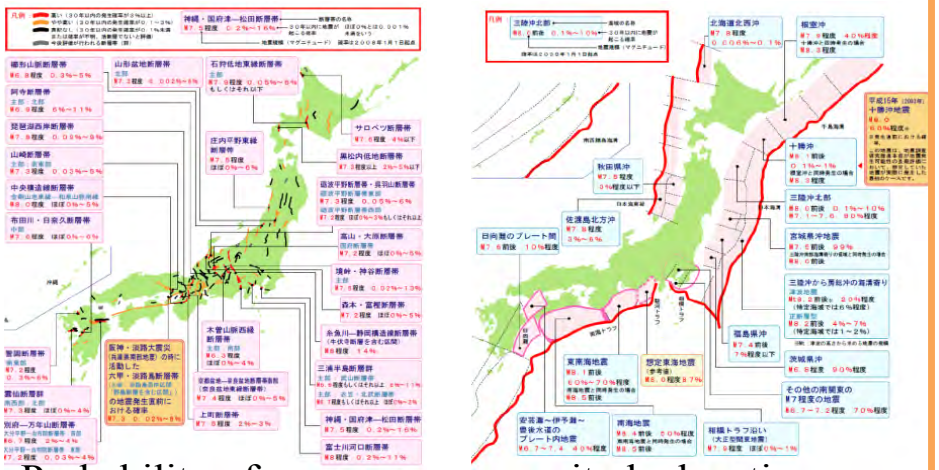
“The borderless world of Science” → enabling knowledge and data exchange each others.

Subduction zones → Crossing border connect the world



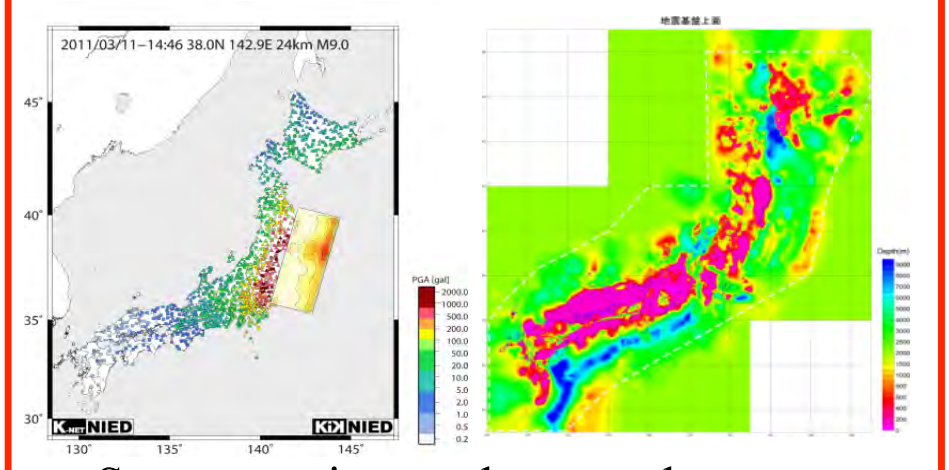
National seismic hazard maps for Japan

Long term evaluation



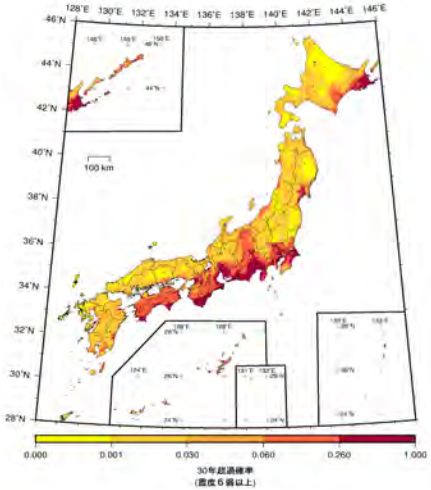
Probability of occurrence, magnitude, location

