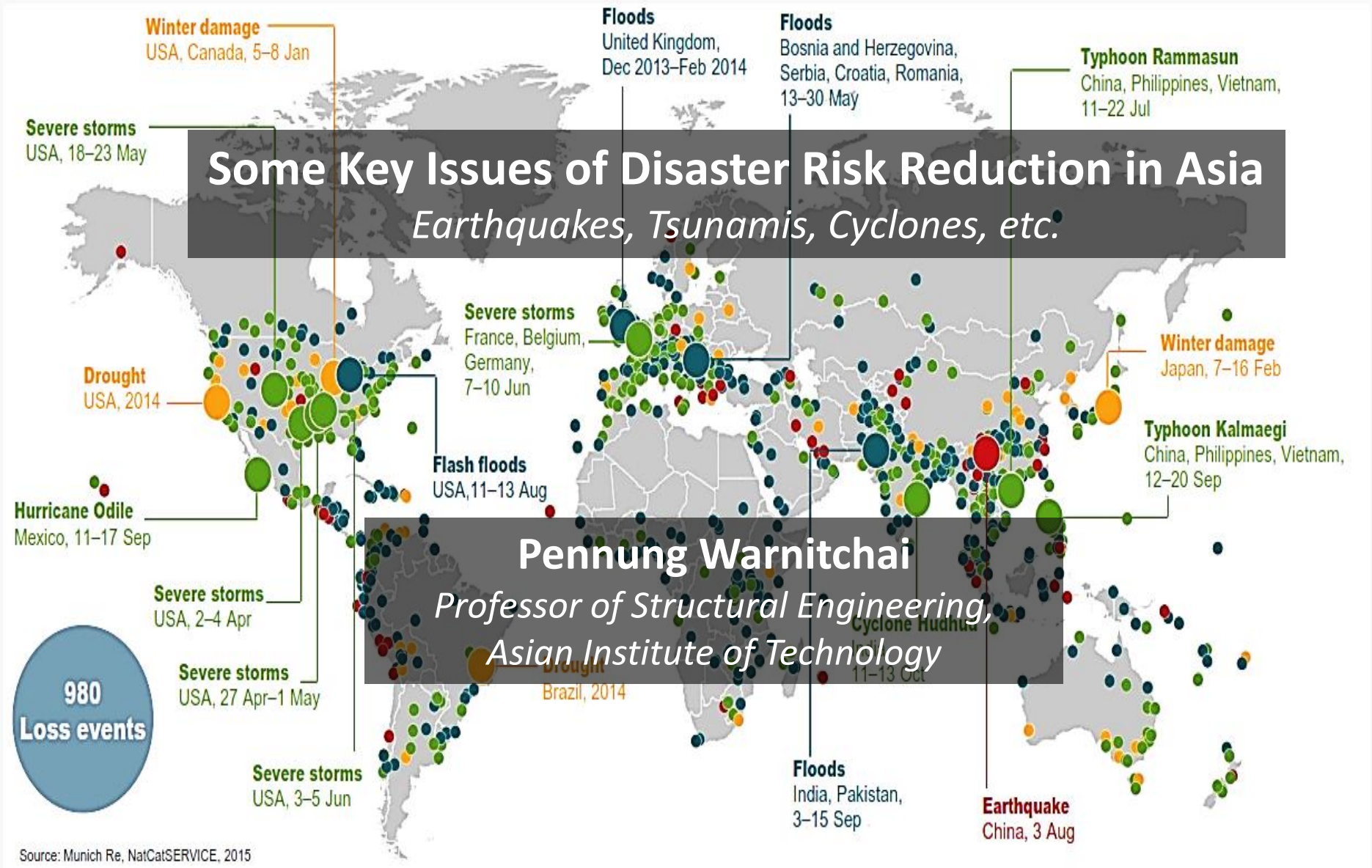


Some Key Issues of Disaster Risk Reduction in Asia

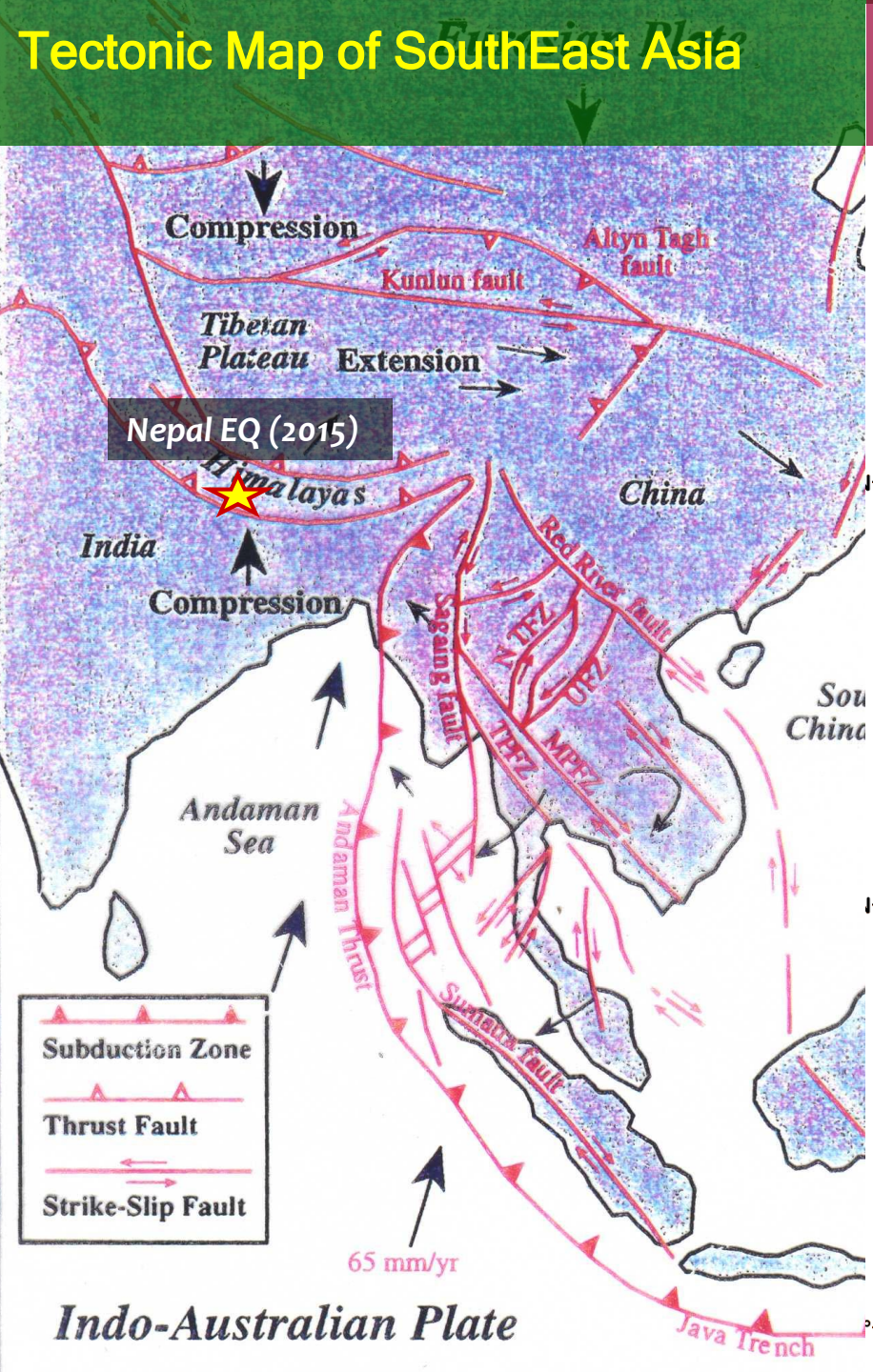
Earthquakes, Tsunamis, Cyclones, etc.

Pennung Warnitchai

Professor of Structural Engineering,

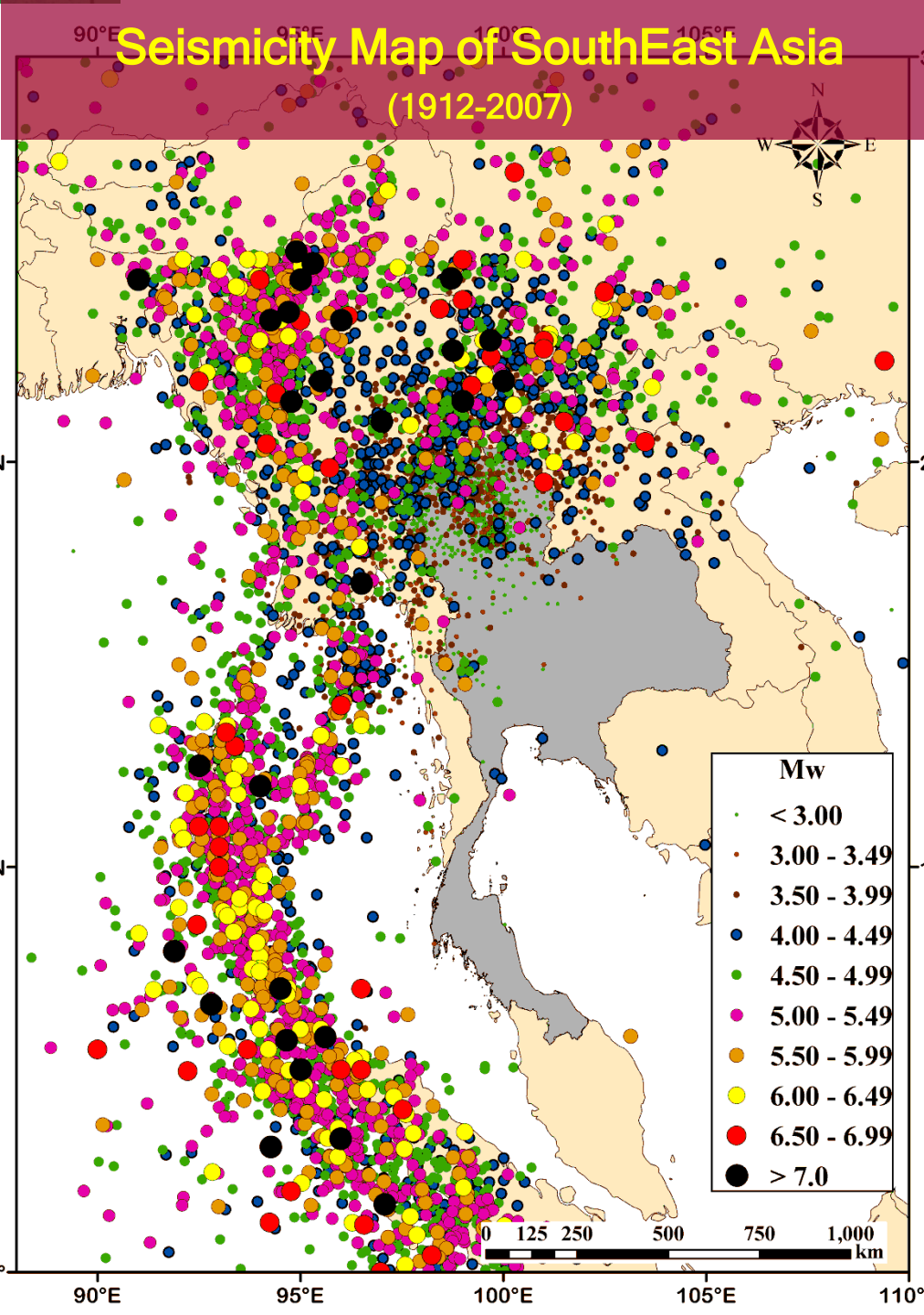
Asian Institute of Technology

Tectonic Map of SouthEast Asia



Seismicity Map of SouthEast Asia

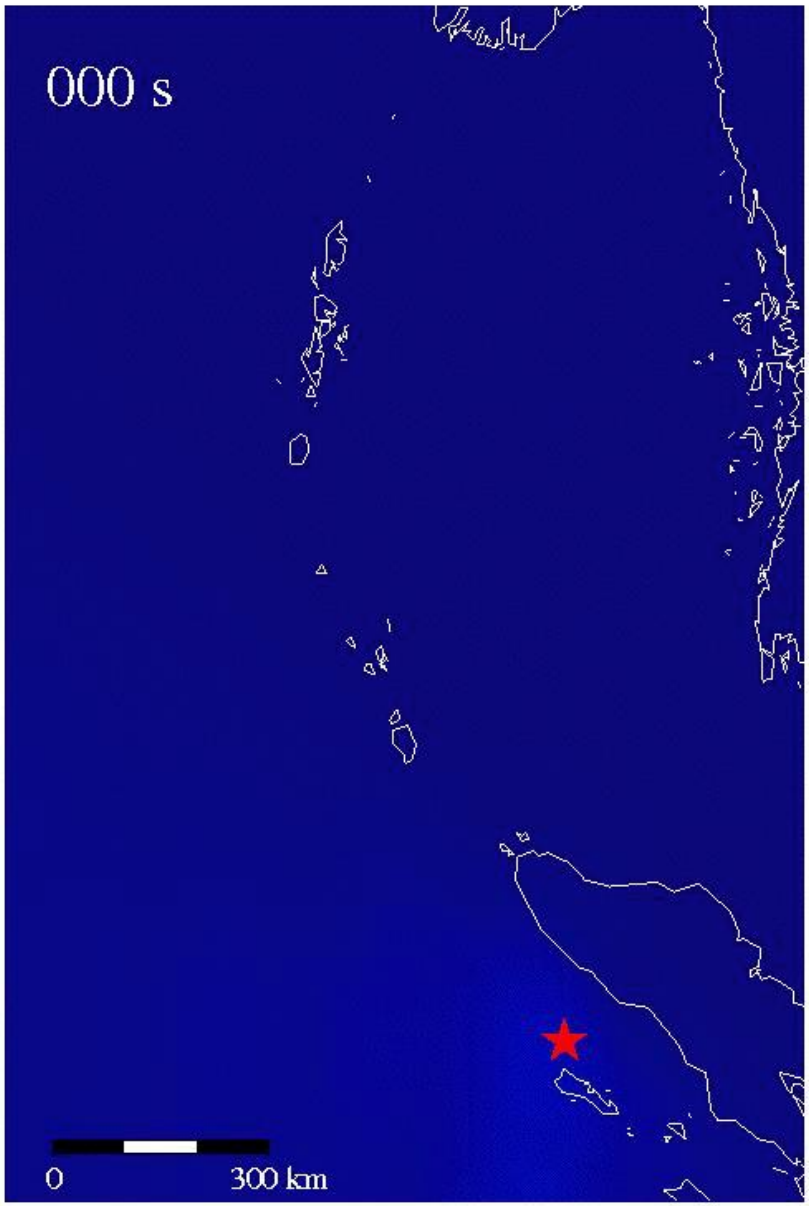
(1912-2007)



