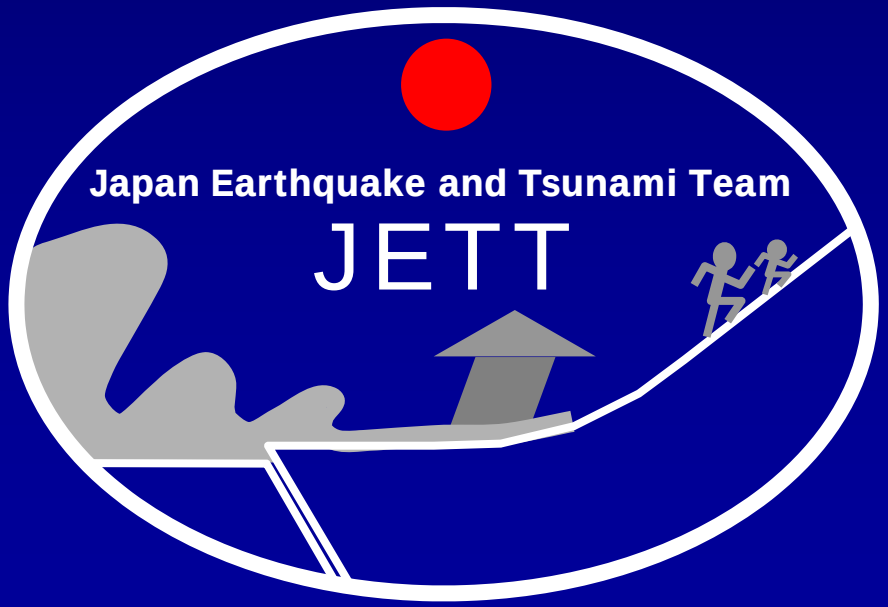
The 8th Conference of the Science Council of Asia (SCA)
Qingdao, May 28-30, 2008

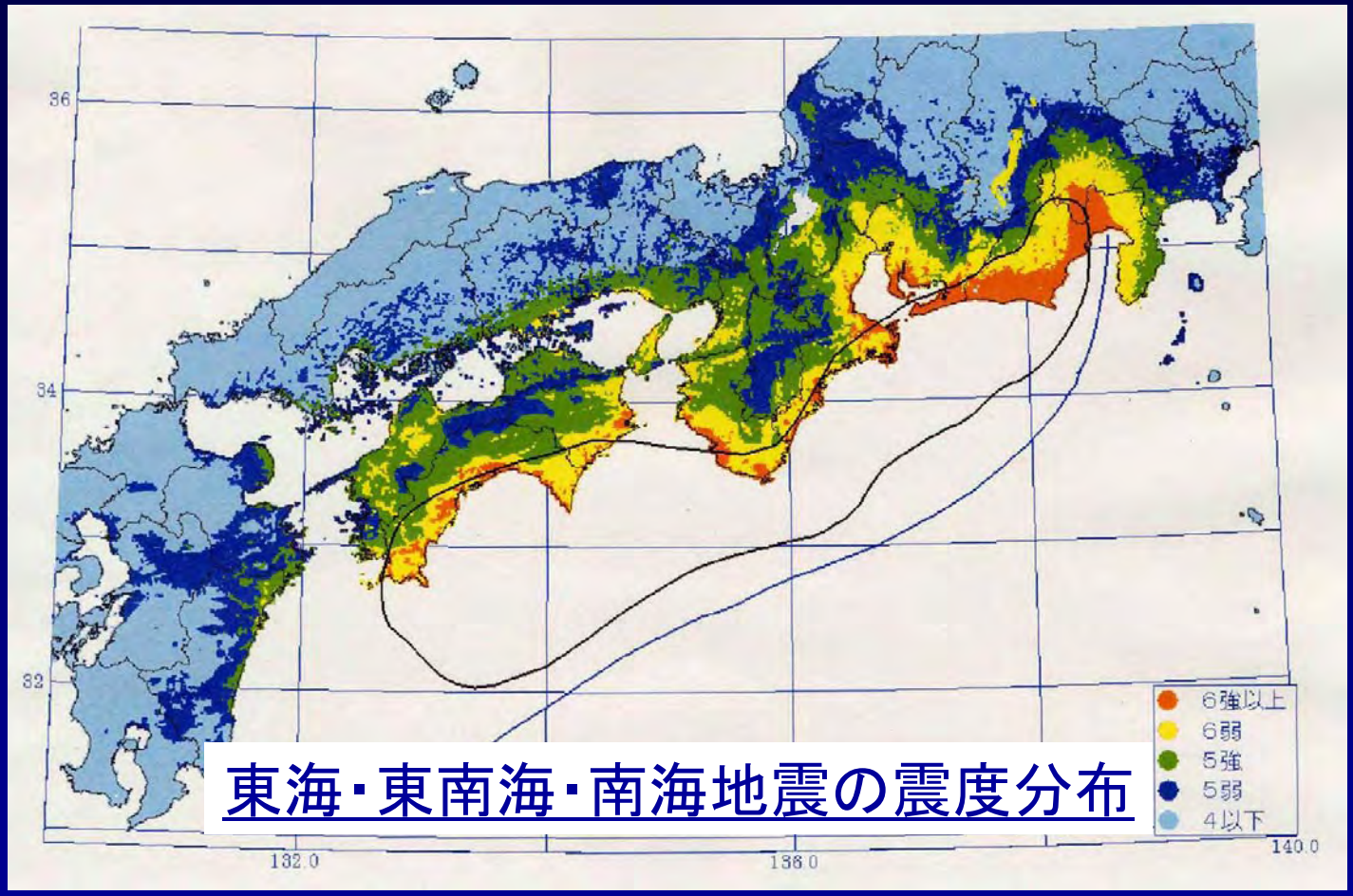
Earthquake and Tsunami Damage Survey in Indonesia and Recommendation for the Reconstruction