Strong-motion evaluation



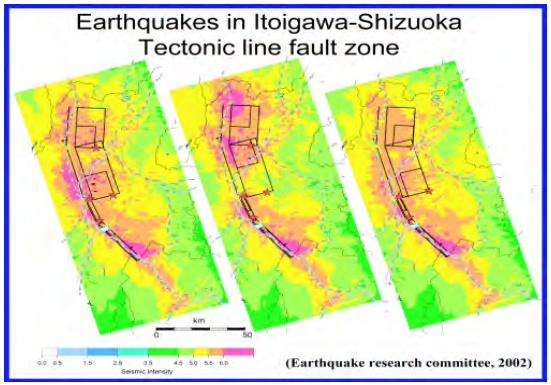
Strong-motion, underground structure

Probabilistic Seismic Hazard Maps



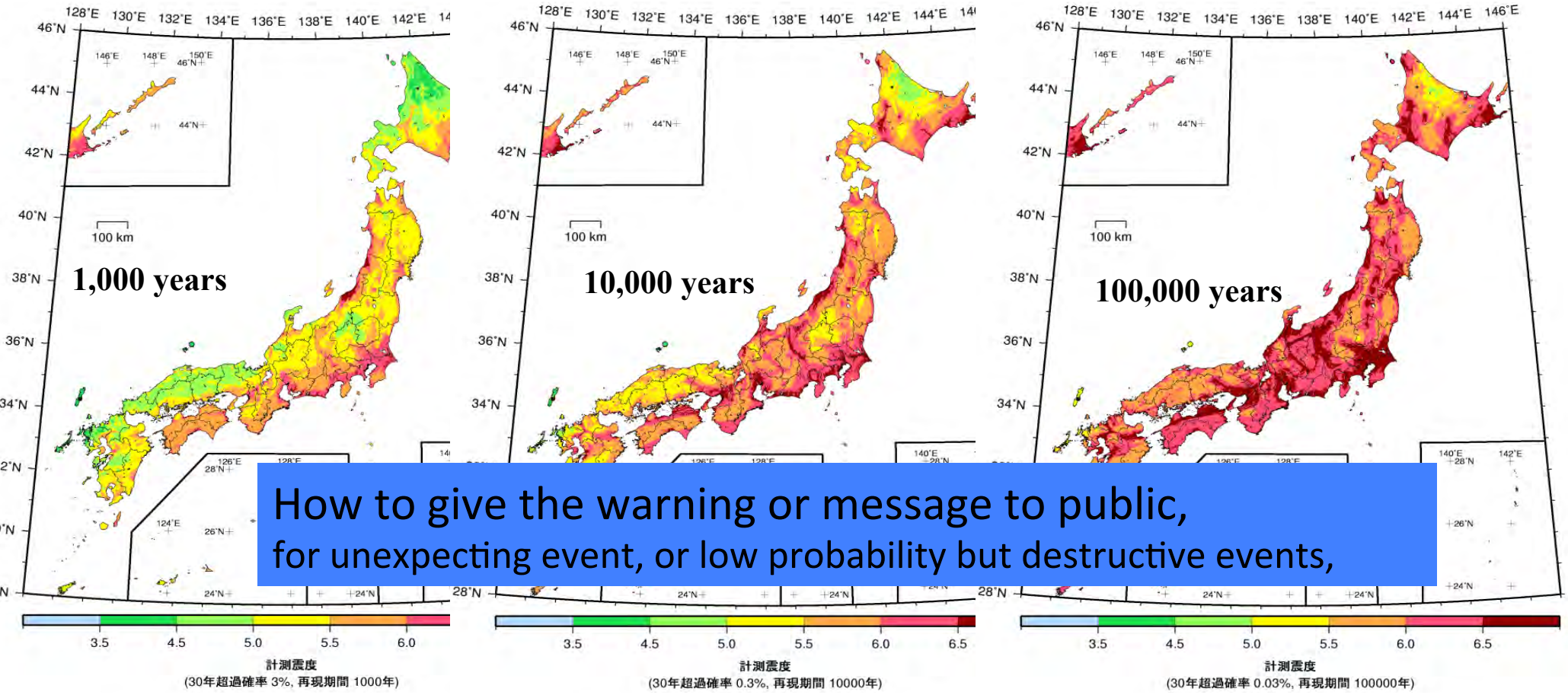
- **Showing the strong-motion intensity with a given probability, or the probability with a given intensity.**
- **Considering all possible earthquakes.**

Scenario Earthquake Shaking Maps



- **Showing the strong-motion intensity around the fault for a specified earthquake.**

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.

How to reduce the variation of uncertainty

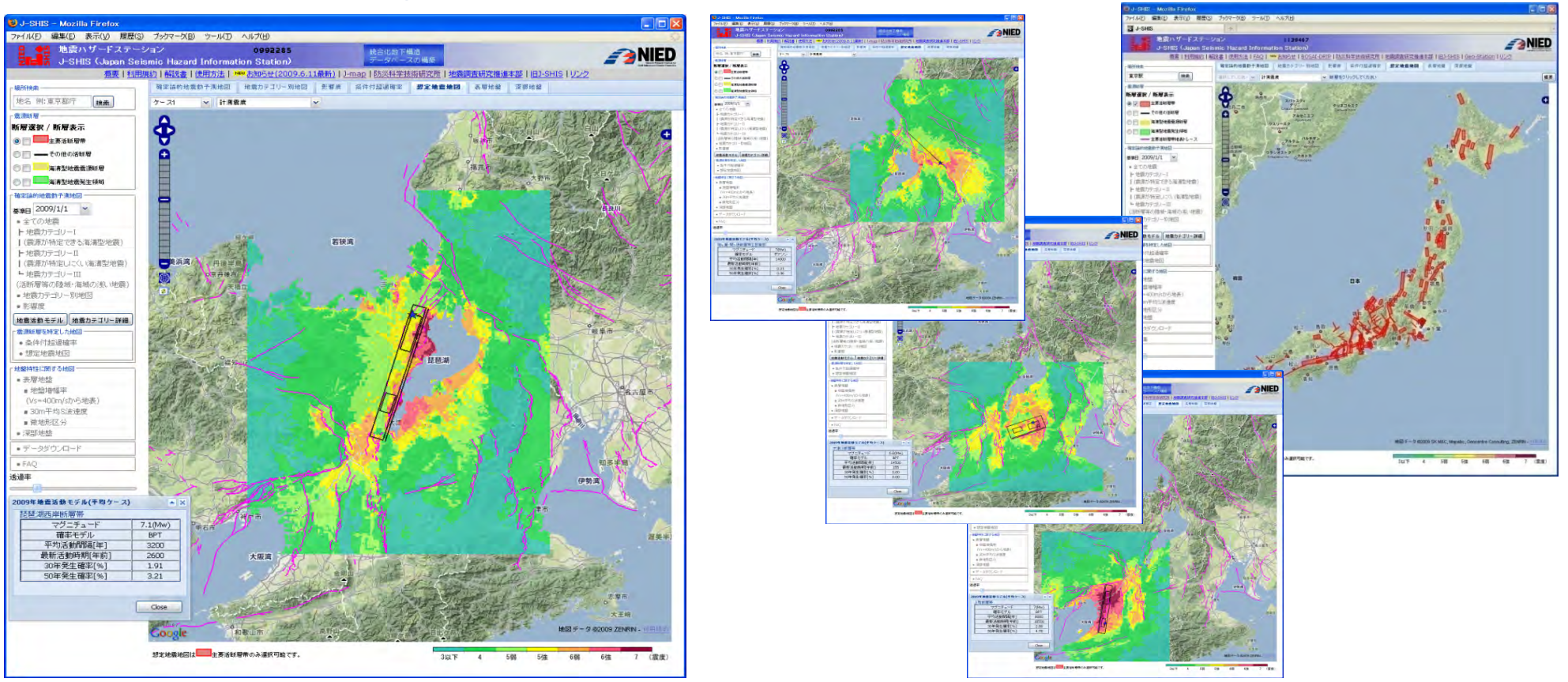
- GMPE => PGA and PGV (now in PSHA, but, large variance in values)

- Requirement of a detail 3D velocity structure for modeling of high frequency.
- Fault Segment, geometry, mechanism
- New concept we created on NIED-TEM meeting

  PSHA => **Simulation-based PSHA** (Japan) to reduce the variation.