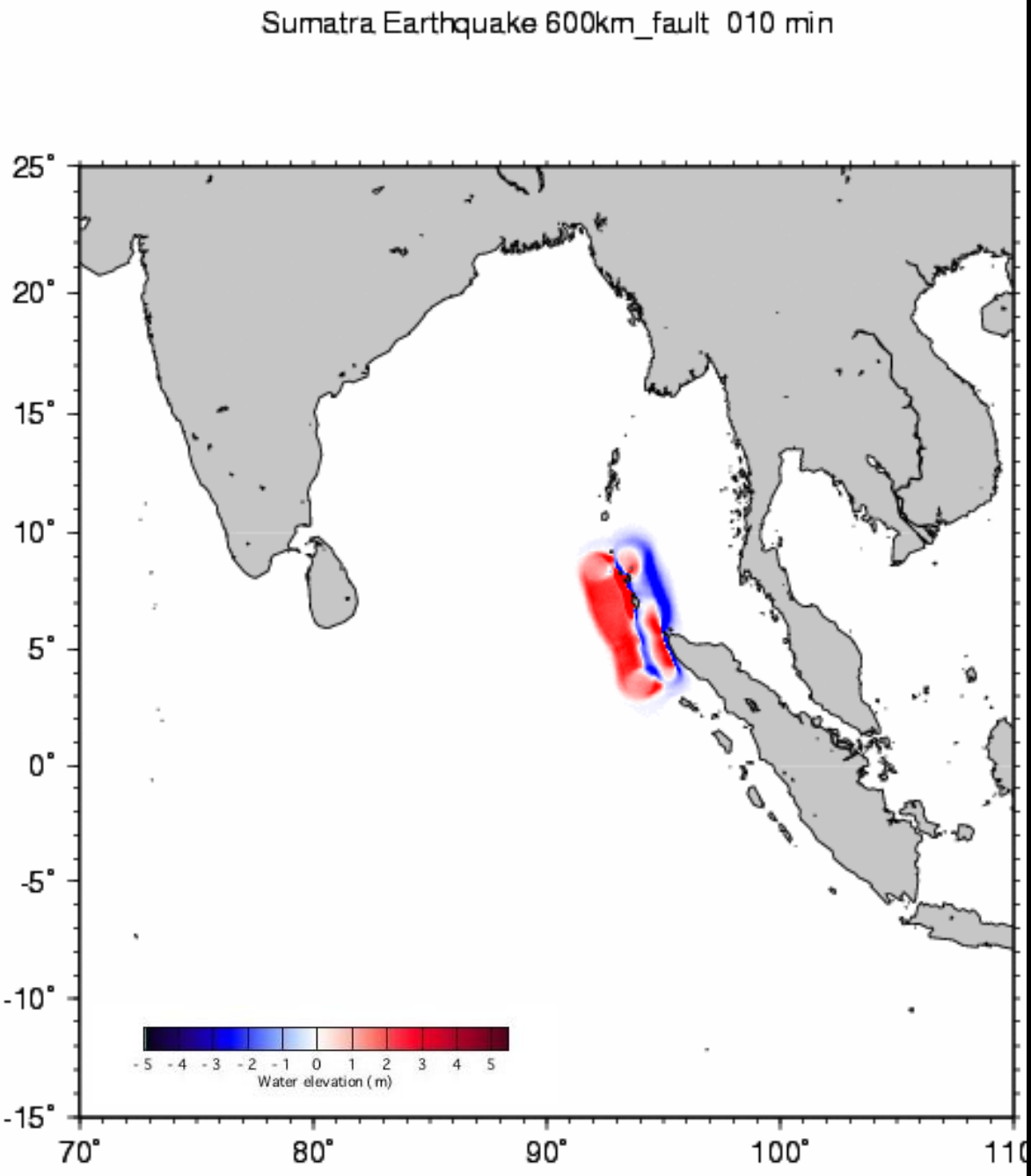
The 26 Dec 2004 Megathrust EQ

Magnitude: 9.3

Rupture Length: 1200 km

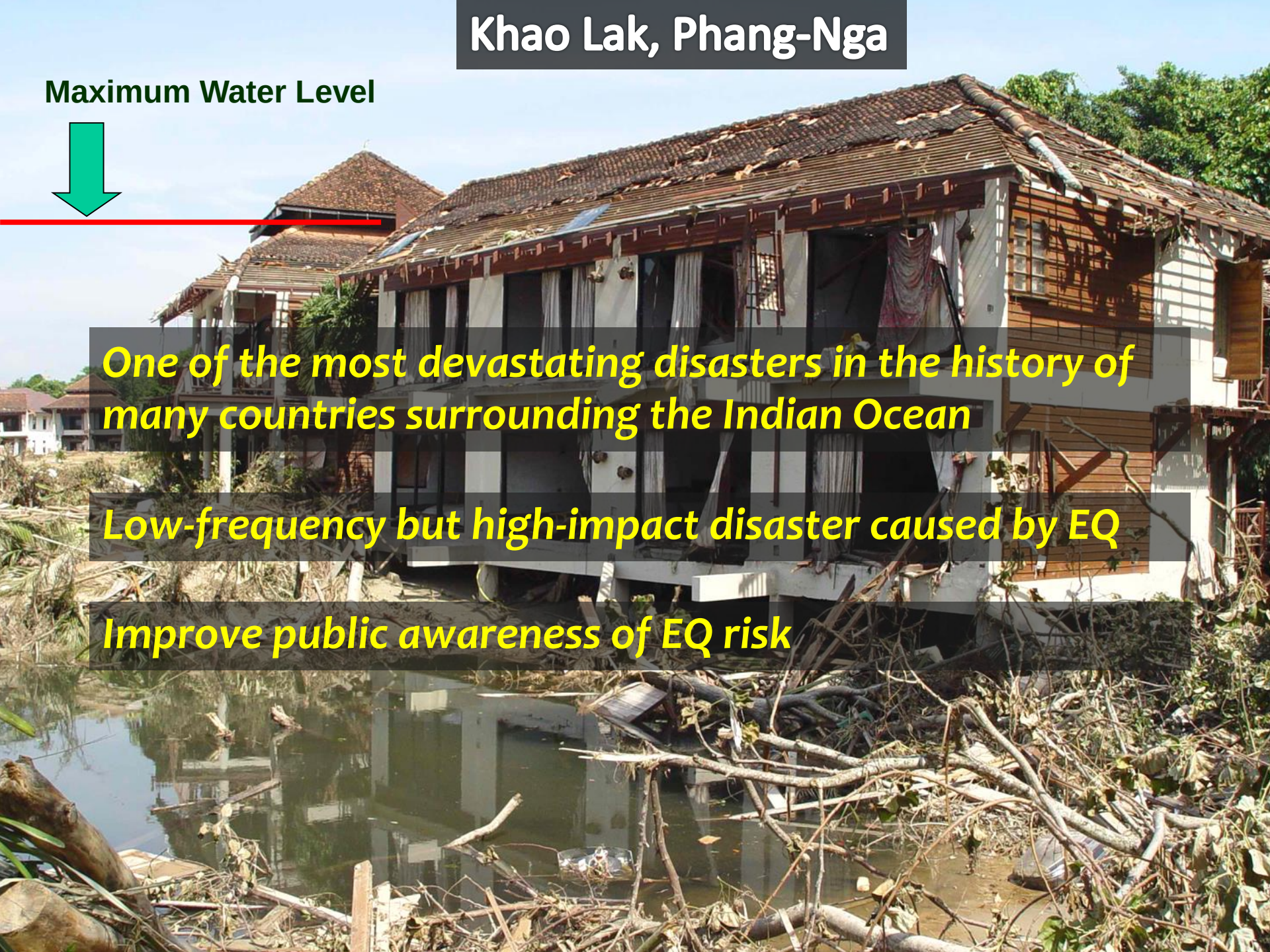


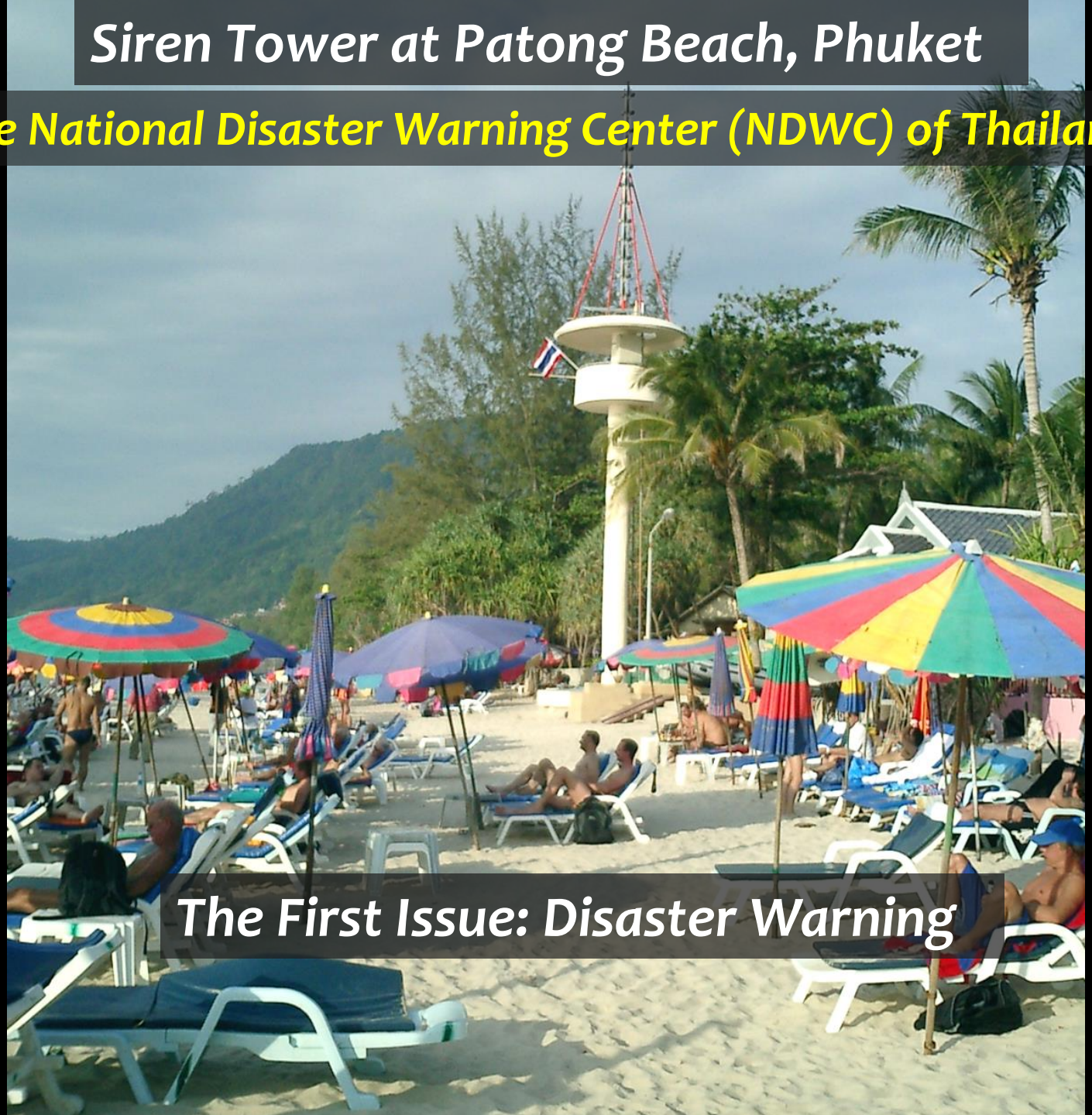
Ishii et al., 2005 Nature



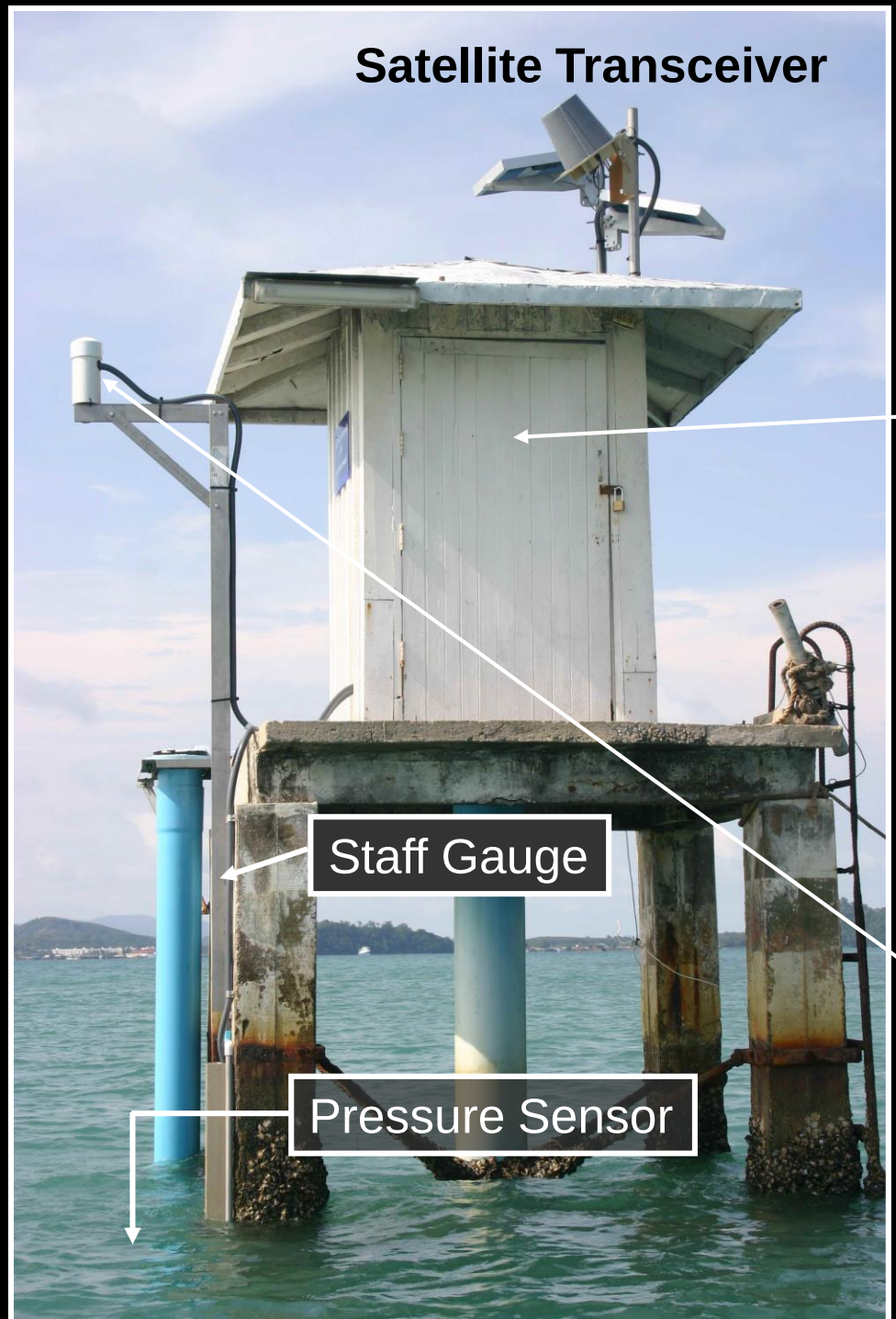
http:*llstaff.aist.go.jp/kenji.satake/Sumatra-E.html*

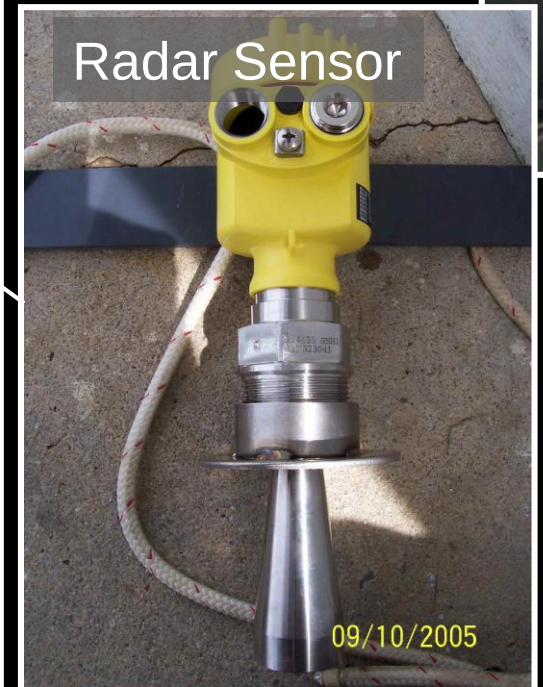

Tsunami Flooding
Kamala Beach, Phuket


Khao Lak, Phang-Nga
Maximum Water Level
One of the most devastating disasters in the history of many countries surrounding the Indian Ocean
Low-frequency but high-impact disaster caused by EQ
Improve public awareness of EQ risk