Hirokazu IEMURA
Kyoto University, Professor

Mulyo Harris Pradono
Kyoto University, Post-doc. Researcher

東南海地震の想定震度分布

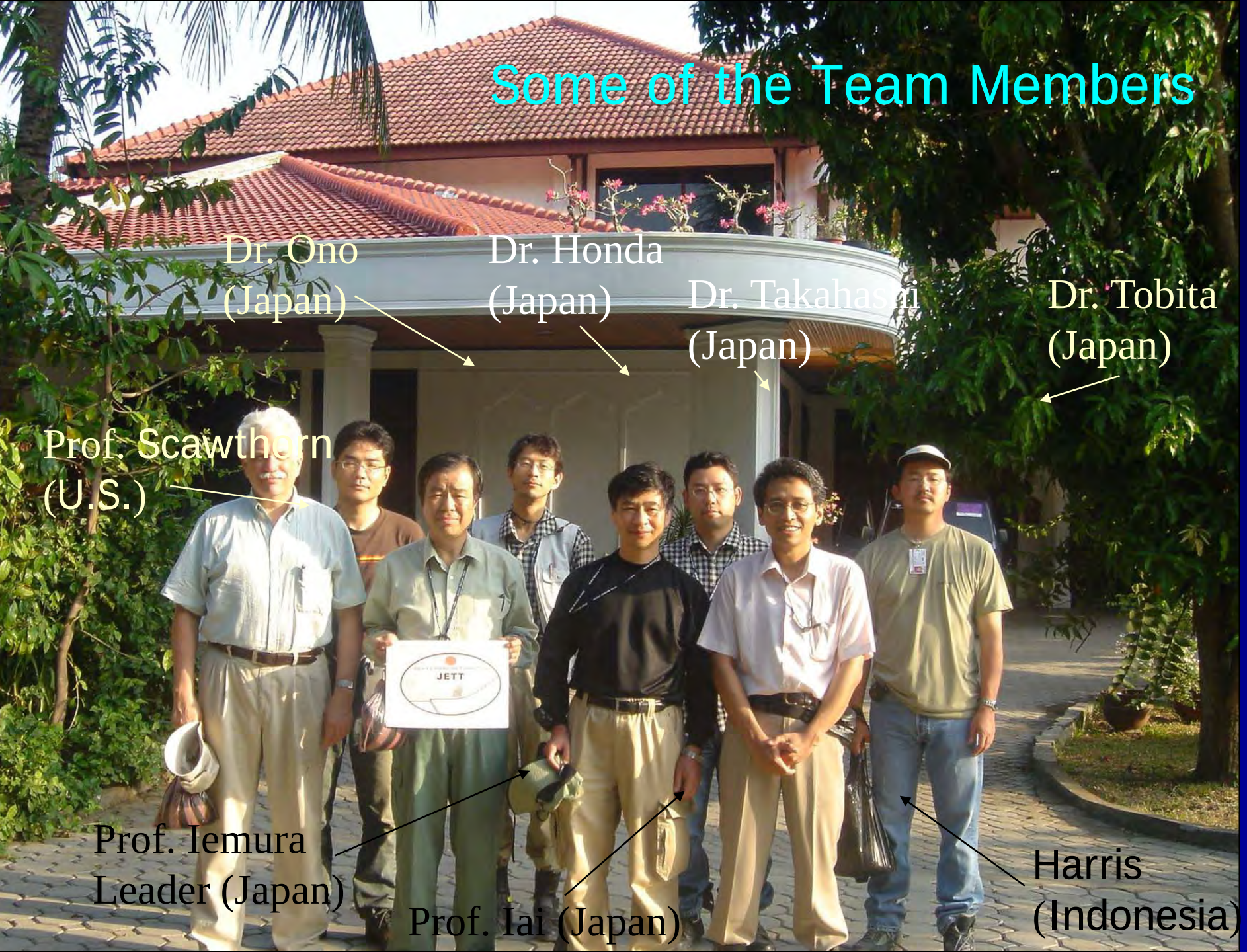


○東南海地震の特徴
- ・やや長周期地震動 （高層ビル 被害大），
- ・継続時間 大（強震1分程度）
- ・最大加速度は想定東海地震と同等の大きいもの

○東南海地震の東海道新幹線エリア内の詳細分析
- ・想定地震動（加速度・速度） により激震地域を選定
- ・対策推進地域は，新大阪まで該当

中央防災会議資料

Some of the Team Members



Recommendations from Our Investigation Team (1)

- ✓ Tsunami Disaster Prevention Measures (Warning, Wave break, Mangrove, Land use, Evacuation)
- ✓ Institute or Center for Earthquake and Tsunami Research
- Tsunami and Earthquake Museum (Monuments, Facts, Data, Education Materials, etc.)