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.

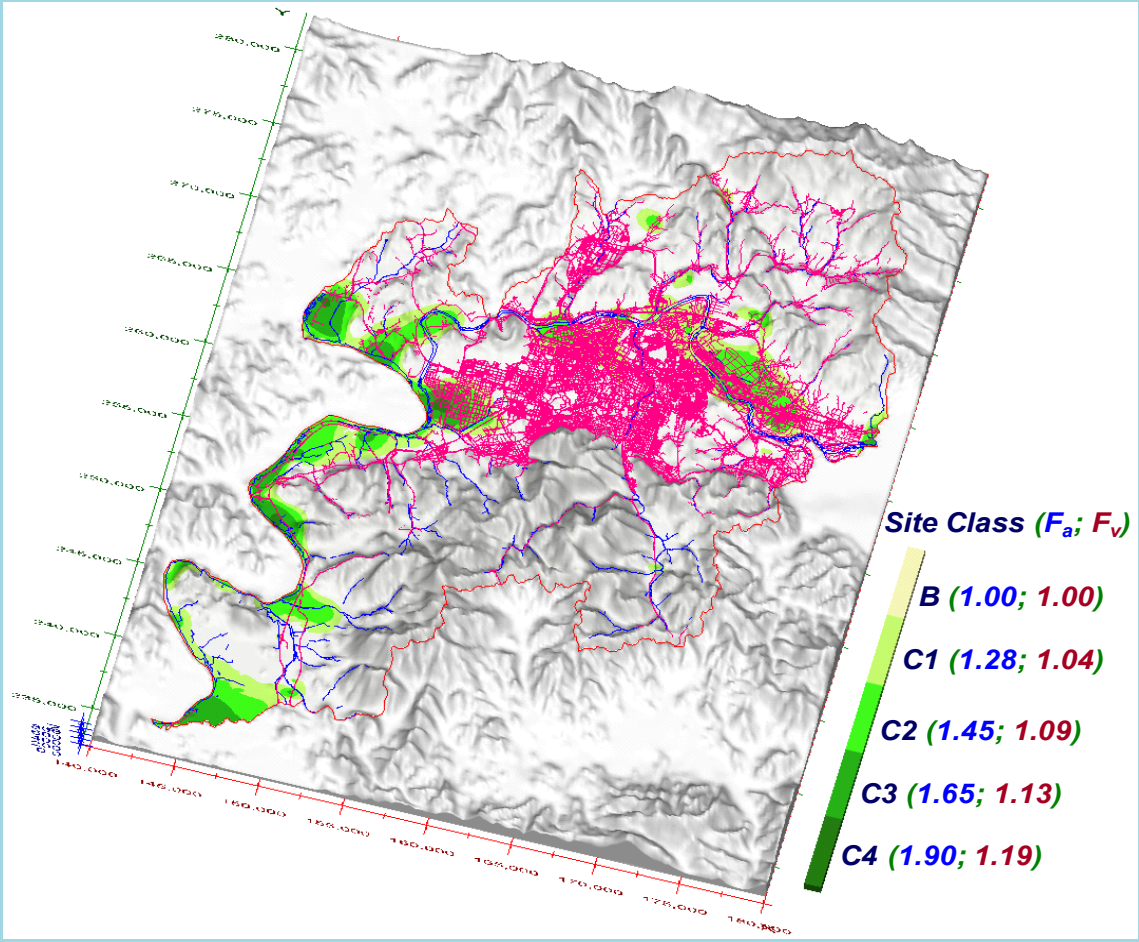
For treatment of uncertainties, we assume several cases of source model and compare the results of them to show deviation of strong-motion evaluation due to uncertainties.

4. Site Amplification

(JEON, 2011)

Site classes based on predominant site period in Daegu

- Site classes C(C1 to C4) in plains
- Max 1.90 for Fa and 1.19 for Fv => Significant Seismic amplification



(X. Li, 2011)

Seismic Ground Motion Parameter Zonation Map of China

——fifth generation map, issued in 2012?