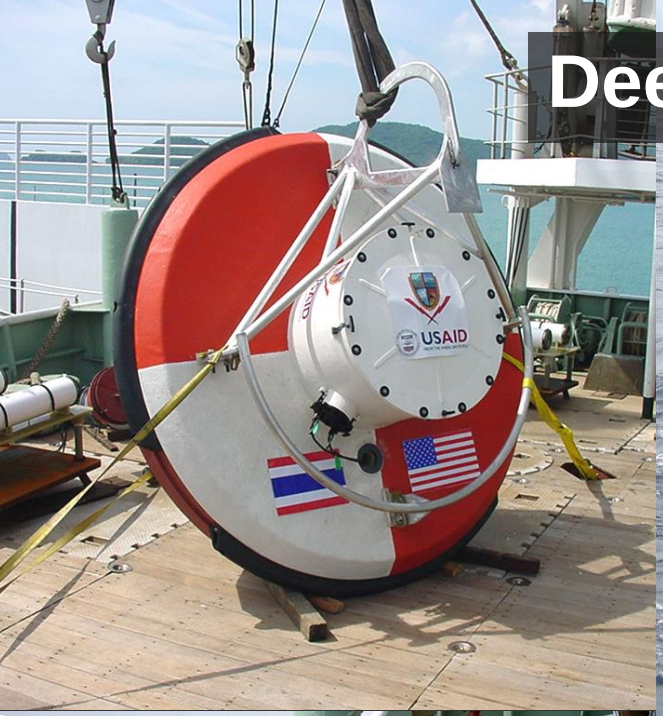

Siren Tower at Patong Beach, Phuket
The National Disaster Warning Center (NDWC) of Thailand
The First Issue: Disaster Warning

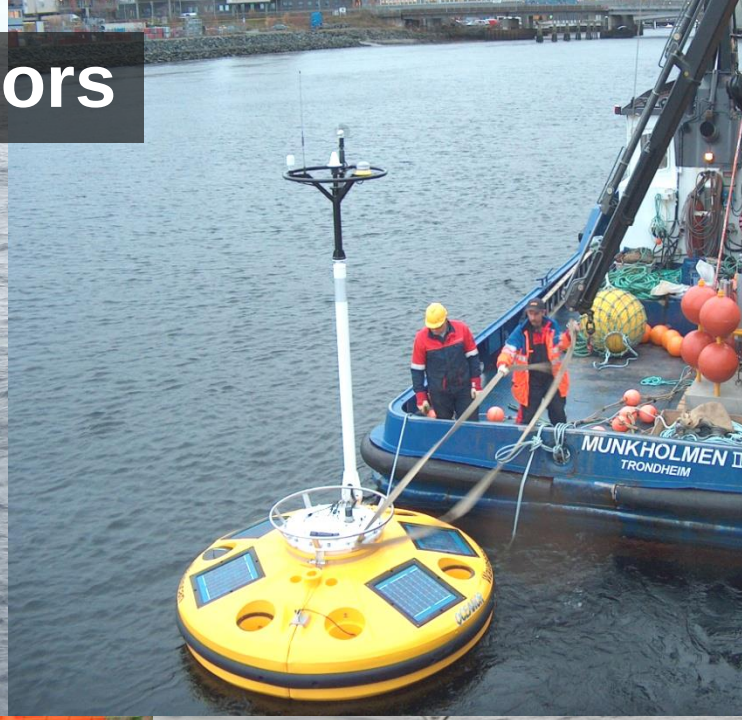
Sea Level Observing Station in Tapao Noi Island near Phuket

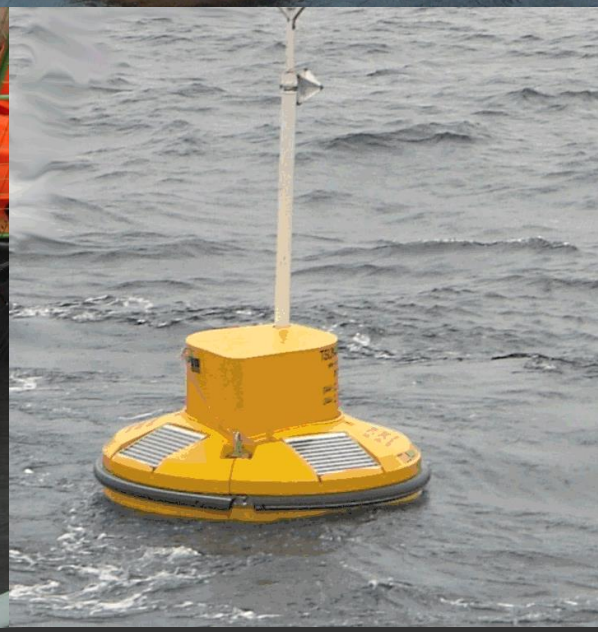




Deep Ocean Sensors







Need Regional Collaboration (not competition) to

Develop and Maintain Disaster Warning System

Exchange data in real time

Share knowledge and good practice

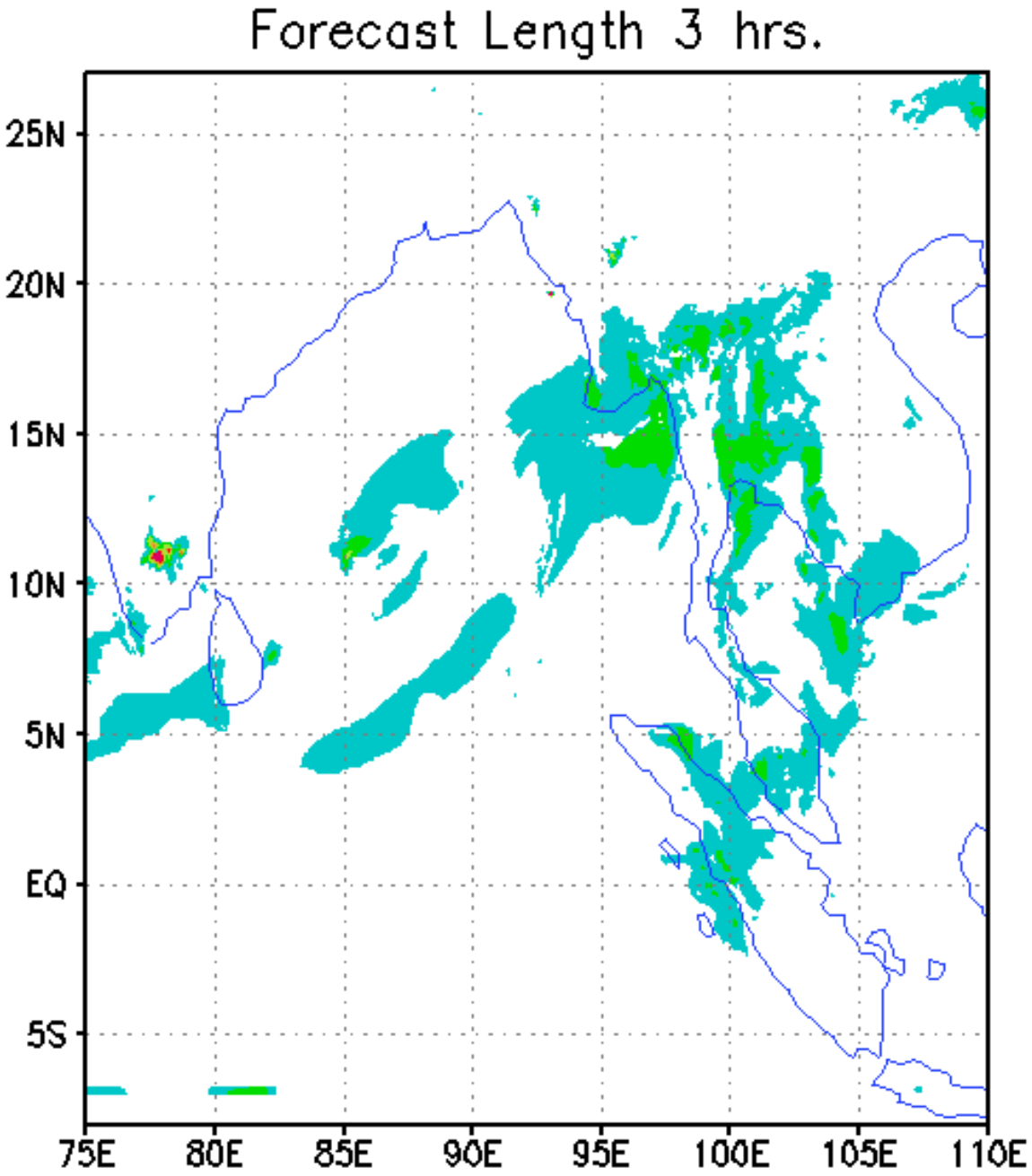
Effective End-to-End Disaster Warning System

Warning messages reach the population at risk

People know what they should do after the warning

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

Developed by Asian Disaster Preparedness Center (ADPC), Located in the AIT campus

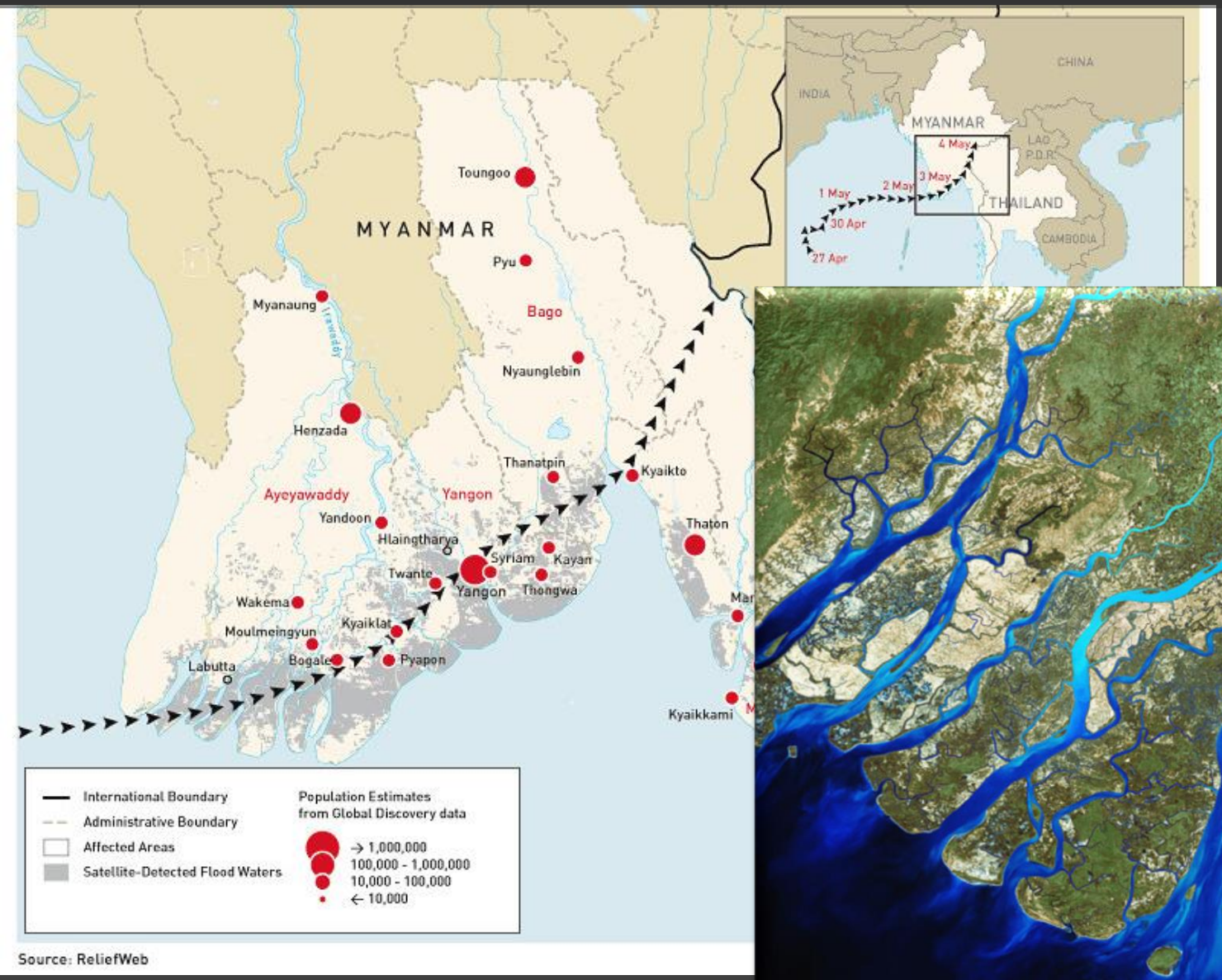


Cyclone Nargis

May 2, 2008

146,000 Deaths in Myanmar

The most affected area: Irrawaddy Delta of Myanmar



Source: ReliefWeb

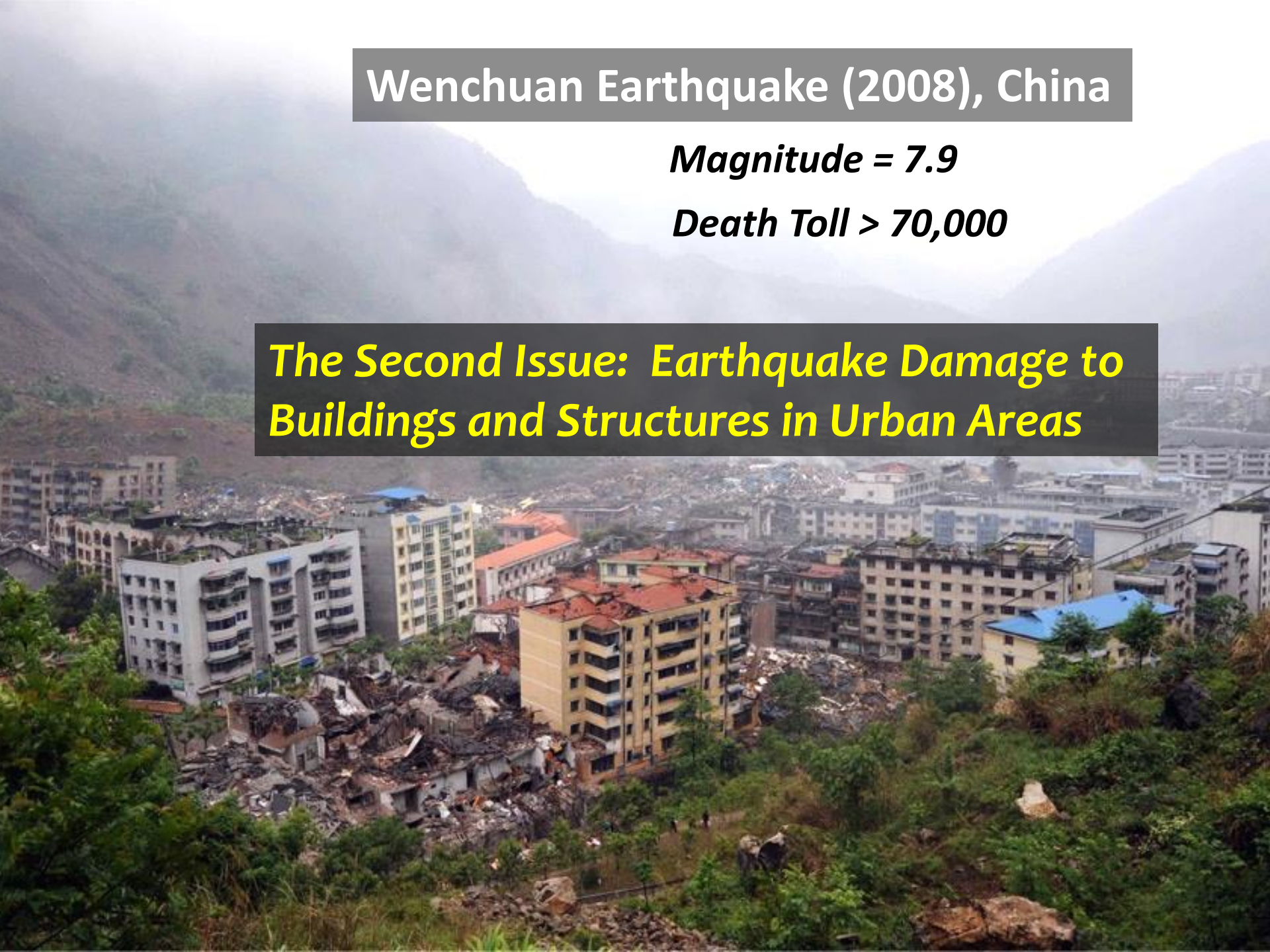

Storm Surge by Cyclone Nargis
Archarlay Village, Myanmar
Storm surge was the main factor for high number of casualties.