Recommendations from Our Investigation Team (2)

- ✓ International Collaborations among Research Institution
- ✓ Tsunami and Earthquake Safe Structural Design (Technologies and Codes)
- ✓ Tsunami Poles and Disaster Education (Not Forget but Understand)

Our Research and Implementation Activities

- Questionnaires for Earthquake Intensity
- Questionnaires for Tsunami Height and Actions
- International Collaboration
- Estimation of Tsunami Force from Bridge Damage
- Water Channel Experiments of Tsunami Attack
- Tsunami Height Memorial Poles and Education

Our Research and Implementation Activities

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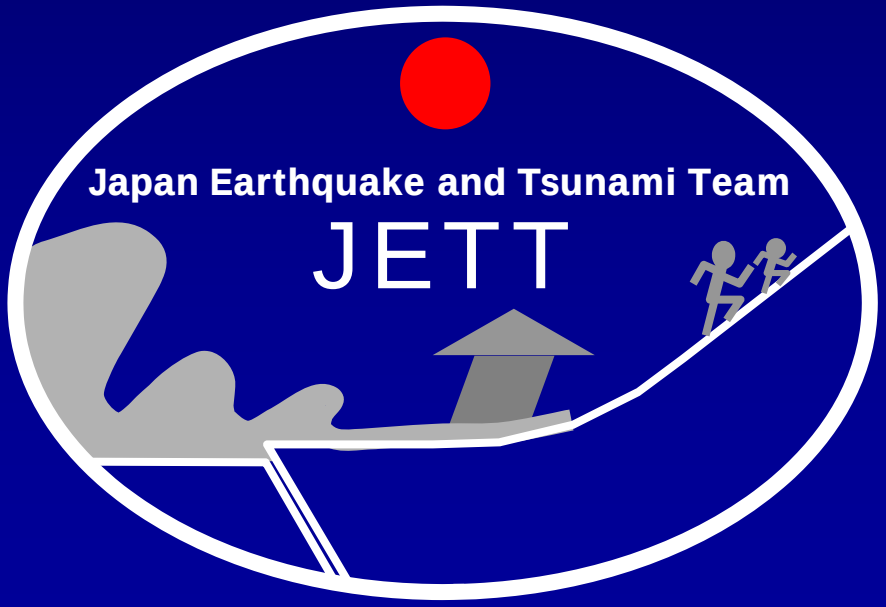
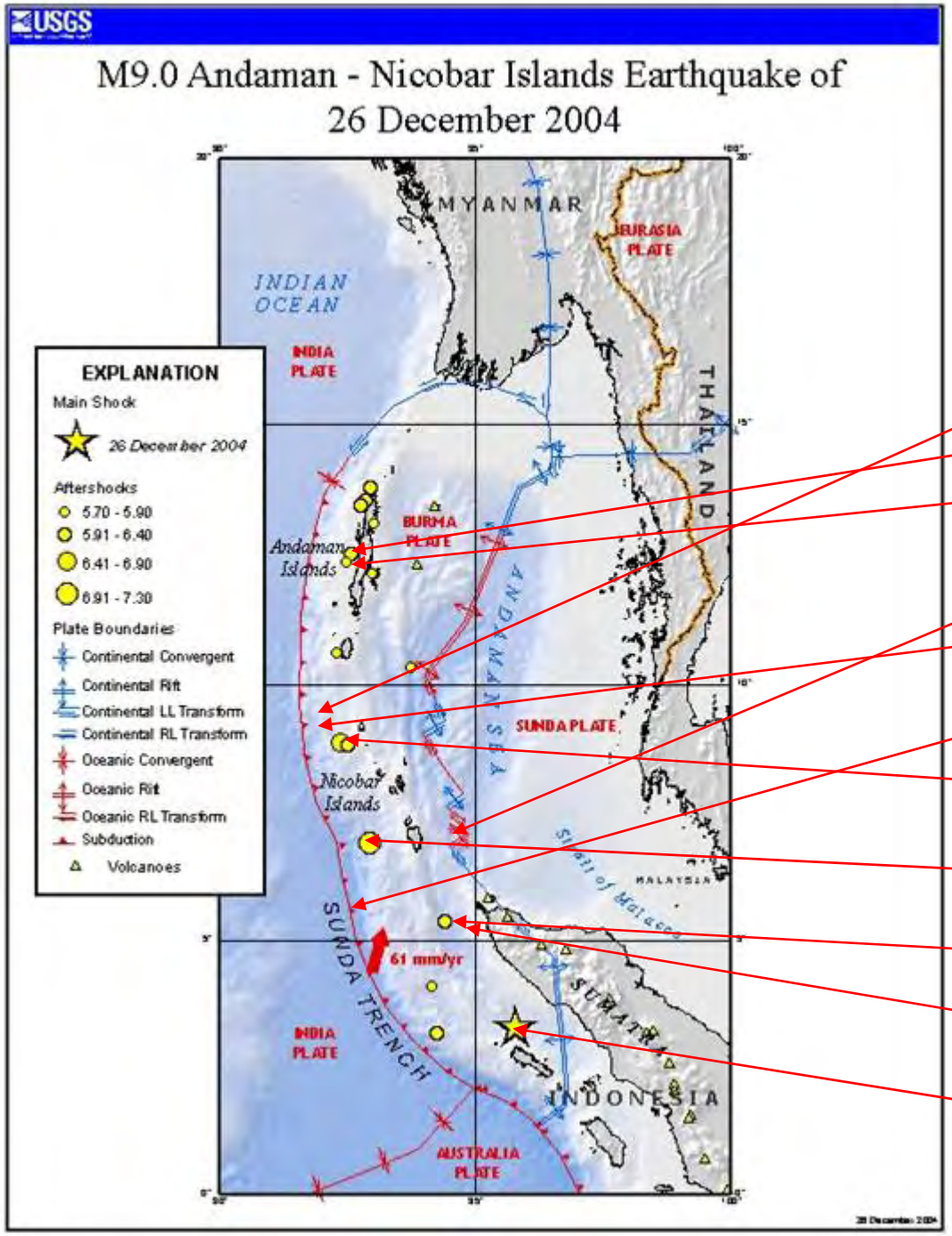
Features of Structural Damage in Banda Aceh Sumatra Earthquake Dec 26, 2004