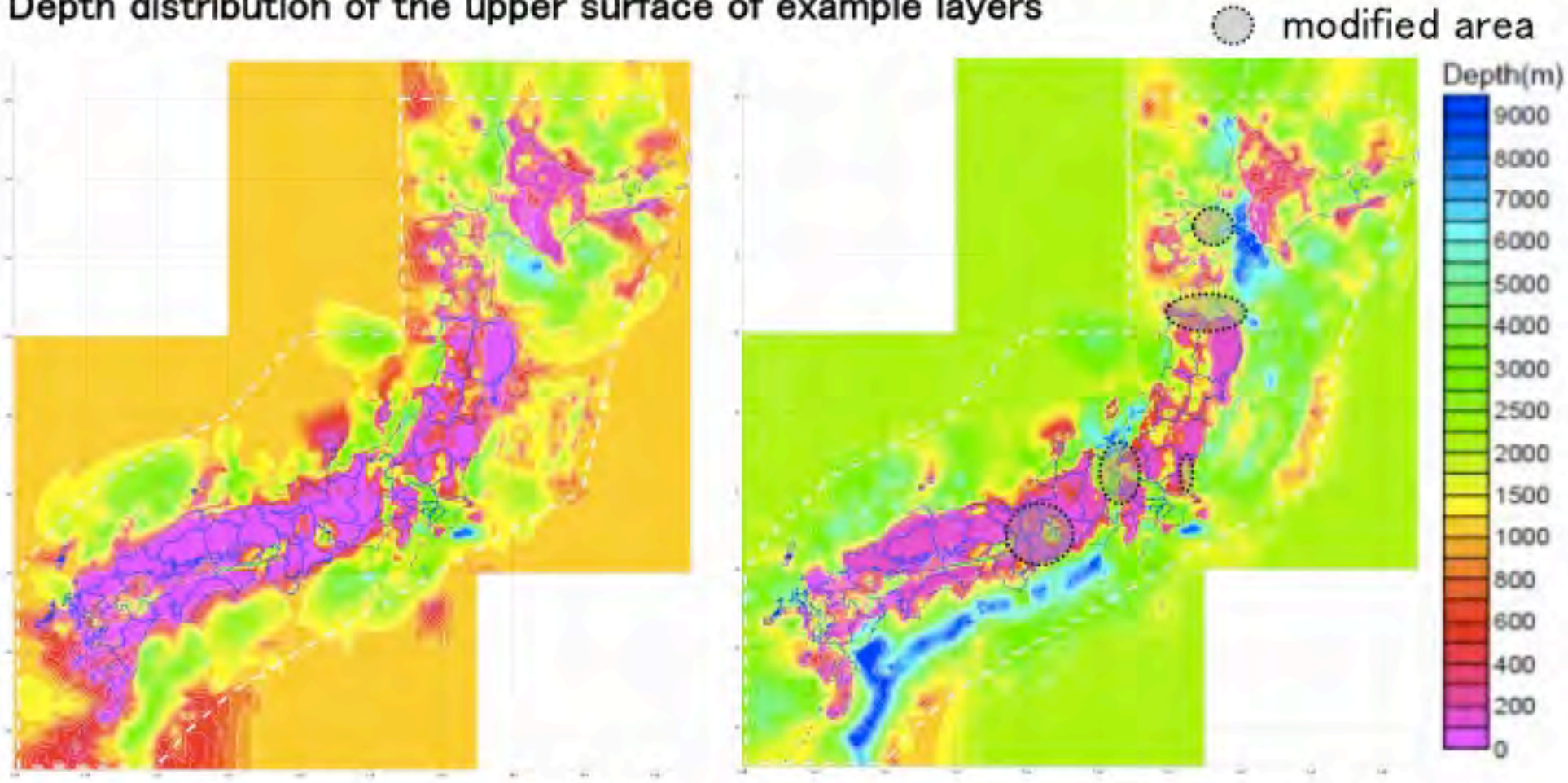
Two tables: for adjustment of peak ground acceleration and spectral characteristic period Tg with site types

Site types	*PGA*(g) for site type II					
	≤0.05	0.10	0.15	0.20	0.30	≥0.40
I_0	0.64	0.68	0.70	0.75	0.85	0.90
I_1	0.80	0.82	0.83	0.85	0.95	1.00
II	1.00	1.00	1.00	1.00	1.00	1.00
III	1.30	1.25	1.15	1.00	1.00	1.00
IV	1.25	1.20	1.10	1.00	0.95	0.90

Tg（s）	Site types				
	I_0	I_1	II	III	IV
1 zone	0.20	0.25	0.35	0.45	0.65
2 zone	0.25	0.30	0.40	0.55	0.75
3 zone	0.30	0.35	0.45	0.65	0.90

1st-order velocity layered model(1)