Wenchuan Earthquake (2008), China

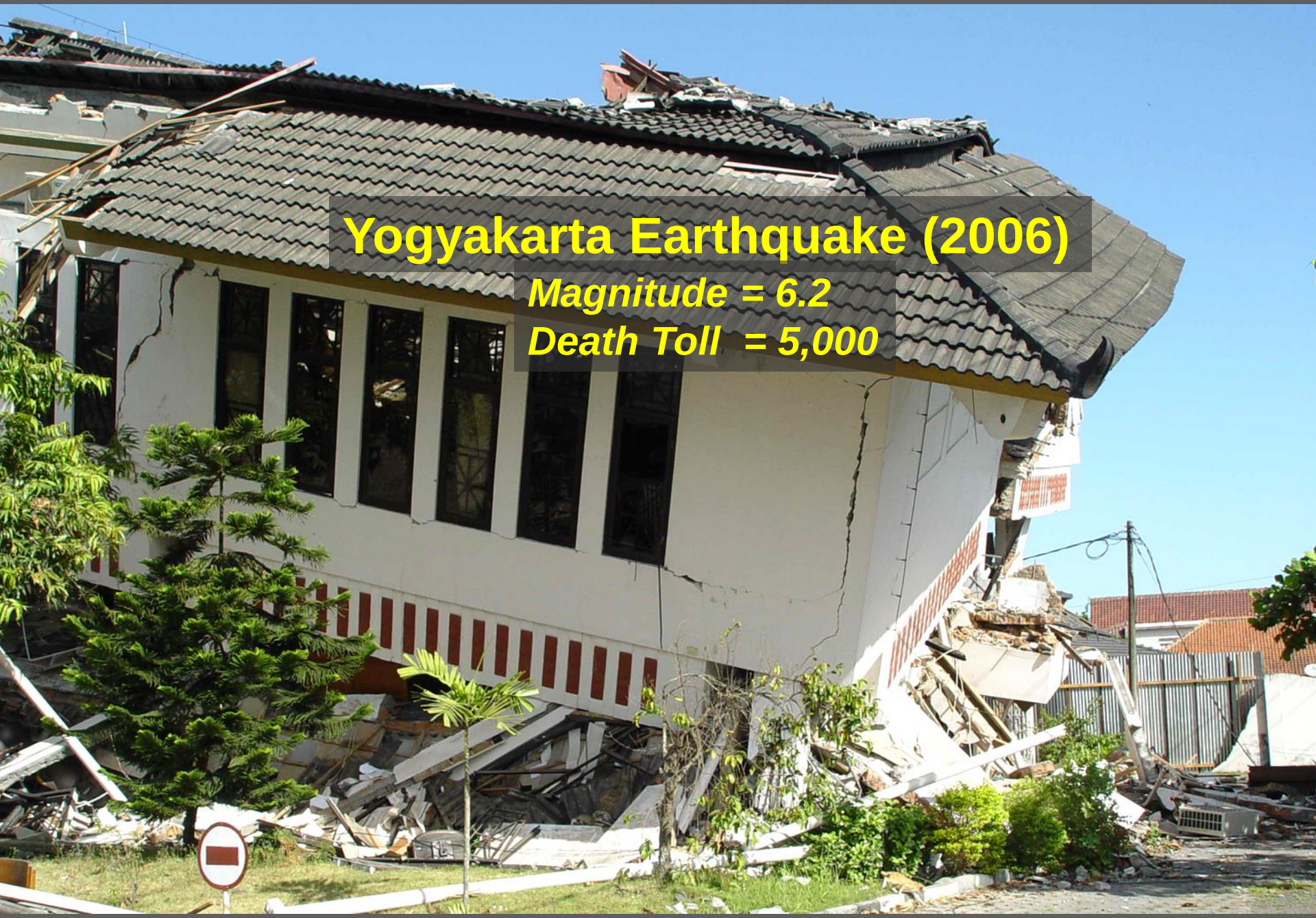
Magnitude = 7.9

Death Toll > 70,000

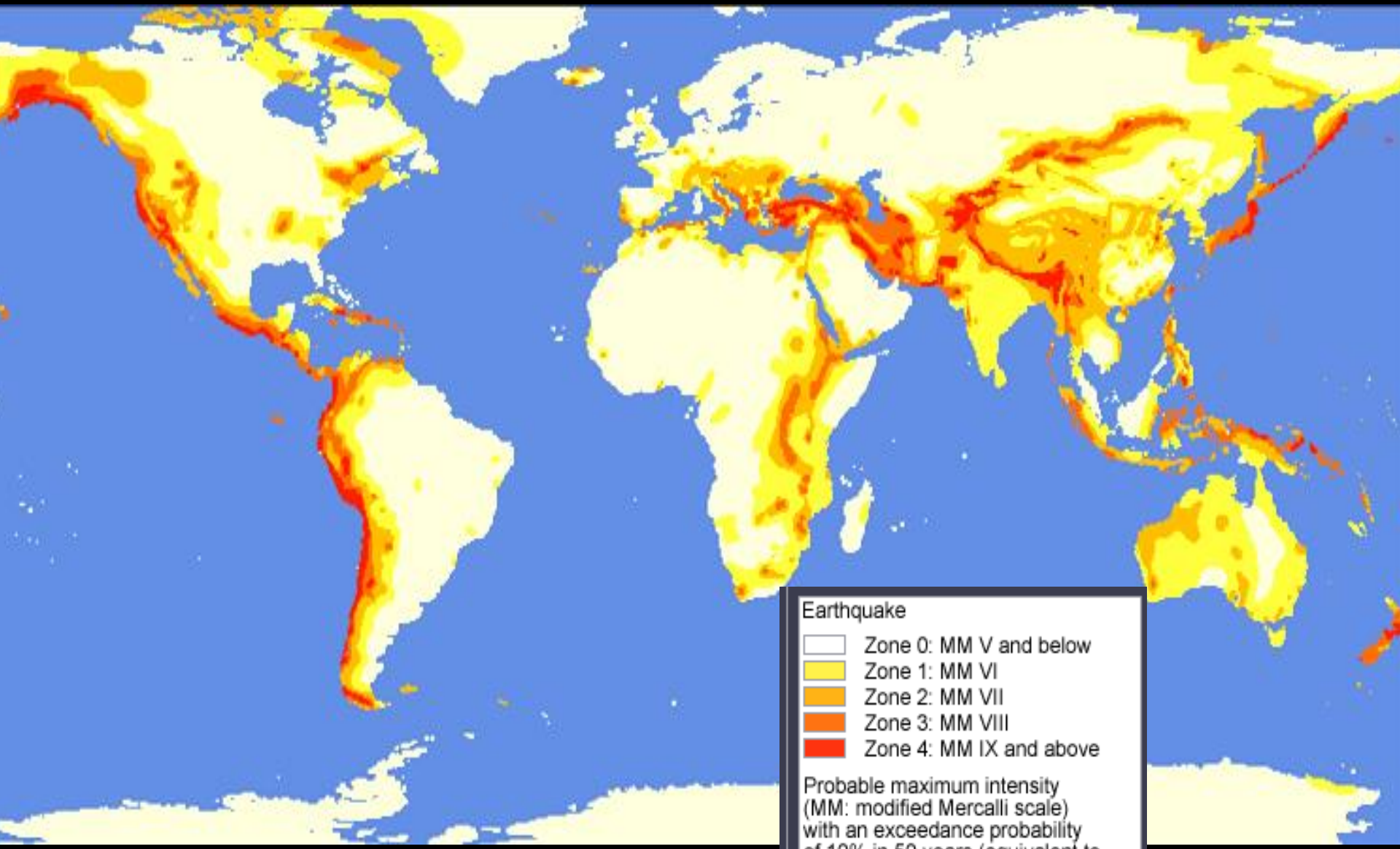
The Second Issue: Earthquake Damage to Buildings and Structures in Urban Areas




Balakot, Kashmir Earthquake (2005)
Magnitude = 7.6
Death Toll = 79,000


Yogyakarta Earthquake (2006)
Magnitude = 6.2
Death Toll = 5,000

Global Seismic Hazard Map



Effective Measures to Mitigate Earthquake Risk

Earthquake Early Warning ?

Earthquake Prediction ?

Post-Earthquake Emergency Response ?

Earthquake-induced Collapse of a Cathedral

Source: Dr. Yutaka Nakamura & Prof. Fumio Yamazaki

Pancake Collapse of Concrete Buildings in Kathmandu (Nepal EQ, 2015)

Effective Measures to Mitigate Earthquake Risk

Earthquake Early Warning ?

Earthquake Prediction ?

Post-Earthquake Emergency Response ★

Earthquake-resistant design of new buildings ★★★

- *Outdated seismic design code*
- *Ineffective code enforcement*
- *Engineers are not familiar with seismic design*
- *Additional cost of construction*

Seismic retrofitting of some existing vulnerable buildings ★

- *High cost*
- *Need more research to develop more cost effective retrofit measures*

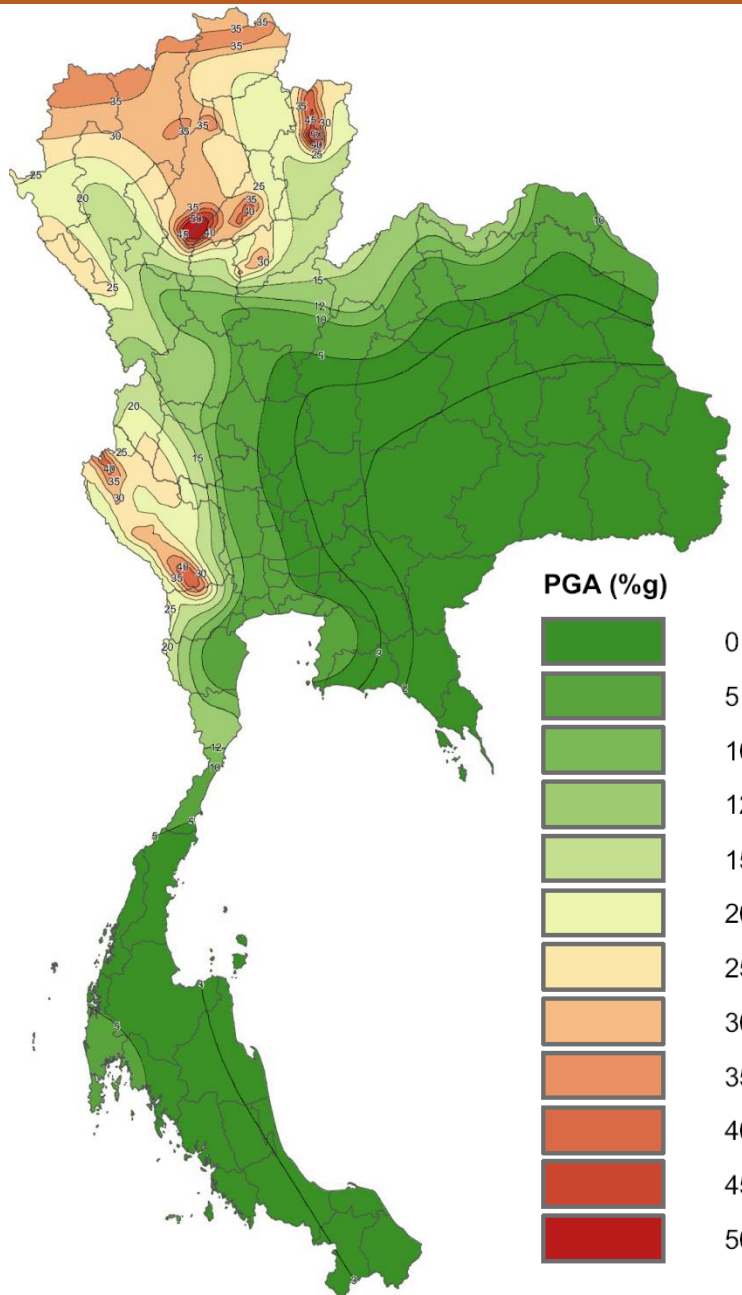
Common problems in many countries

Crustal Faults in and near Thailand

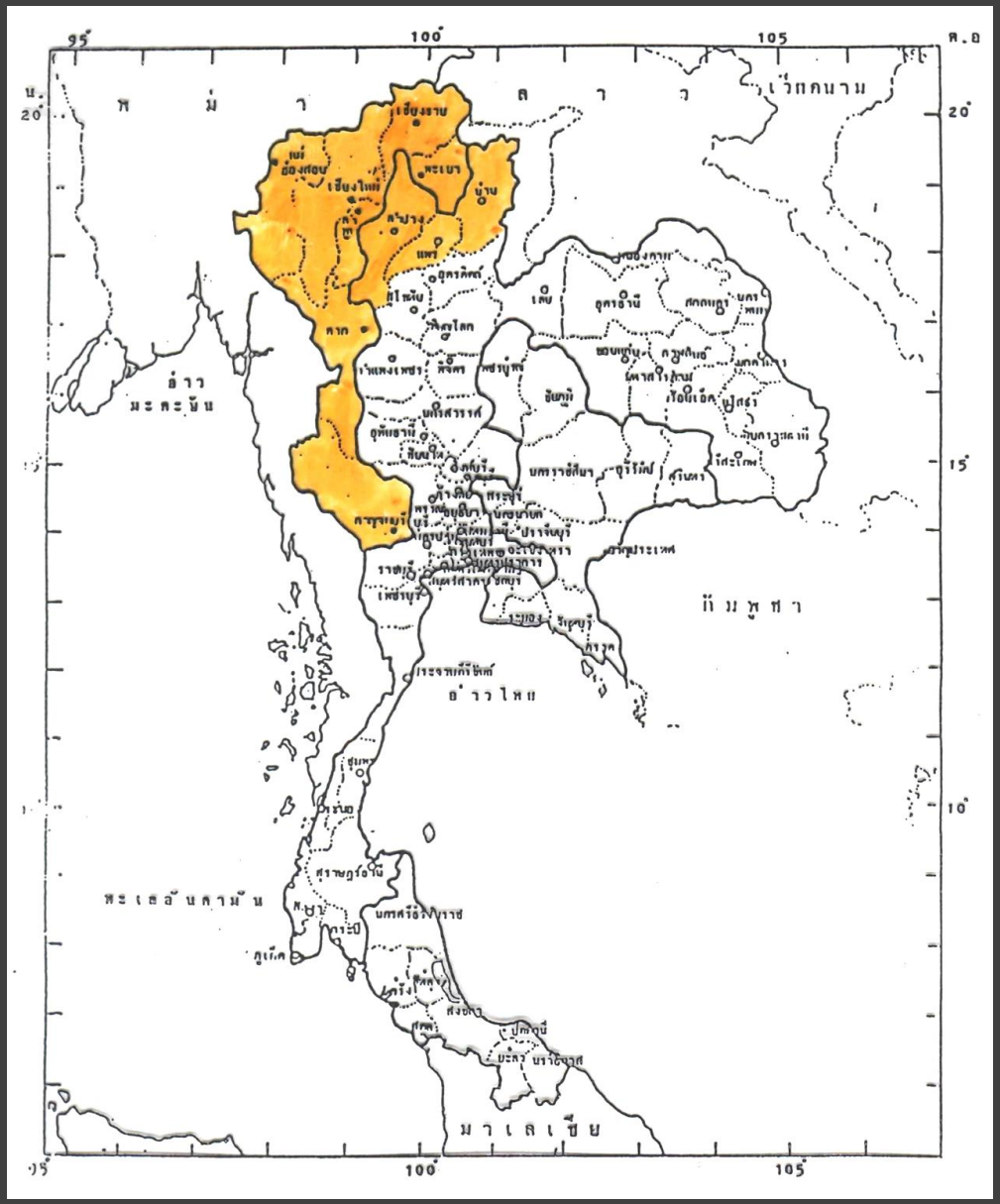
1. Mae Chan Fault (SS
2. Central Phayao Fau
3. Mae Kuang Fault (S
4. Pua Fault (N)
5. Thoen Fault (N)
6. Long Fault (N)
7. Phrae Fault (N)
8. Phrae basin Fault (
9. Nam Pat Fault (N)
10. Moei Fault(SS)
11. Sri Sawat Fault (S
12. Chao Phraya Basi
13. Three Pagoda Fau
14. Bong Ti Fault (SS)
15. Tavoy Fault (SS)
16. Kungyaungale Fau
17. Tenasserim Fault
18. Ranong Fault (SS)
19. Chumphon Basin
20. Khlong Marui Faul
21. Sagaing Fault (SS)