Main Earthquake and Sequence of Aftershocks

02:22:01UTC M5.8 8.85N 92.42E

02:15:59UTC M5.7 12.33N 92.48E

02:15:50UTC M5.3 12.10N 92.19E

02:00:40UTC M6.0 6.83N 94.61E

01:59:14UTC M5.5 8.37N 92.43E

01:40:07UTC M5.5 5.76N 93.03E

01:22:27UTC M6.0 7.68N 93.72E

01:21:26UTC M6.1 6.36N 93.35E

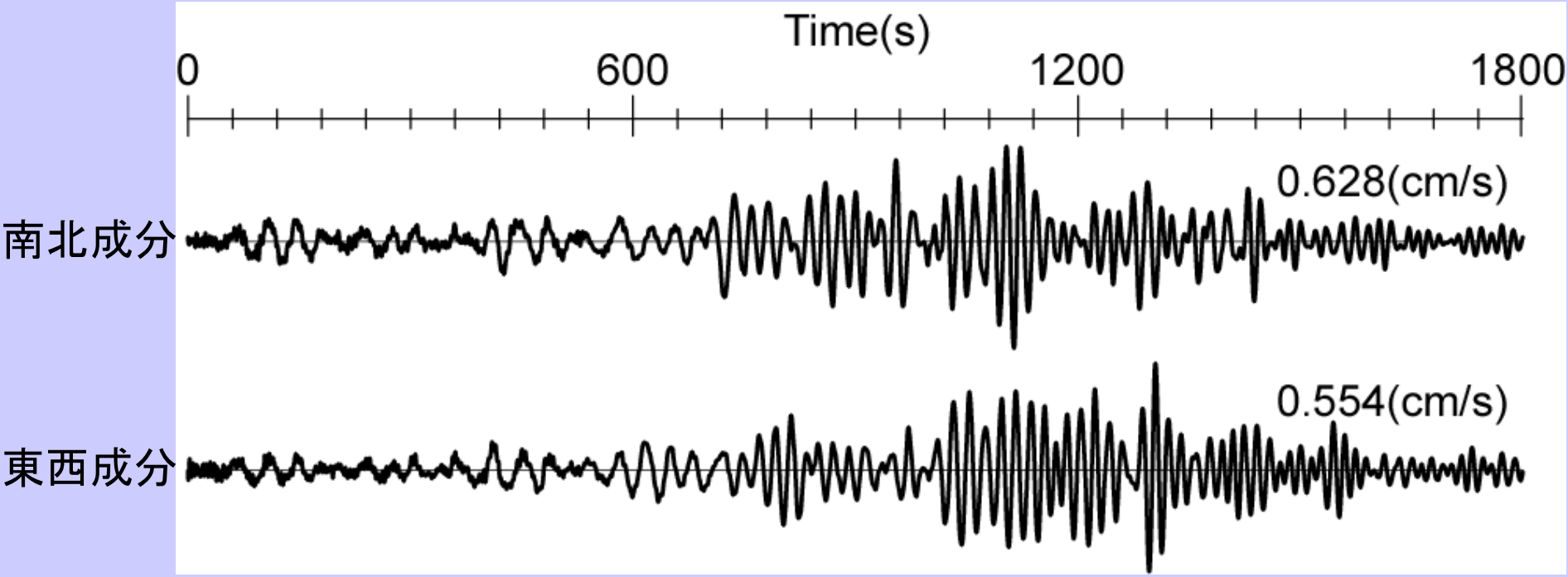
01:25:49UTC M6.0 5.54N 94.17E

01:48:49UTC M5.8 5.40N 94.42E

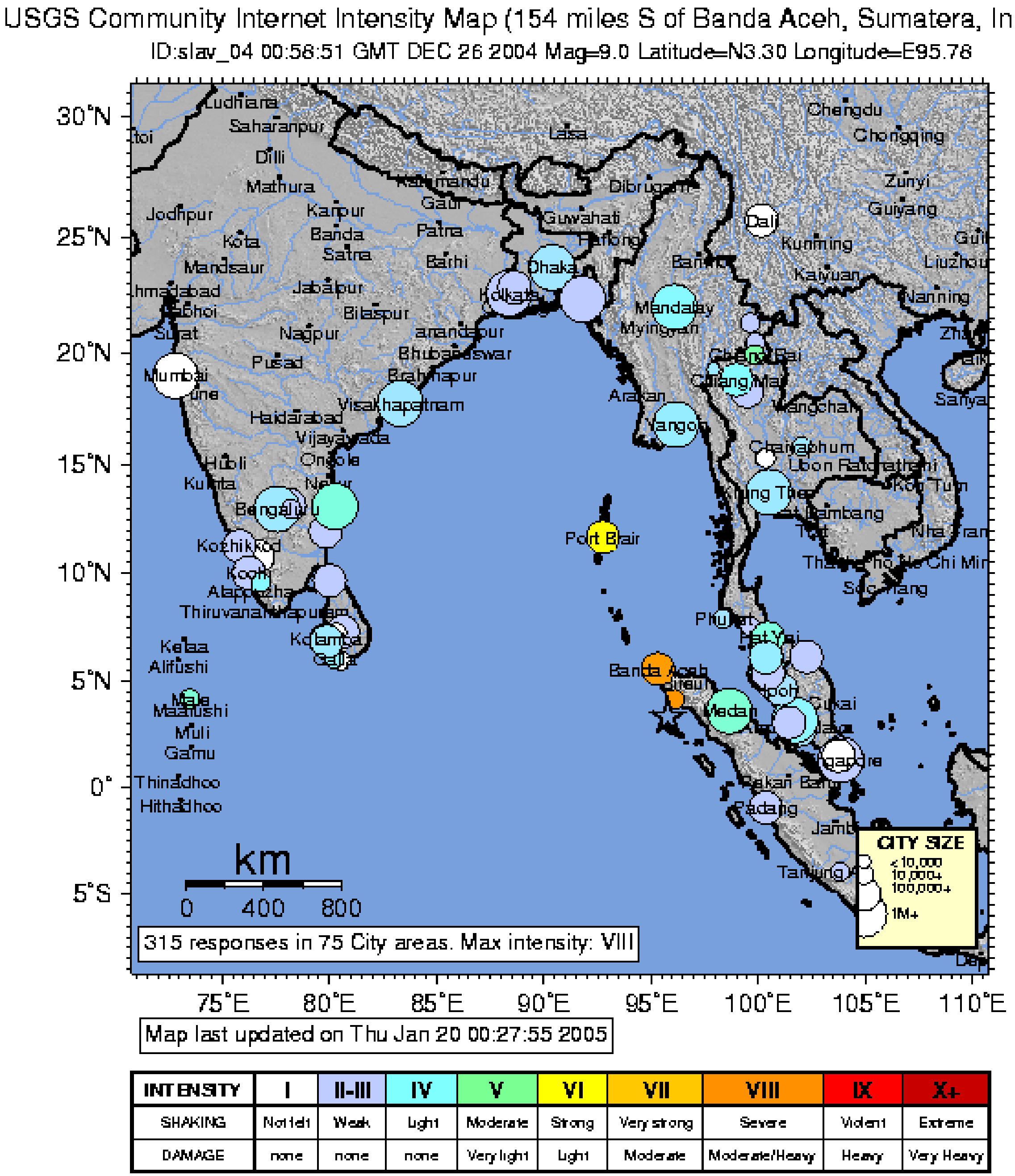
00:58:53UTC M9.0 3.31N 95.55E

Source: USGS http://neic.usgs.gov

Velocity Record of Off-Sumatra Earthquake in Osaka



TTT（盾津）



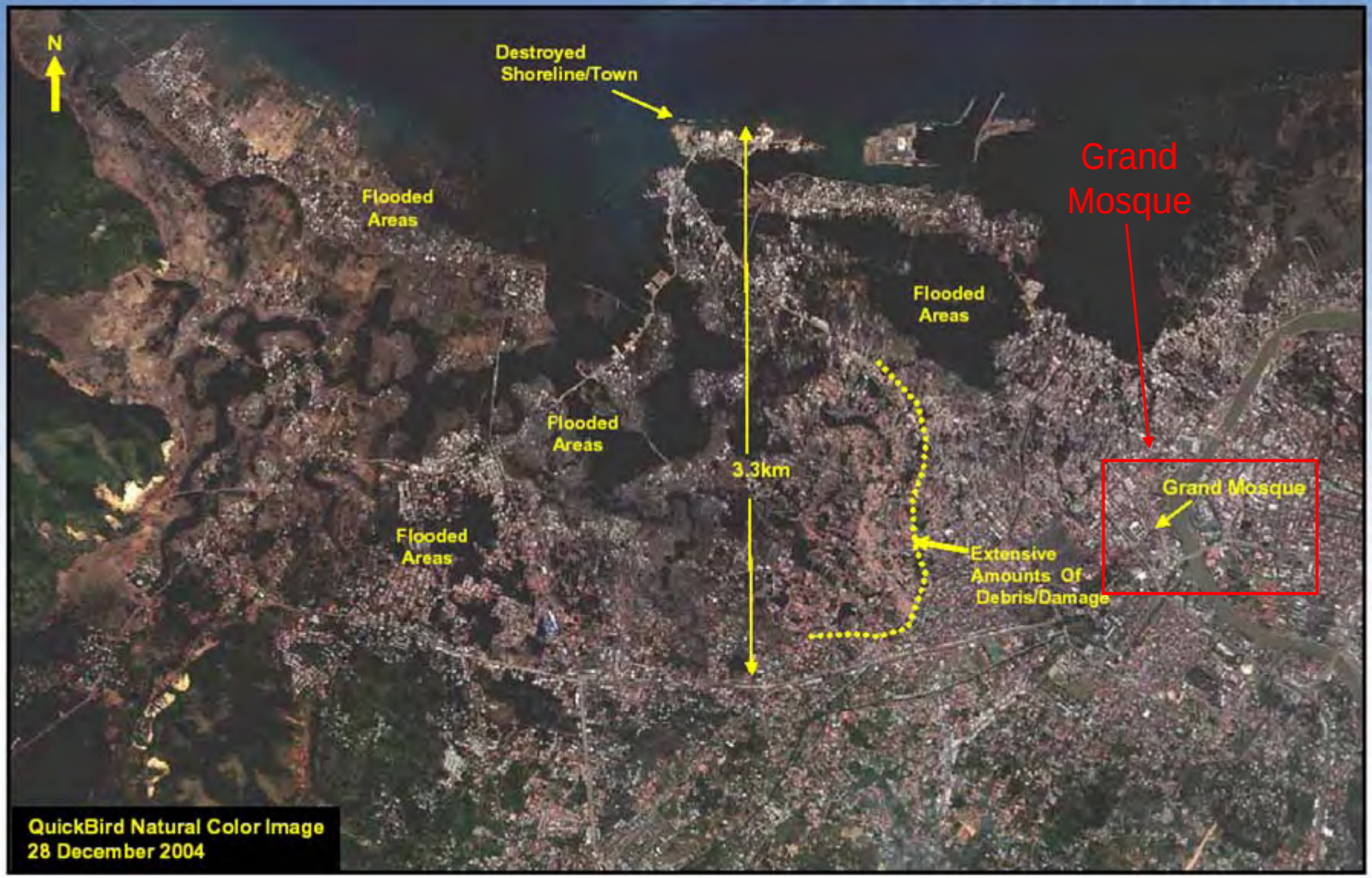
Intensities

The earthquake was felt (VIII) at Banda Aceh and (V) at Medan, Sumatra. It was felt (II-IV) in parts of Bangladesh, India, Malaysia, Maldives, Myanmar, Singapore, Sri Langka, and Thailand. Subsidence and landslides were observed in Sumatra

Source: USGS Earthquake Hazard Program http://neic.usgs.gov/eqinthenews/2004/usslav

Source: Digital Globe Analysis
http://www.digitalglobe.com

Banda Aceh, Indonesia




知事公邸
2005年1月5日
SELAT MALAKA
Visited sites
Governor Office
Displaced Bridge
BANDA ACEH CITY
Photo Source: Digital Globe
http://www.digitalglobe.com