Depth distribution of the upper surface of example layers

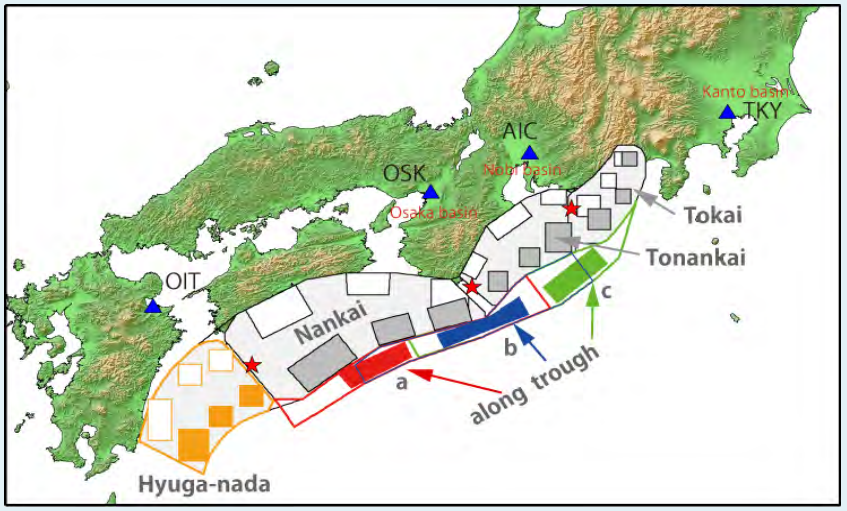


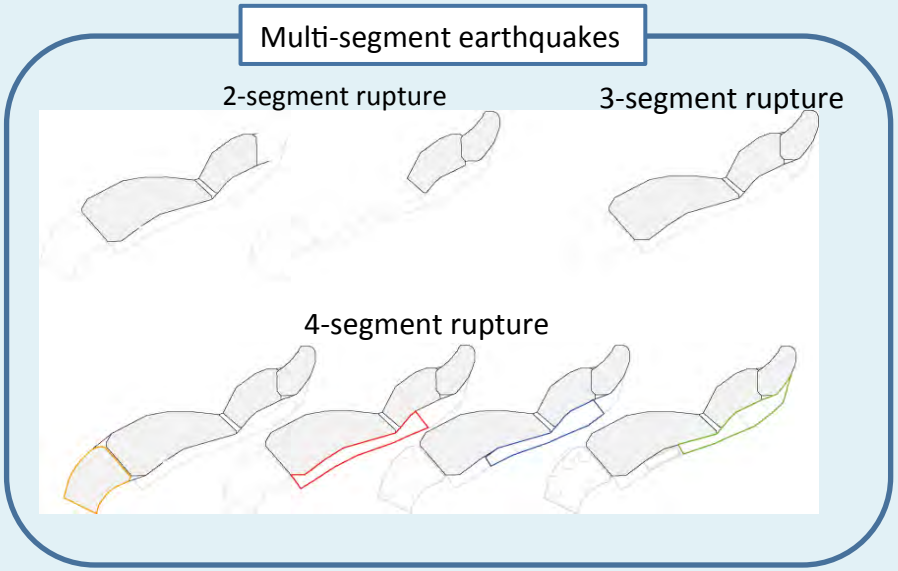
Upper surface of the layer *No.25*
(Vs = 2.1km/s)

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

Characterized source model for the Nankai trough earthquakes

(Maeda, 2012)



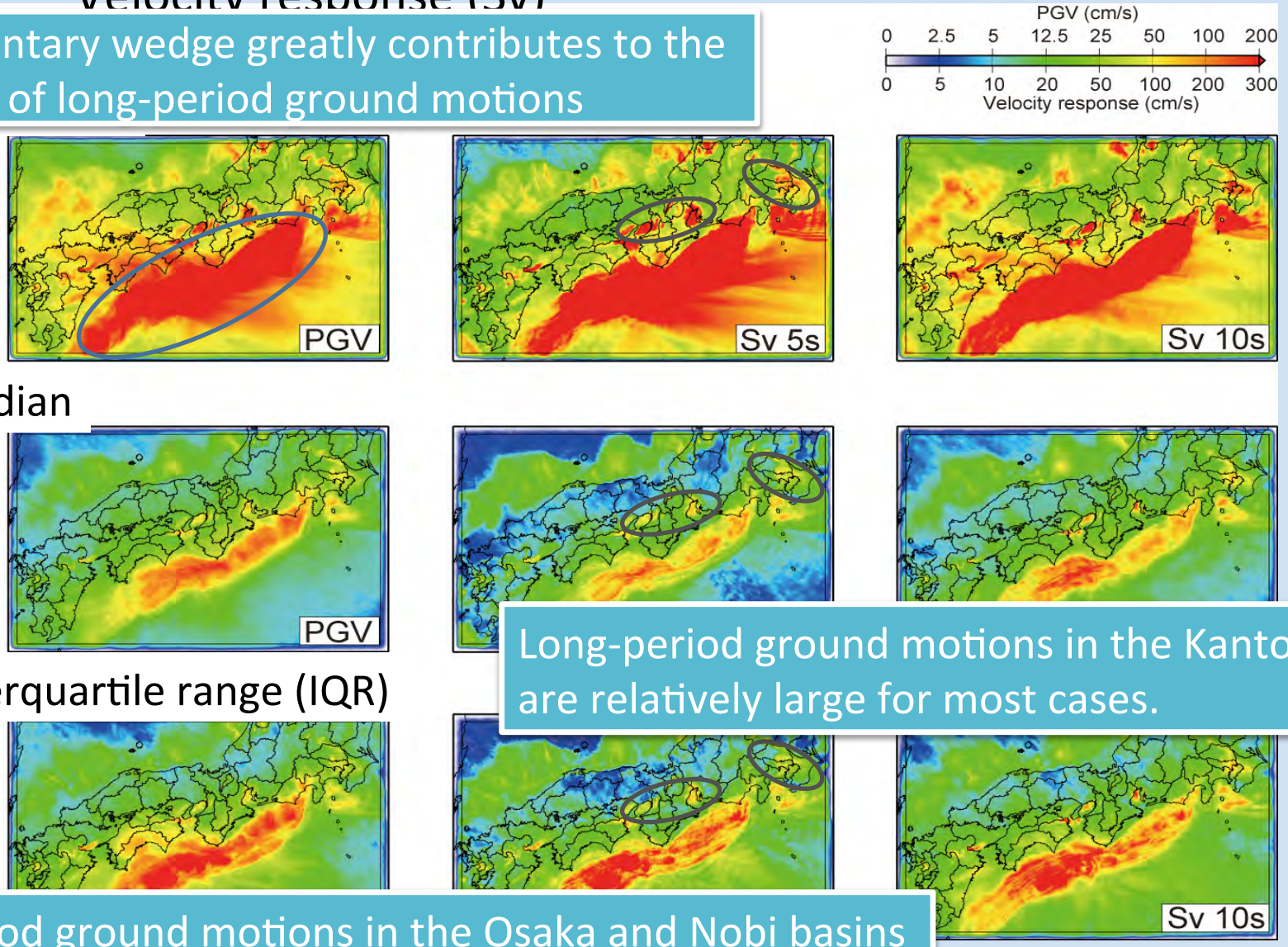


- Source areas (14 cases x 3)
  - ◆ Single-segment earthquake
    - Nankai (ANNKI: Mw 8.5),
    - Tonankai (ATNKI: Mw 8.2),
    - Tokai (ATOKI: Mw 8.0),
    - Hyuga-nada (AHGND: Mw 8.3),
    - and along the trough (ATRGH: Mw 8.1) 3 cases (a, b, c).
      - 36 hours/ 1 scenario
      - 60000 steps (120 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