SS= Strike-Slip Fault
N = Normal Fault

Peak Ground Acceleration for 2500-yr Return Period



The 1st Ministerial Regulation for Seismic Design

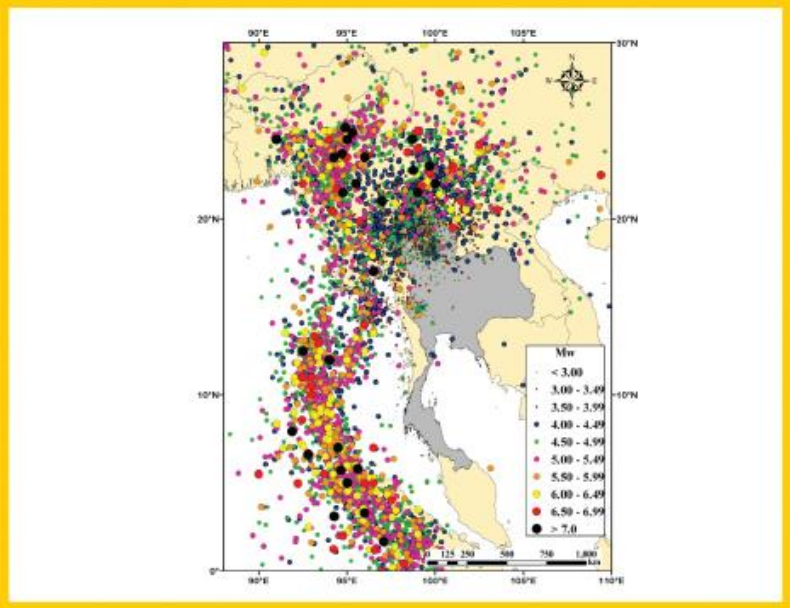


Effective since Nov. 1997

Limited to 10 provinces

Limited to public buildings, essential facilities, hazardous facilities, and structures with more than 15-m high

Design requirements are similar to those of the 1985 UBC Zone 2



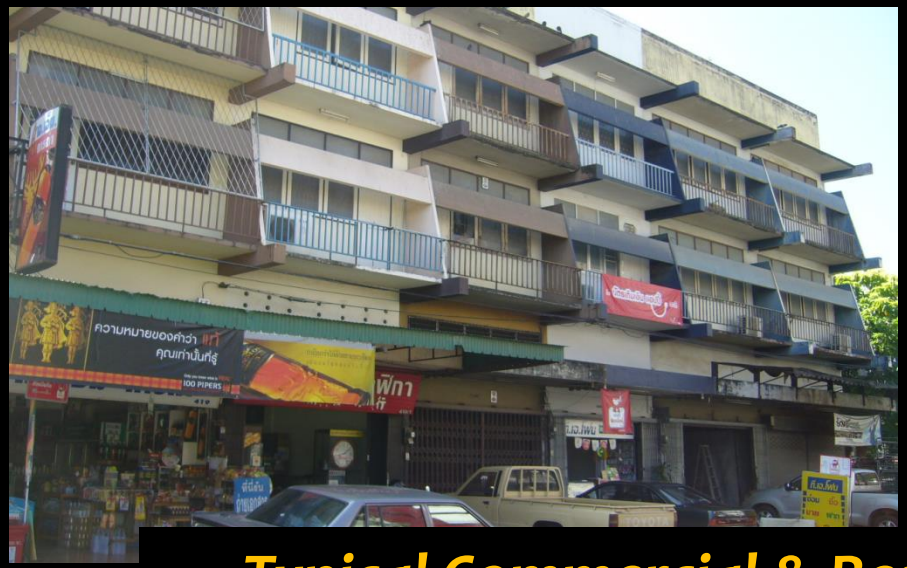
National Standard DPT 1302: Seismic Resistant Design of Buildings and Structures

Issued by Department of Public Works and Town & Country Planning,Ministry of Interior (2009)

Model Code: ASCE 7-05

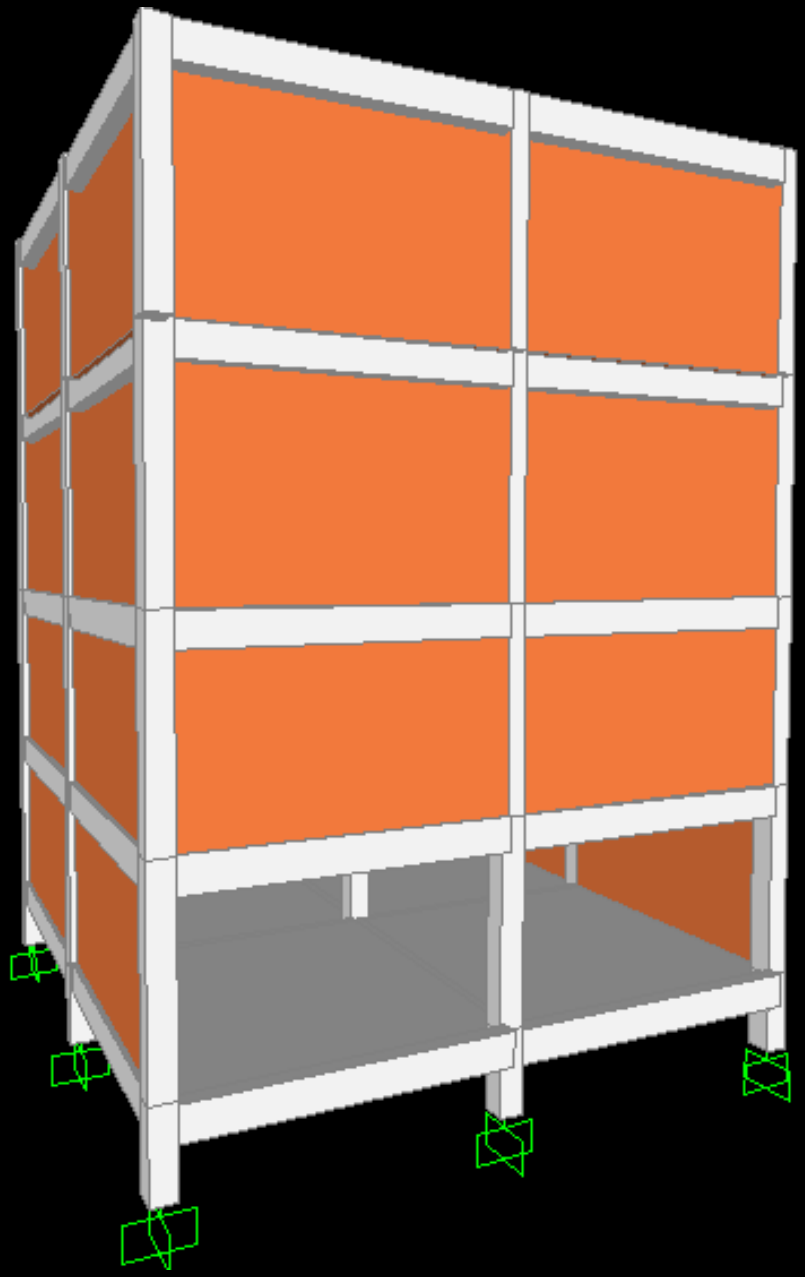
Require the values of Spectral Acceleration at 0.2 sec and 1.0 sec at 2500-yr return period for defining Maximum Considered Earthquake (MCE) ground motion

Basic Problem : A large number of existing buildings are vulnerable to earthquake ground shaking !



Typical Commercial & Residential Concrete Buildings

Typical Commercial-Residential RC Building

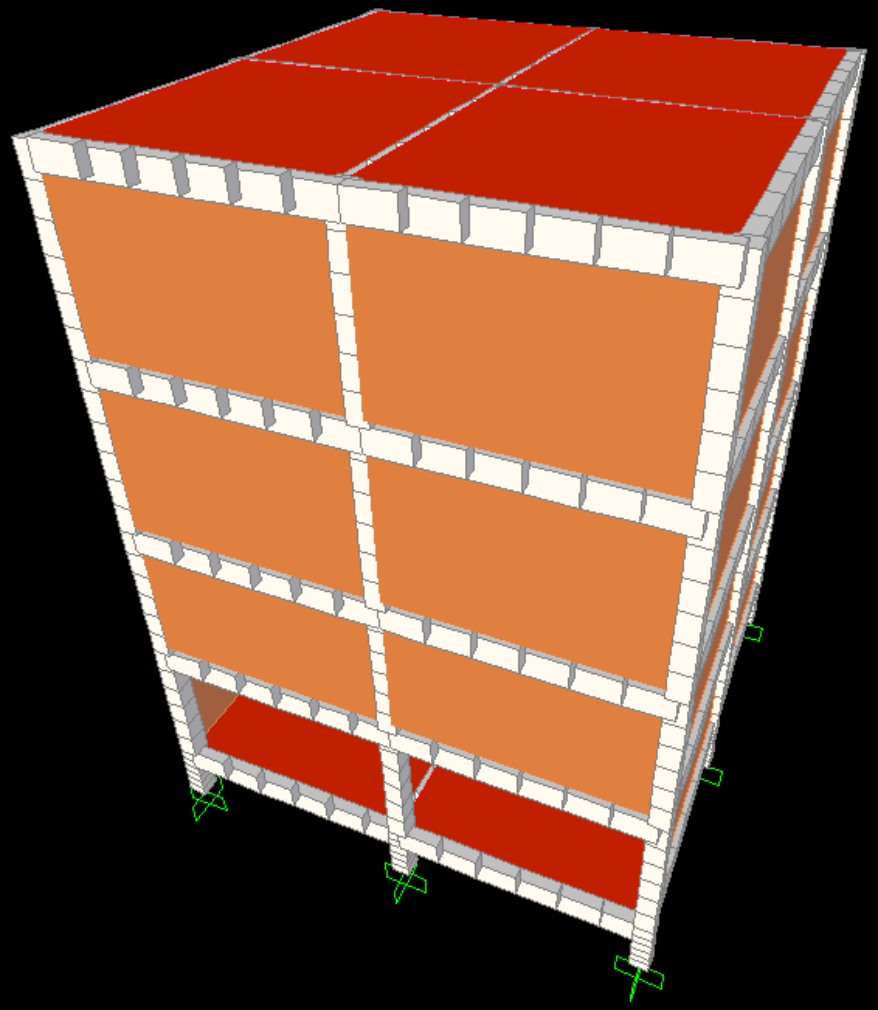


VULNERABILITY FACTORS

- Soft/Weak First Story
- Torsional Irregularity
- Non-seismic Detailing

3D-view generated by SAP2000 v10

Elastic Dynamic Response (Modal Analysis)

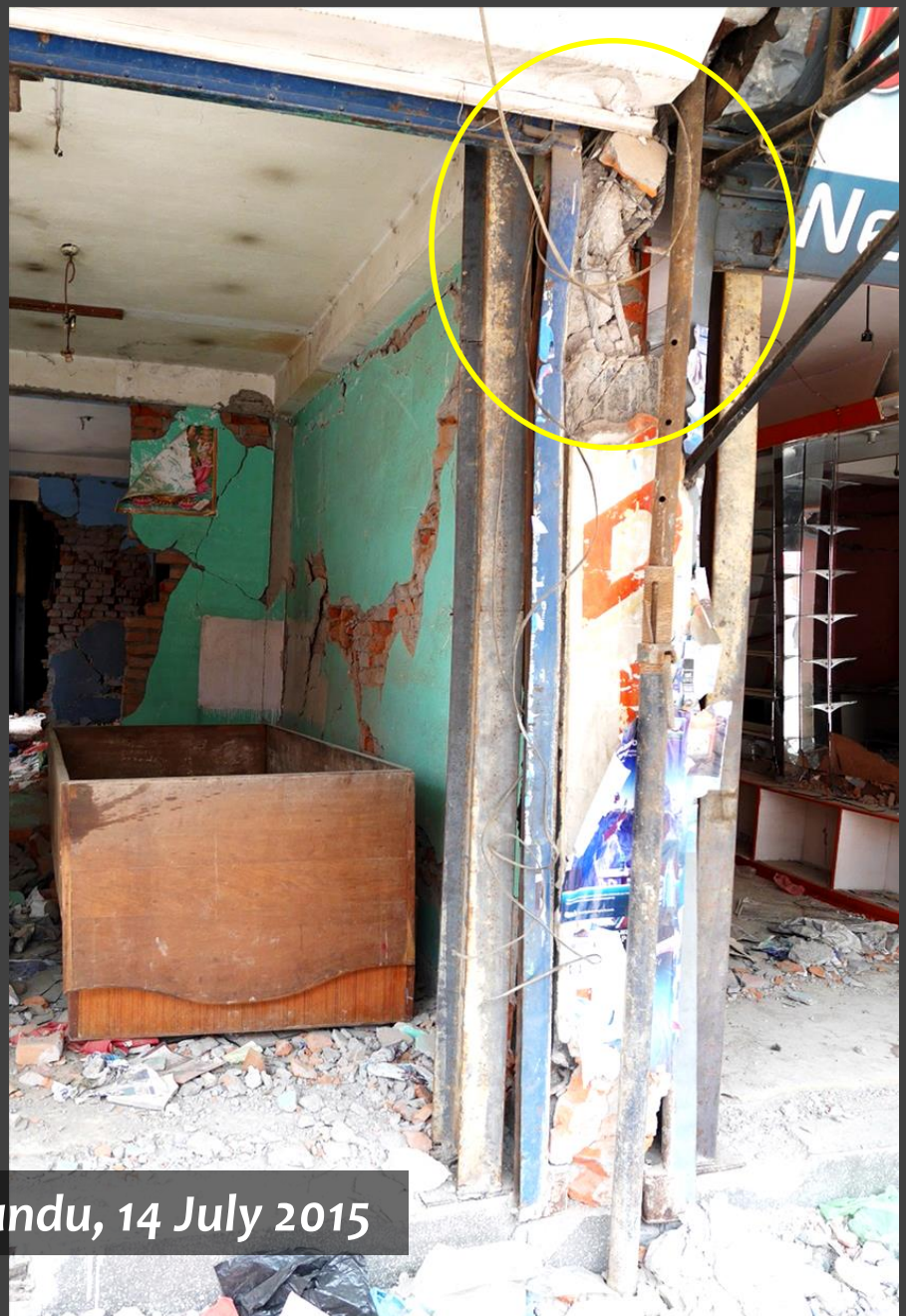


Lateral-Torsional Movement (period = 0.50 sec)

Soft-story Collapse of Commercial/Residential Buildings in the 1999 Chi-Chi Earthquake (Taiwan)