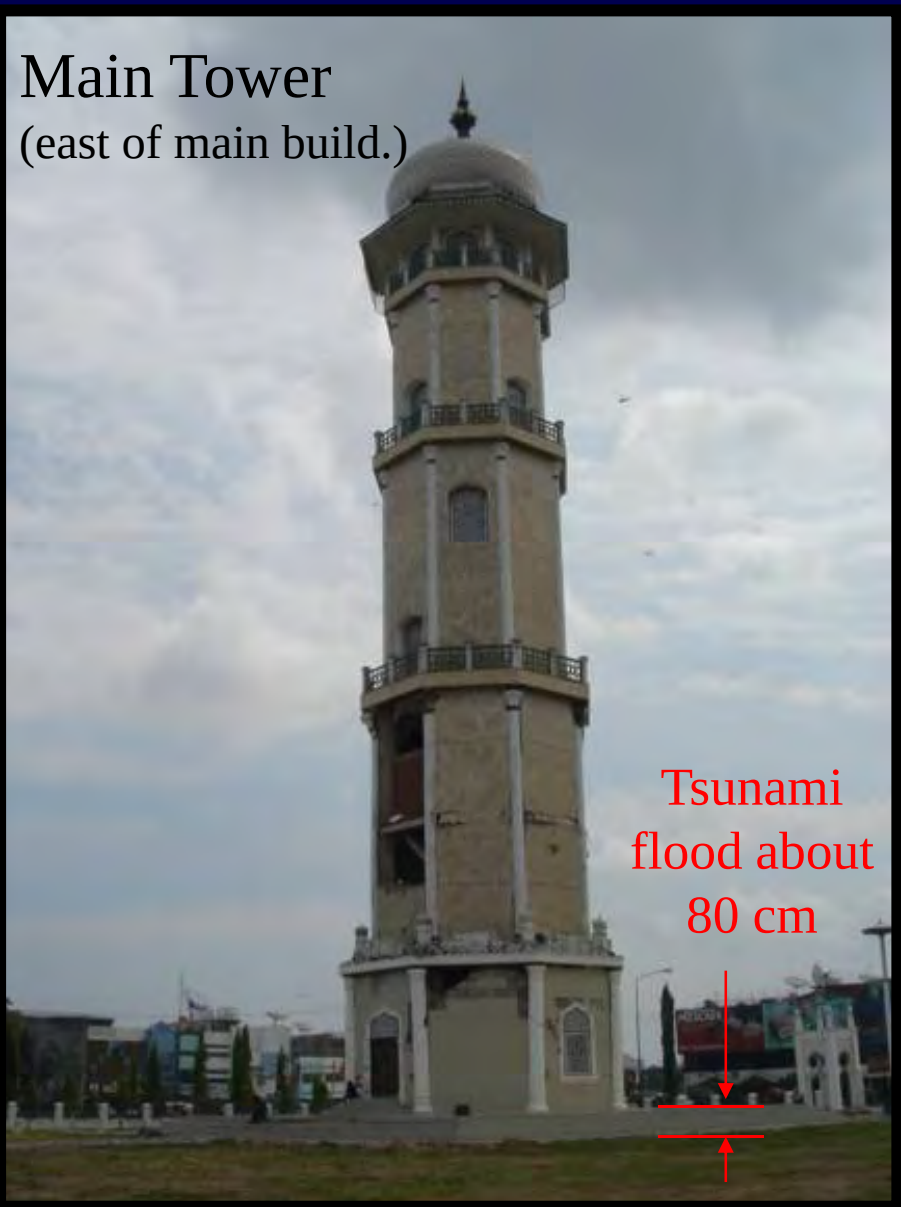
大モスク周辺の衛星写真（バンダアチェ）
12月28日，2004

Source: Digital Globe Analysis
http://www.digitalglobe.com

Nearby Buildings March 02, 2005

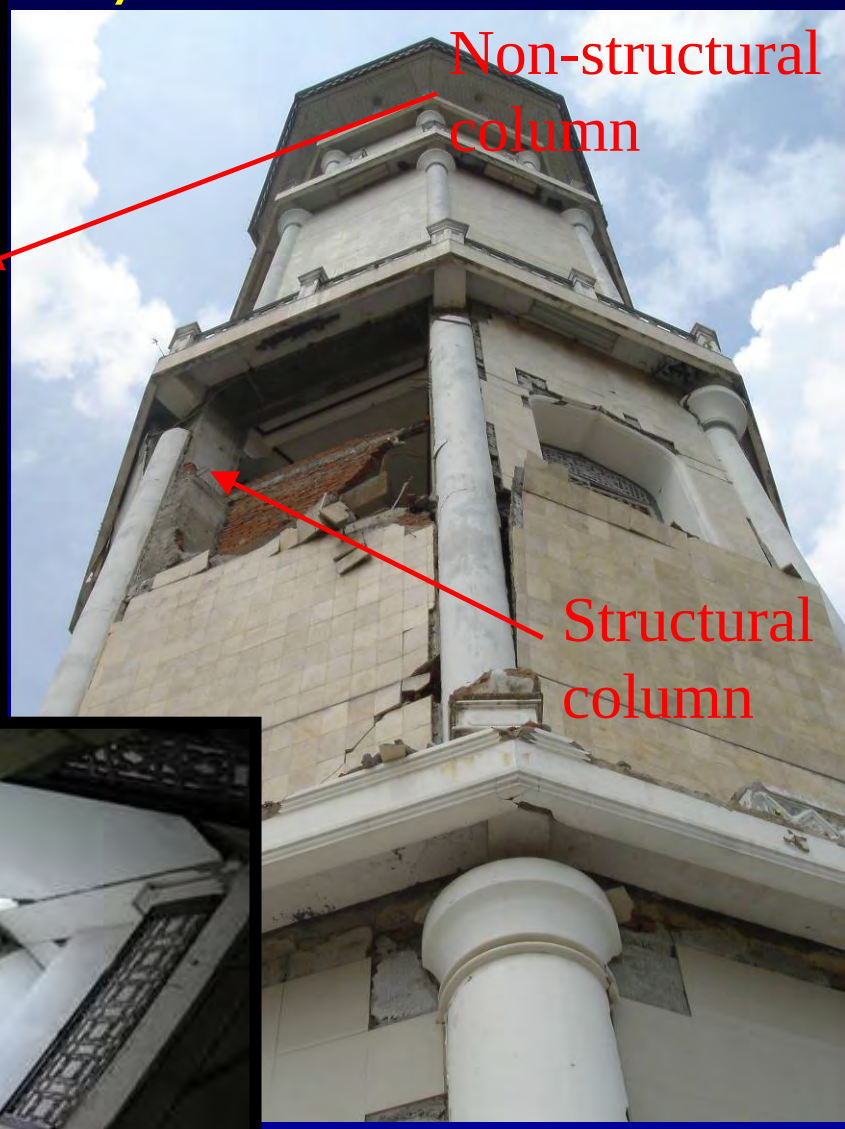
One-story nearby house is intact

Baiturrahman Grand Mosque
Survey March 02, 2004



Severe cracking and spalling of concrete

Baiturrahman Grand Mosque
Survey March 02, 2004



Nearby Buildings March 02, 2005 (Kuala Tripa Hotel)