(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

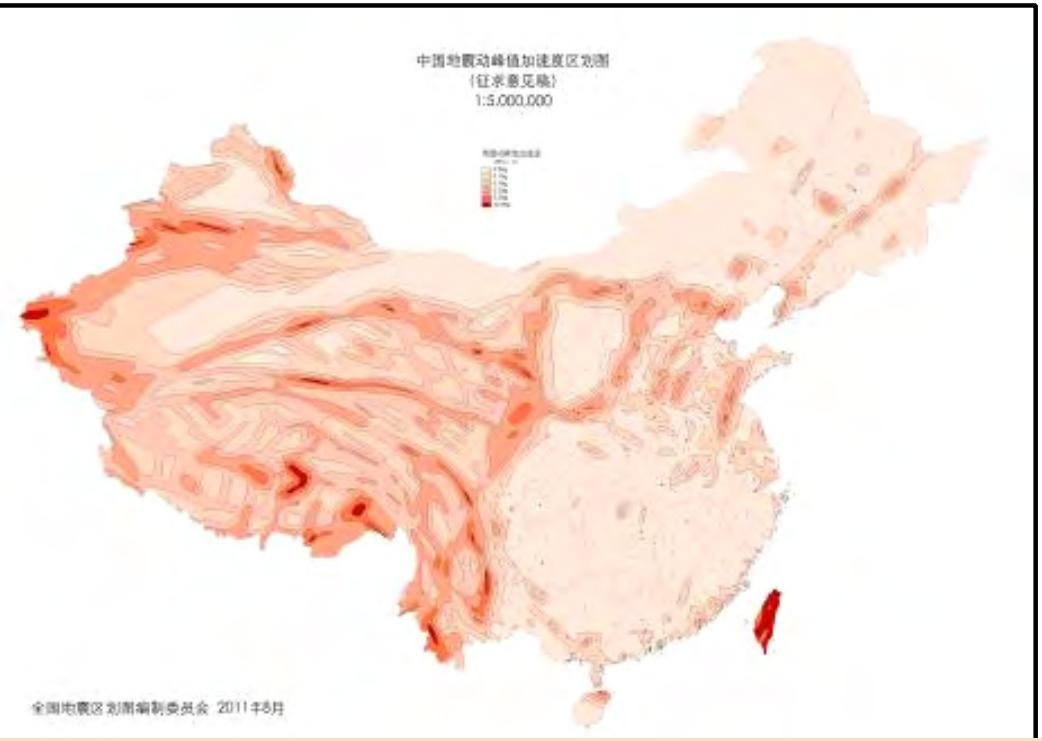


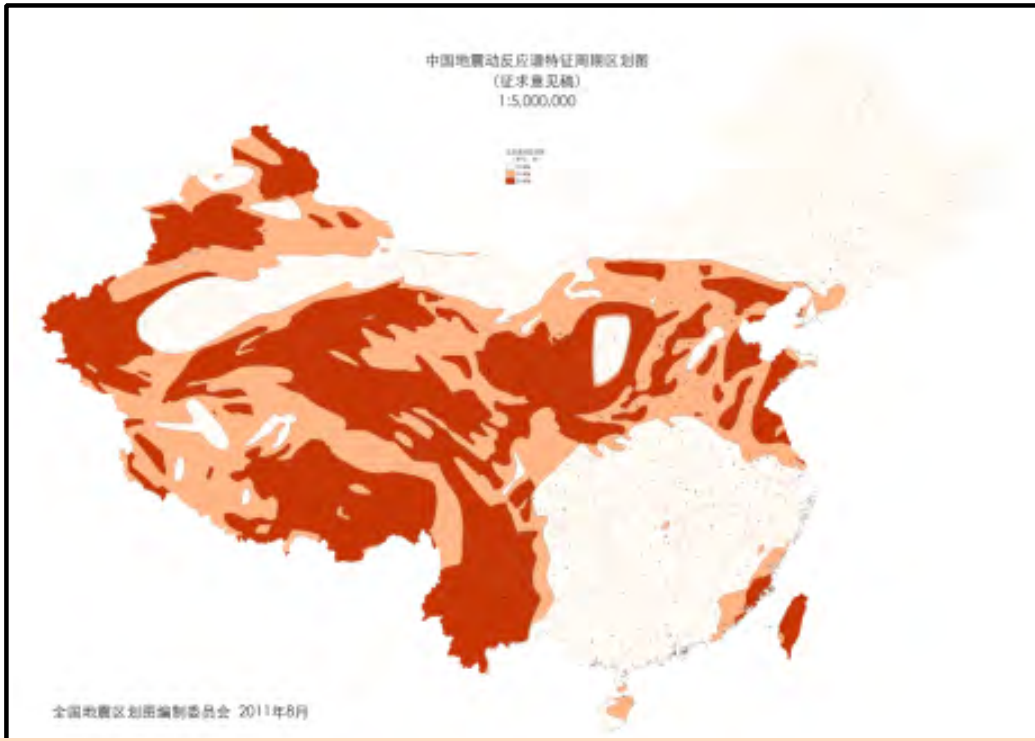
Long-period ground motions in the Kanto basin are relatively large for most cases.