Collapse & Failure by Soft Story + Torsional Irregularity

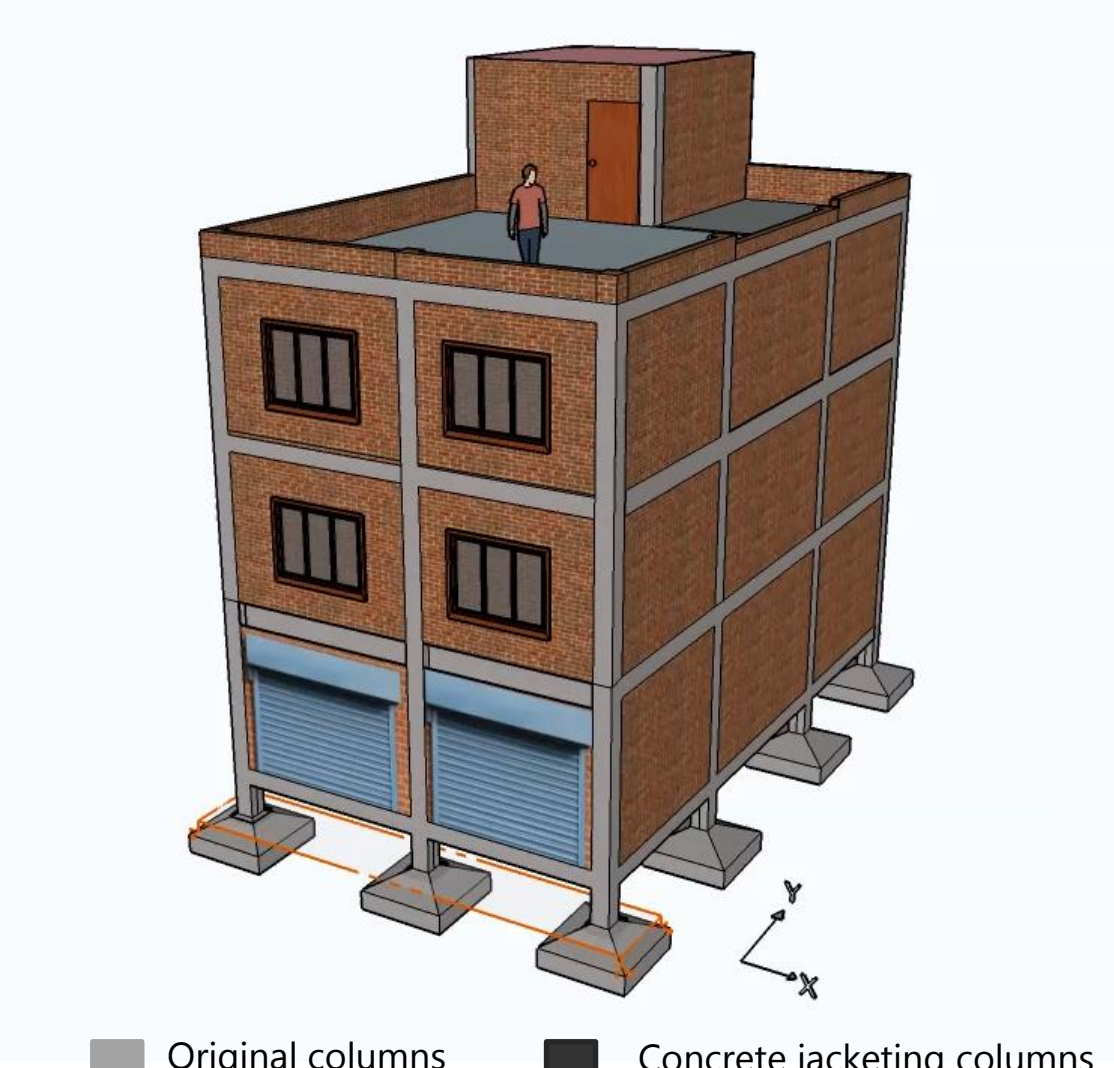
First-Story Failure by Soft Story + Torsional Irregularity