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

(X. Li, 2011)

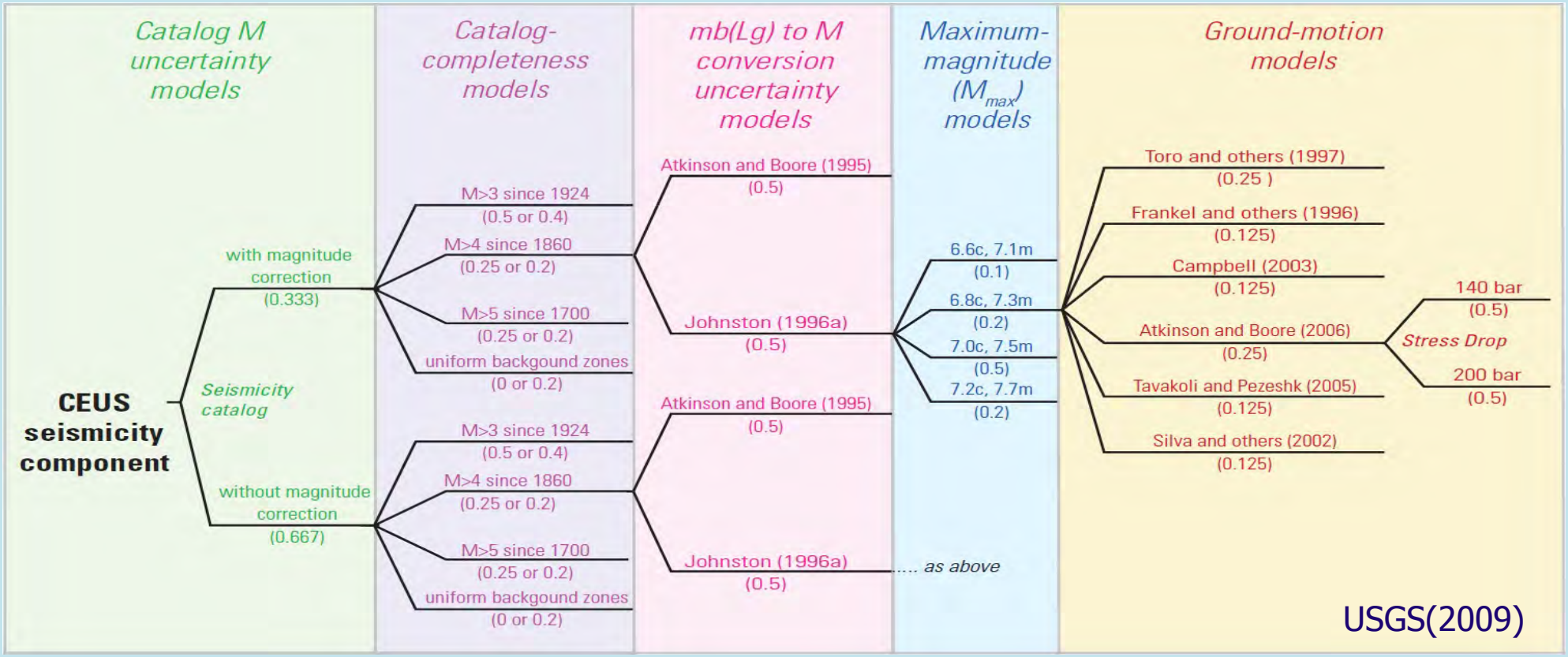
peak ground acceleration map and spectral characteristic period map





3. PSHM Calculation

(JEON, 2011)



- Construction of specialist committee to conduct the logic tree evaluation, consisted of various major field
- Now, finalizing the logic tree & preparing input data and parameters

Comparison of GEM's PSHA and Loss calculation, Japan side has been working many areas differently, some over requirements in GEM, but needed in Japan, and some have not been finished yet.

	Source Model	Stochastic Events Set	Rupture Model	GMPE
Prob.Seis.Haz.Map*	○	○	○	○
Sce.EQ.Shak. Map*	○	~	○	○
SiteAmp. Fac. Map*	○	~	○	~
Sub.Stru.Map	○	~	○	~
Expos.Population	~	~	○	~
Vulnerability	△	~	△	~
Total Loss(NLIRO)	○	~	○	~

* Mesh 1km^2 --> 250m^2; J-SHIS done ○; Going to △; NA ~

PGA

PGA

PGV / PBV
IJMA intensity

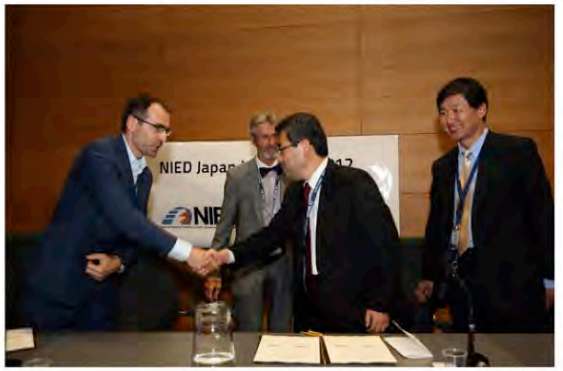
Exisit Maps	Probability of Exceedance	in Expose t years	Map Scale/ Mesh Size	Update base	Probability yearly Y= – (ln(1–P))/t	Return periods Years
China	PGA for a 10%	50	1:5,000,000	? 10 year	0.002	475
	PGA for a 2%	50	1:5,000,000		0.0004	2475
	PGA for a 10%	50	1:5,000,000		0.002	475
	PGA for a 10%	50	1:5,000,000		0.002	475
Korea	PGA for a 39%	50	1 x 1 km	5 year	0.01	100~
Korea	PGA for a 10%	200	1 x 1 km	5 year	0.002	475
Korea	PGA for a 10 %	500	1 x 1 km	5 year	0.0002	4800
Japan	IJMA >= 6– Upper	30	250m^2	yearly		
	IJMA >= 6– Lower	30	250m^2	yearly		
	IJMA >= 5– Upper	30	250m^2	yearly		
	IJMA >= 5– Lower	30	250m^2	yearly		
PGV /PBV	IJMA for a 3%	30	250m^2	yearly	0.00102	985
PGV /PBV	IJMA for a 6%	30	250m^2	yearly	0.00206	485
PGV /PBV	IJMA for a 2%	50	250m^2	yearly	0.0004	2475
PGV /PBV	IJMA for a 5%	50	250m^2	yearly	0.0010	975
PGV /PBV	IJMA for a 10%	50	250m^2	yearly	0.002	475
PGV /PBV	IJMA for a 39%	50	250m^2	yearly	0.010	101

- 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 honour 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”.

Partners | 26 Sep 2012

NIED JAPAN JOINS GEM TO WORK TOGETHER ON RISK ASSESSMENT



‘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.“ Hiroyuki Fujiwara, representative for Japan’s National Institute for Earth Science and Disaster Prevention (NIED), explained the institute’s reasons for joining GEM in a brief speech. Today at the 15WCEE, NIED adhered as the 15th **Public Participant** in GEM’s global public-private undertaking.

The GEM effort is growing and having more public and private participants on board is critical to sustain GEM and the important work hundreds of collaborators on global and regional scales are doing to develop (open) tools, databases and best practice. Rui Pinho commented that ‘for GEM it is a great honour 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”. Because earthquakes are low probability, high impact events, working together on a global level and developing best practice is critical. Japan and Japanese institutions with their long history and advanced knowledge should be integral part of in this international collaboration and this partnership confirms that. We are looking forward to a long and fruitful collaboration.

IN BRIEF

GEM works because of all the people involved. We look forward to more organisations and individuals that become part of the effort, leveraging on the knowledge, tools and resources being developed, sharing data, approaches and funds and ideas for further collaboration.

CATEGORIES

Meetings (0)
Partners (1)
Events (1)
General (2)
Blog (0)
OpenQuake (1)
Website Development (1)

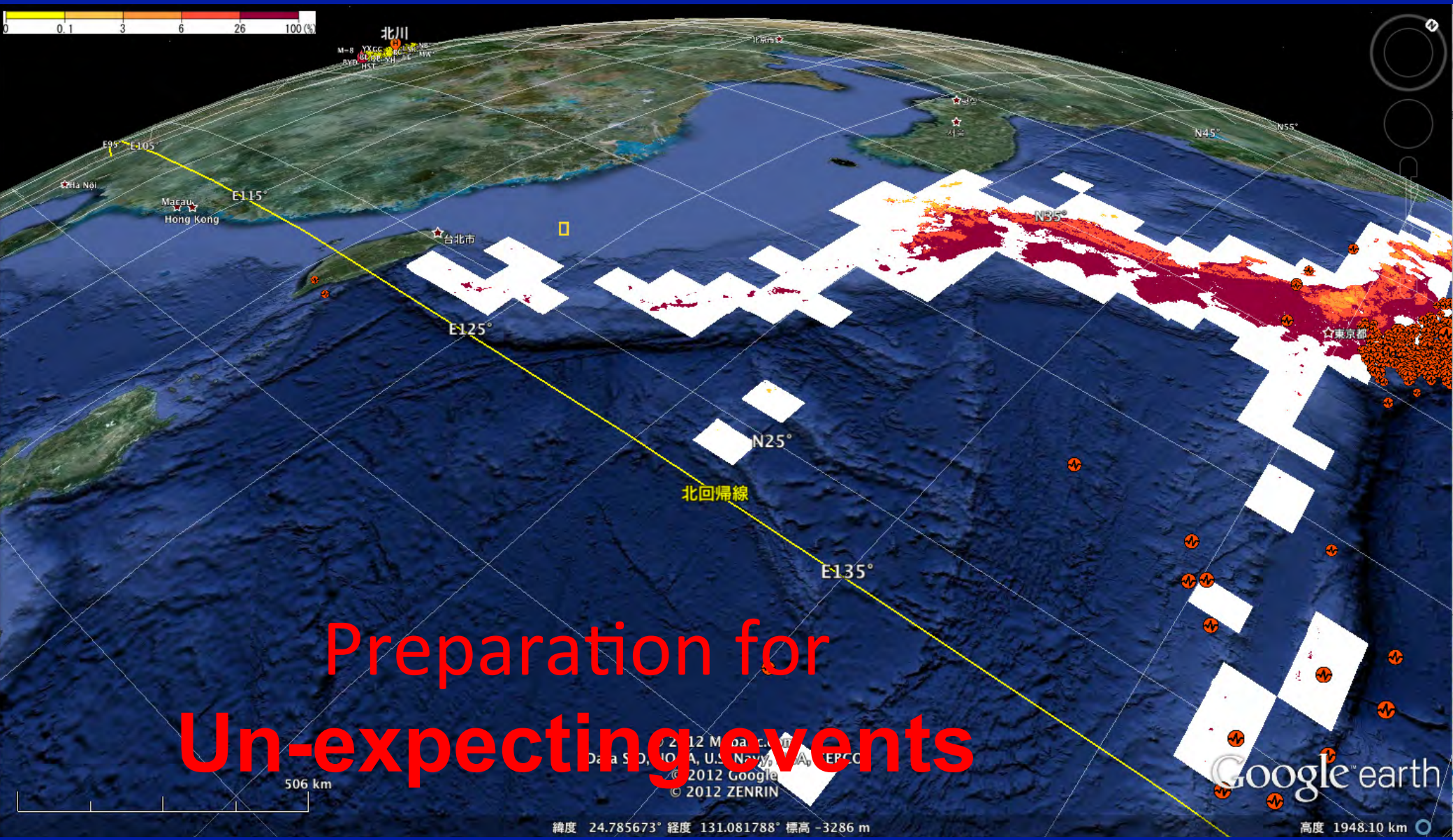
TWITTER

GEM
NIED Japan joins GEM. Welcome NIED; we definitely look forward to sharing knowledge & experiences on hazard and risk (assessment)
about 7 days ago

GEM
@pjdohertygis Thanks, it was about time. We look forward to discuss GIS developments and show you where #OpenQuake is heading
about 7 days ago

GEM
@damoslim Thanks ! We look forward to lots of discussion from 17.15 onwards. And today at the end NIED Japan will join GEM
about 7 days ago

Island arc around East Asian area



Preparation for

Un-expecting events

Thank you for your attention