Gongabu, Kathmandu, 14 July 2015

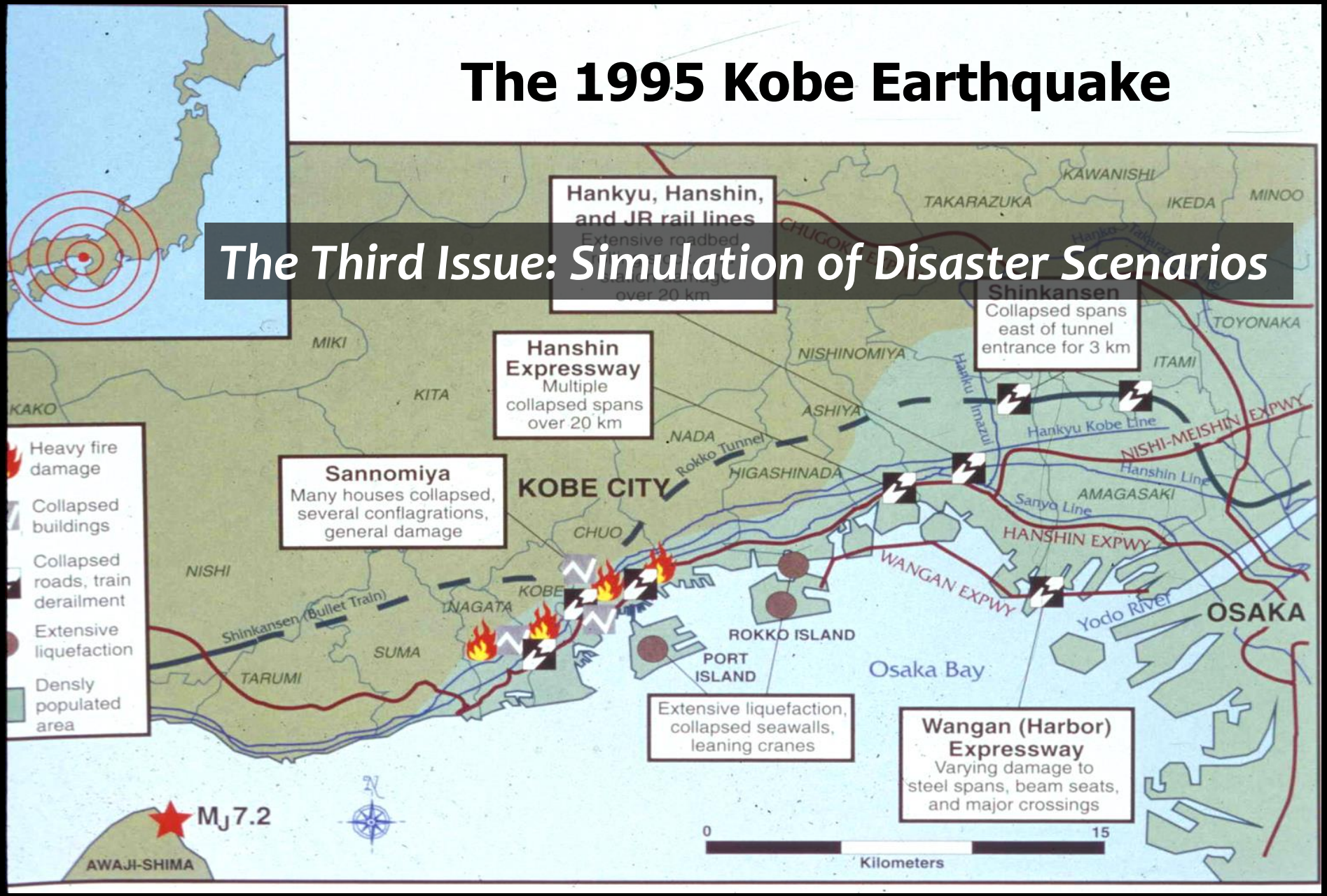
Inside the Building

Seismic Retrofit Method for Low-rise, Street-front Concrete Buildings

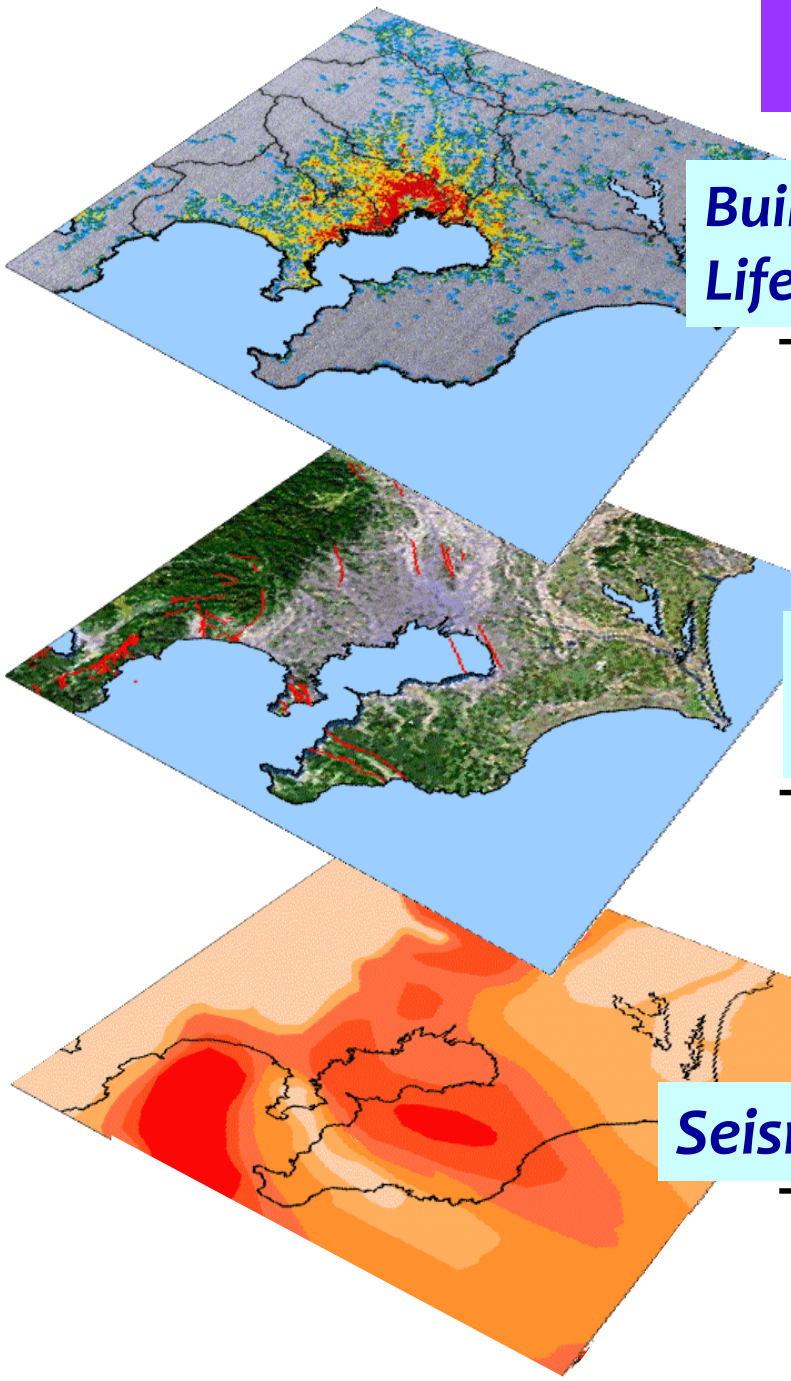


The 1995 Kobe Earthquake

The Third Issue: Simulation of Disaster Scenarios



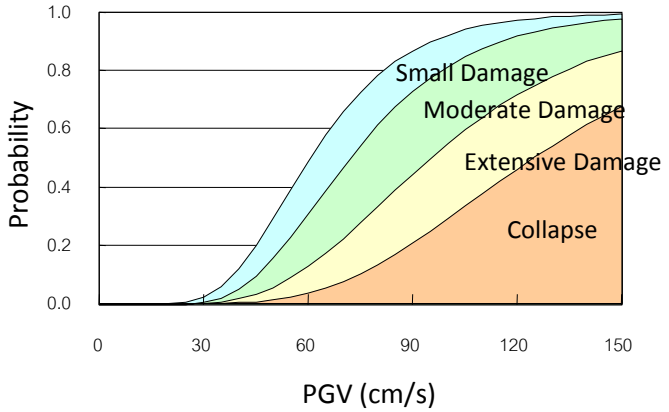
Seismic Loss Estimation using GIS



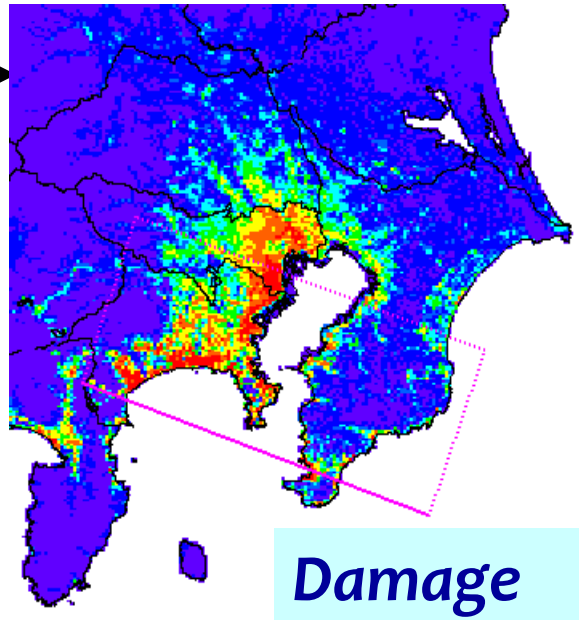
Building Stock
Lifeline Systems

Geological Data

Seismic Hazard

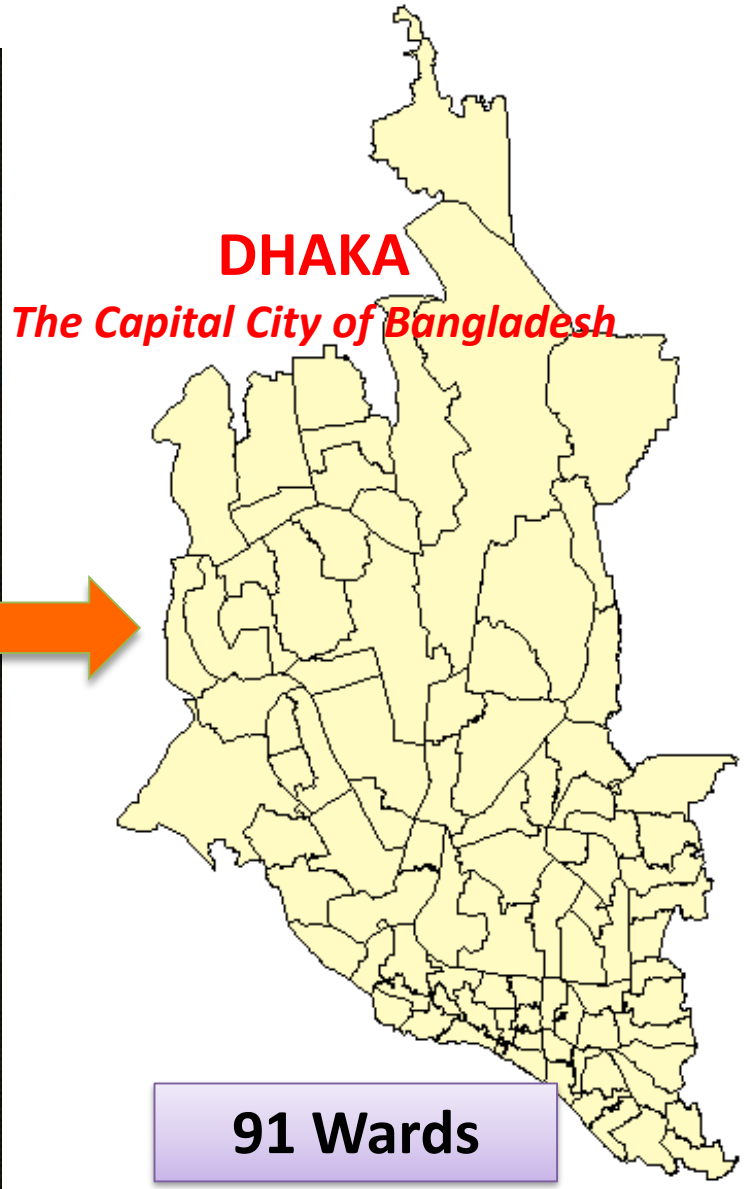


Vulnerability



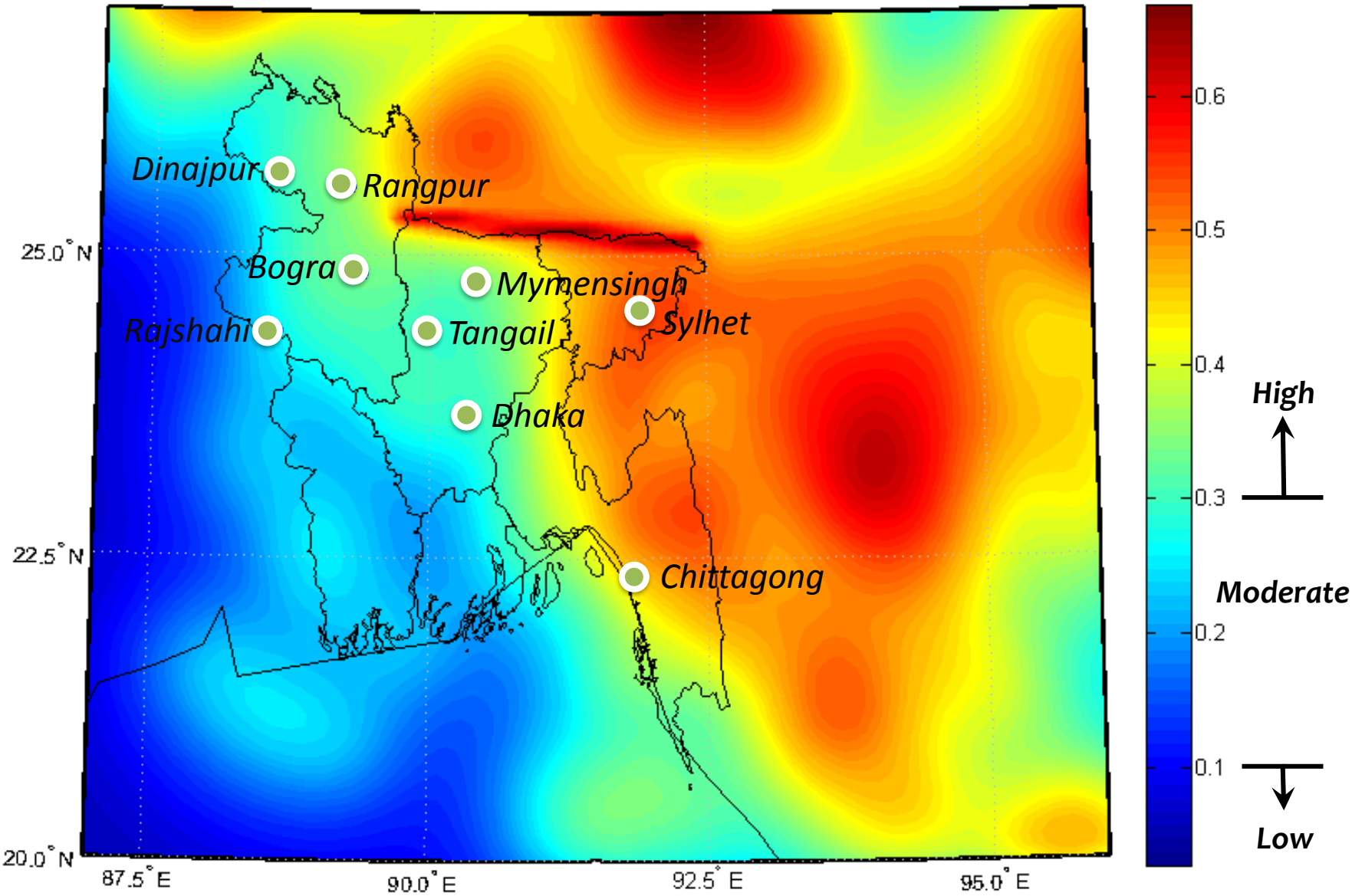
Damage

A Project under the Comprehensive Disaster Management Program (CDMP) of the Government of Bangladesh



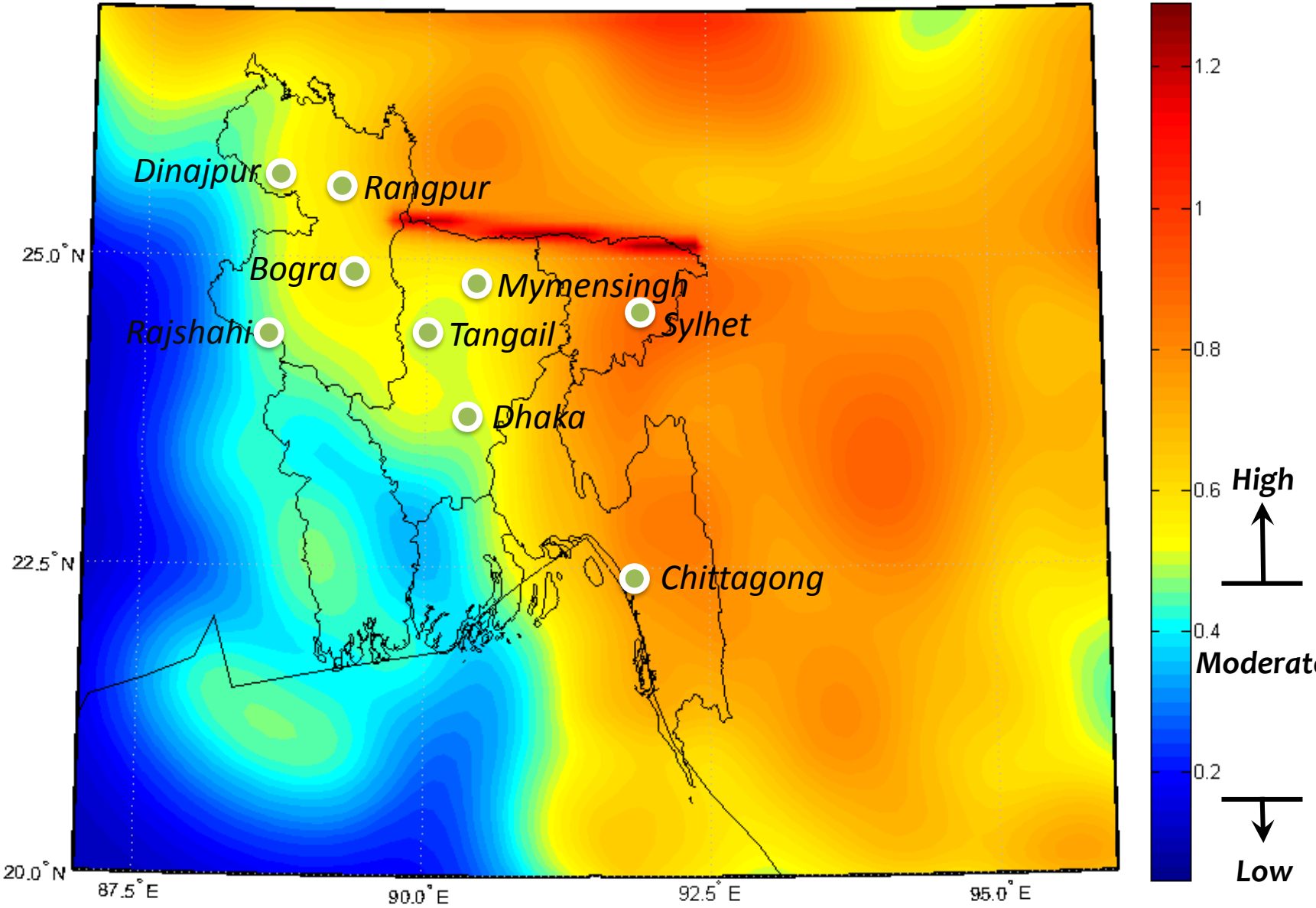
Seismic Hazard Map of Bangladesh

Peak Ground Acceleration (PGA) for a 500-year return period



Seismic Hazard Map of Bangladesh

Peak Ground Acceleration (PGA) for a 2500-year return period



Damage to Concrete Buildings in Dhaka City

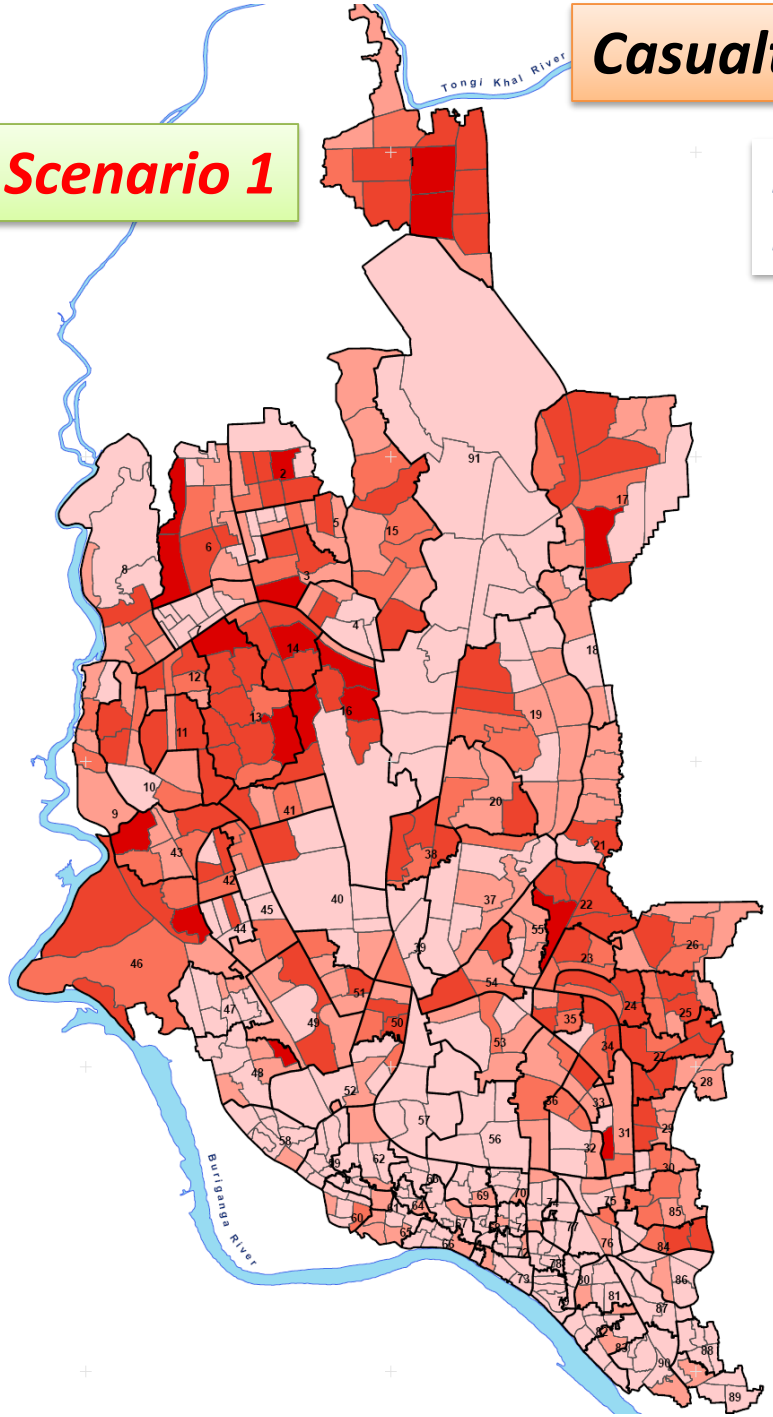
EQ Scenario 1
(500-yr Return Period)

Number of Concrete Buildings
(moderately damage to complete failure)

	0-50
	50-100
	100-150
	150-250
	250-450

Casualties in Dhaka City

EQ Scenario 1



Number of Injuries Levels 2+3+4

- 0-50
- 50-100
- 100-300
- 300-600
- 600-1200

Severity Level 1: Injuries will require medical attention but hospitalization is not needed

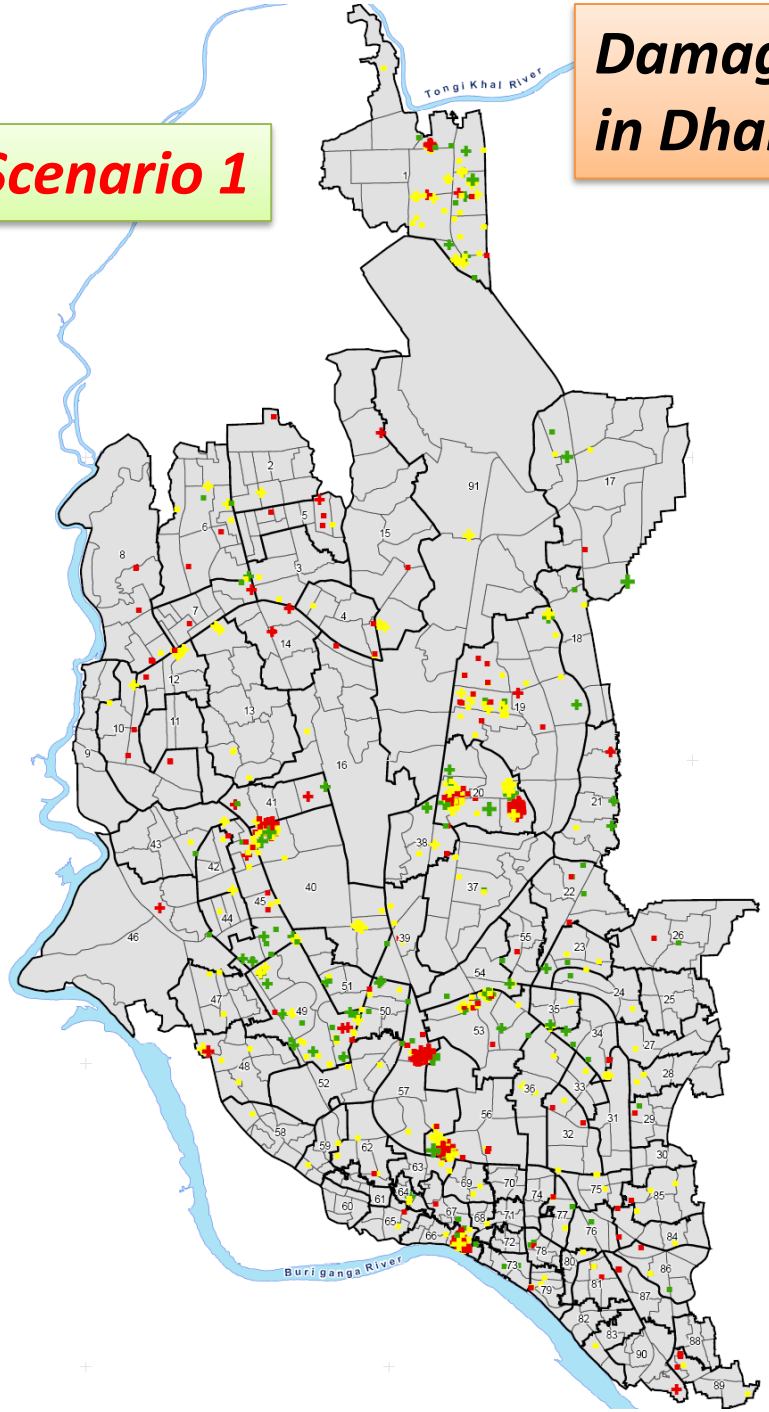
Severity Level 2: Injuries will require hospitalization but are not considered life-threatening

Severity Level 3: Injuries will require hospitalization and can become life-threatening if not promptly treated

Severity Level 4: Victims are killed by the earthquake

Damage to Medical Care Facilities in Dhaka City

EQ Scenario 1



Medical Care Facility

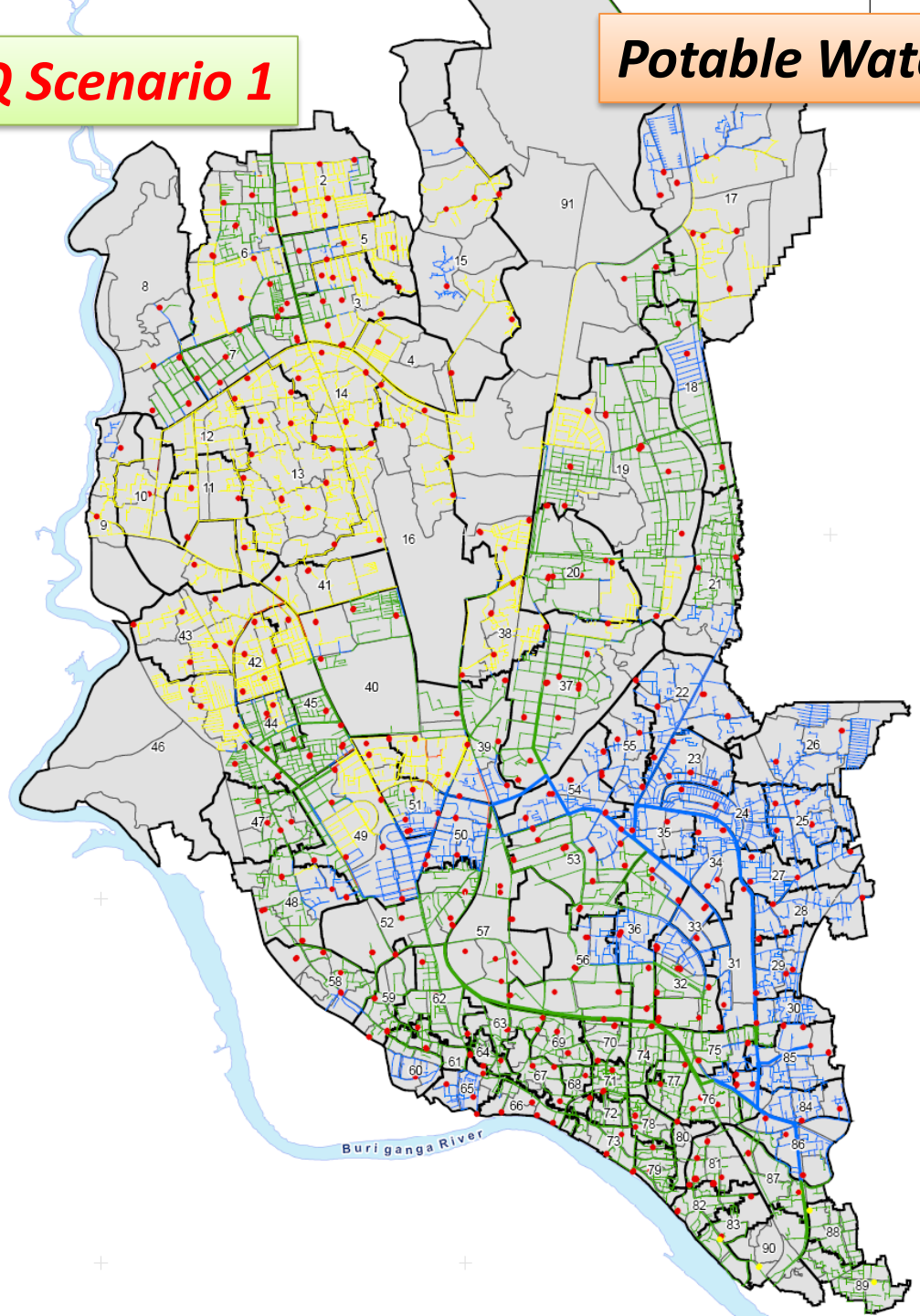
- Large Hospital
- Medium Hospital
- Small Hospital
- Medical Clinic

Percent Functional of Medical Care Facility at Day 1

- < 30%
- 30% - 70%
- > 70%

EQ Scenario 1

Potable Water System in Dhaka City



Percent Functional of Potable Water Facility at Day1

- < 30%
- 30% - 70%
- > 70%

Potable Water Pipeline

- Large pipe (Diameter > 20')
- Small pipe (Diameter < 20')

Potable Water Pipeline

Number of Repair/ k.m.

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 3.0

HAZUS-MH: Models

Develop emergency response plans

- *Emergency medical services*
- *Temporary shelters*
- *Emergency water and power*
- *Planning for critical transportation outages*

Organize emergency response excercises

Develop mitigation plans

- *Identify elements at risks*
- *Strengthen existing buildings and structures*
- *Building code enforcement*
- *Land use planning*

Develop recovery plans

- *Housing recovery strategy*
- *Long-term economic recovery planning*

FLOOD **HURRICANE** **EARTHQUAKE**

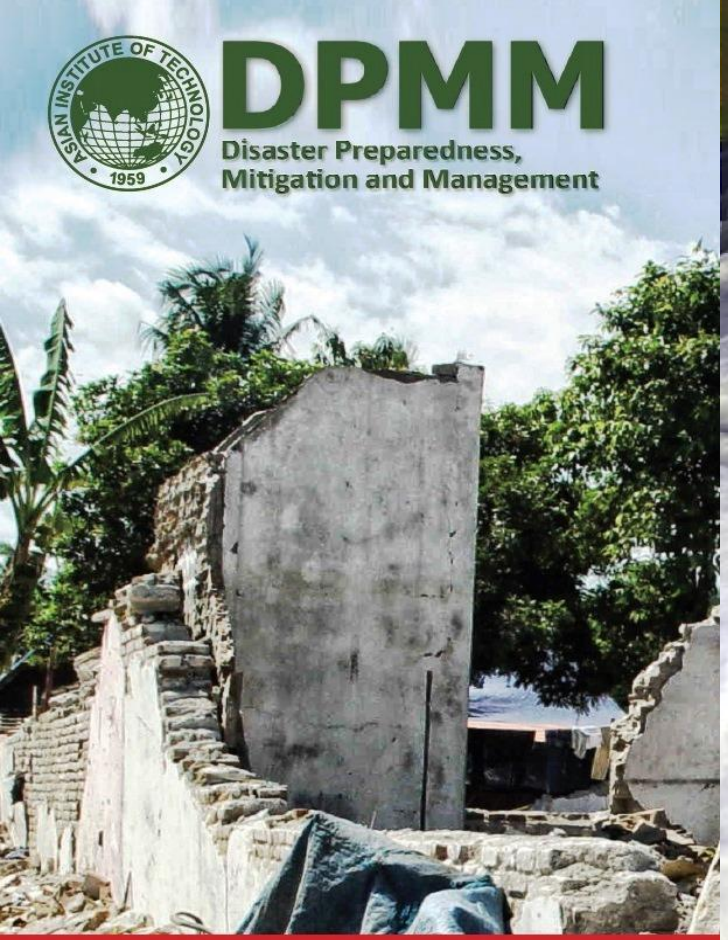
The Fourth Issue: DRR Program Managers

Urgent Need for Human Resource Development

Asian countries are becoming increasingly vulnerable to various types of disasters including earthquakes, landslides, floods, droughts, forest fires, typhoons and man-made hazards.

But, they have displayed very limited capacity to respond to such disasters.

We need to instill the necessary interdisciplinary capacities in people on the front lines of disaster response and preparedness.



DPMM

Disaster Preparedness, Mitigation and Management

DISASTER PREPAREDNESS, MITIGATION AND MANAGEMENT (DPMM)

POST-GRADUATE PROGRAM

School of Environment, Resources and Development (SERD)
School of Engineering and Technology (SET)

The necessary interdisciplinary capacities in people on the front lines of disaster response and preparedness:

- *Have a profound scientific understanding of disasters*
- *Ability to assess risks using appropriate tools and techniques*
- *Ability to develop disaster management plans*
- *Capable of applying suitable measures to mitigate risk*
- *Possess the skills necessary for handling complex emergency situations*
- *Able to communicate with various stakeholders and policy makers on issues associated with disaster preparedness, mitigation and management.*

Science, Engineering & Technology

Development, Management & Social Science

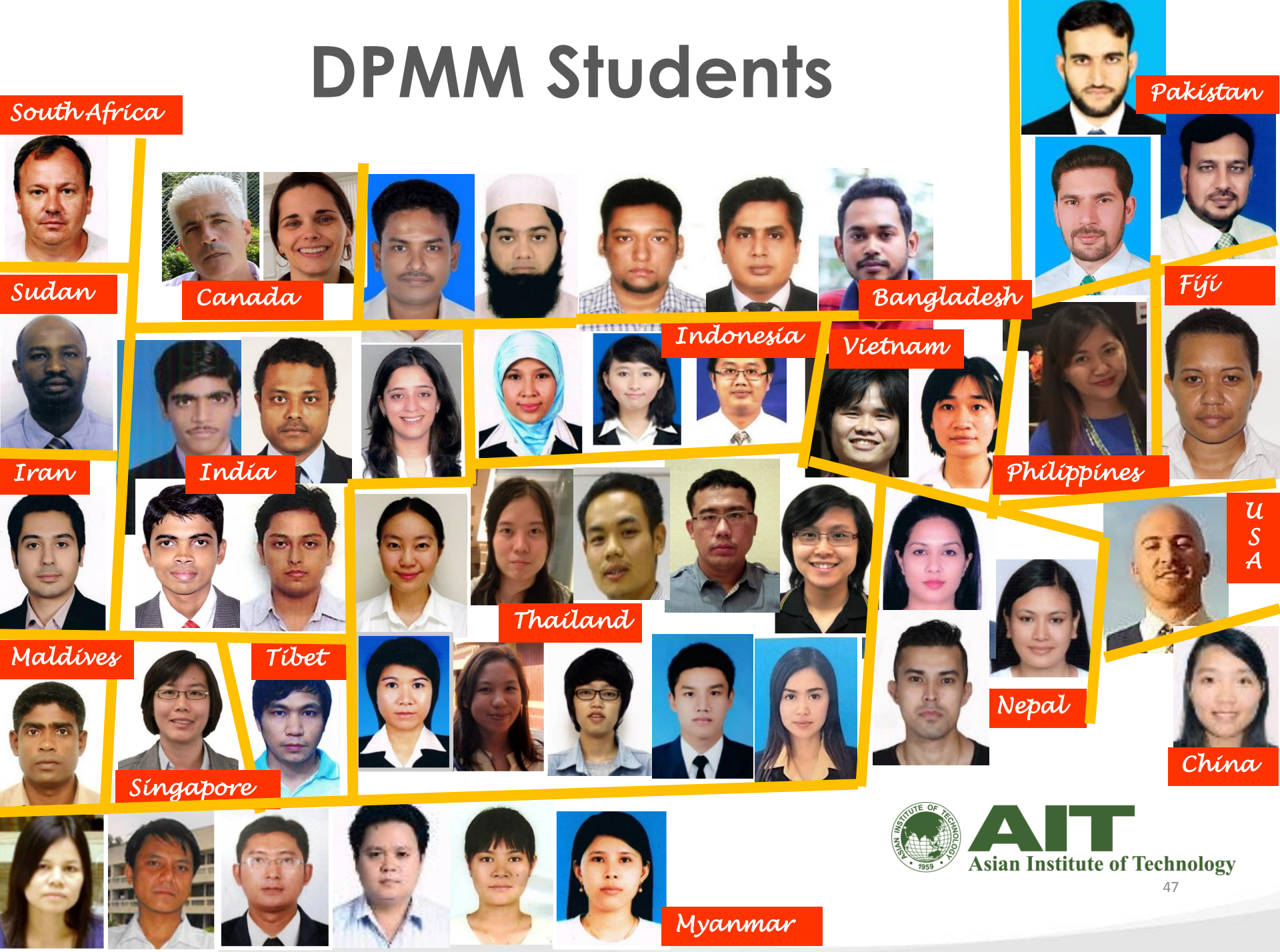
Managing Disasters (R)

- *Mitigation of Earthquake Disasters (E)*
- *Floods and Droughts (E)*
- *Climate Hazards and Early Warning Systems (E)*
- *Remote Sensing and GIS for Disaster Risk Mitigation (E)*

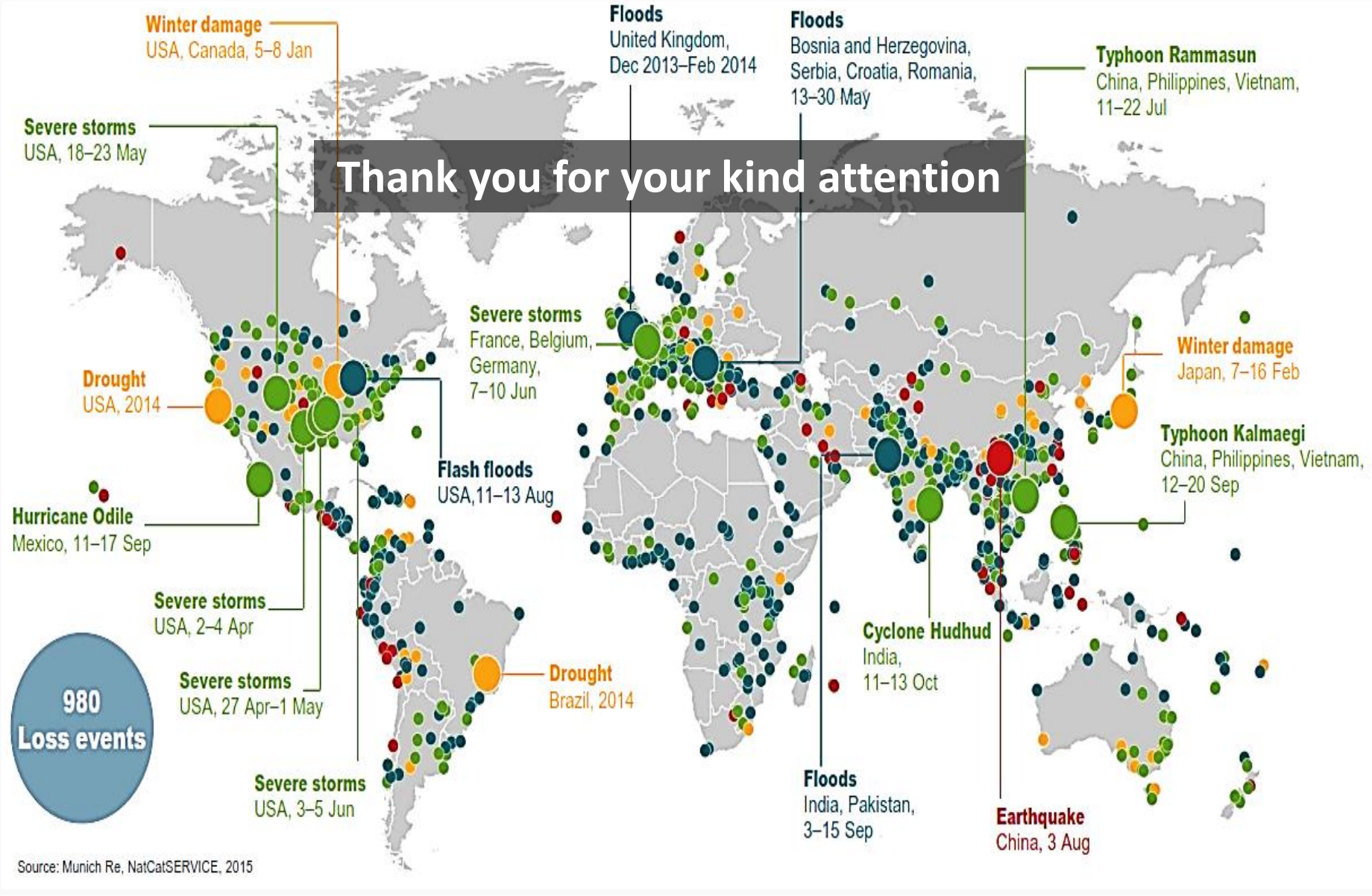
- *Disaster Management and Humanitarian Assistance (E)*
- *Community Based Disaster Risk Management: Theory and Practice (R)*
- *Disaster Response and Emergency Management (E)*
- *Human Conflicts and Humanitarian Emergency Management (E)*
- *Disaster Governance, Policy and Risk Management(E)*

AIT
Asian Institute of Technology

DPMM Students



AIT
Asian Institute of Technology



Thank you for your kind attention