The hotel was expanded from a 4-story hotel to a 5-story hotel

Nearby Buildings March 02, 2005 (Water Tower)

Spalling of concrete cover at the core tower

Carrying out questionnaire

at Syiah Kuala Cemetery

at Krueng Raya

Iemura et al., 2005

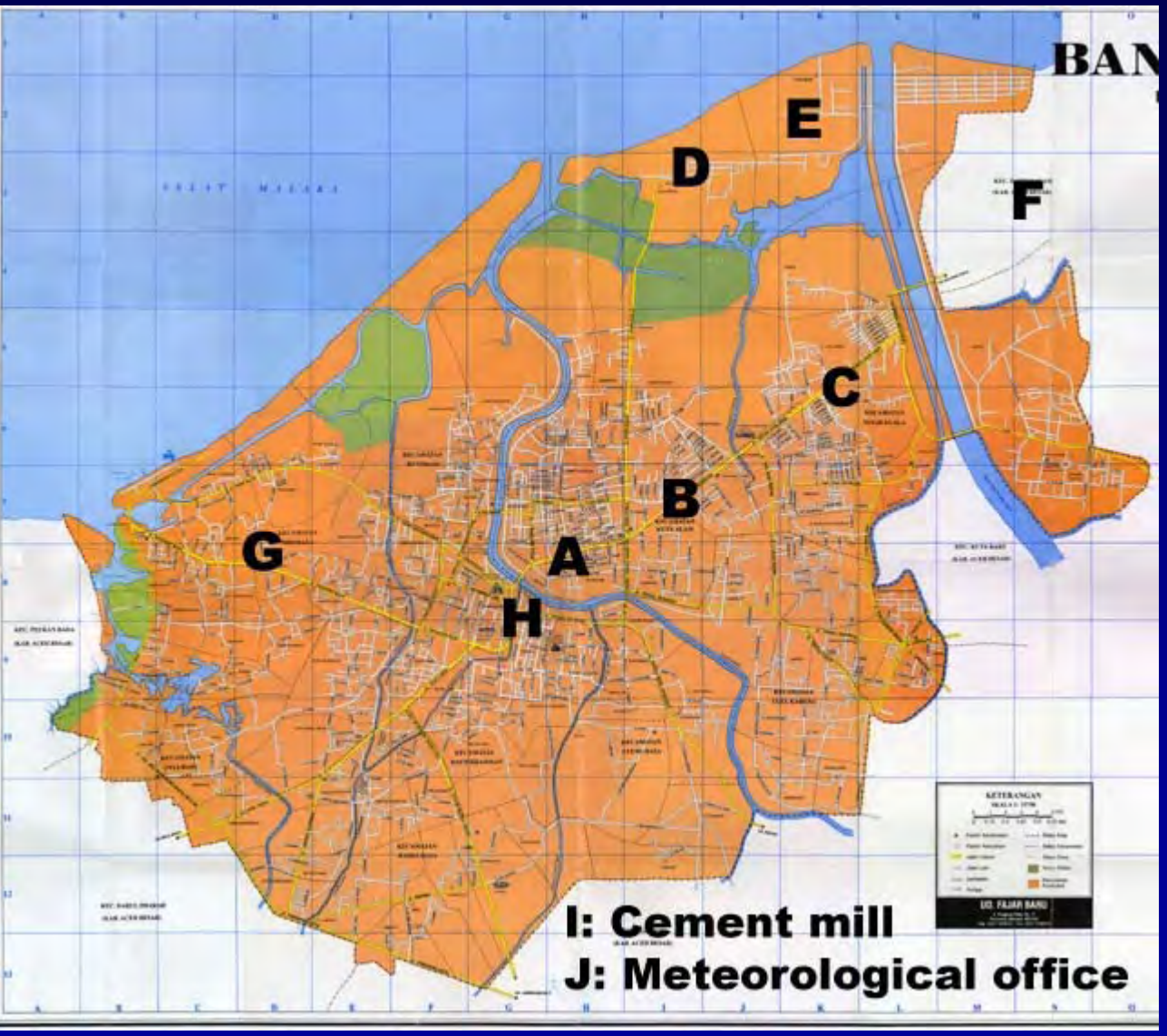
Questionnaires on Earthquake Intensity

- Estimation of earthquake intensity (JMA Intensity) from questionnaires
  - Professor Ota's Method in 1979 is used to calculate the local intensity

Questionnaires on Earthquake Intensity

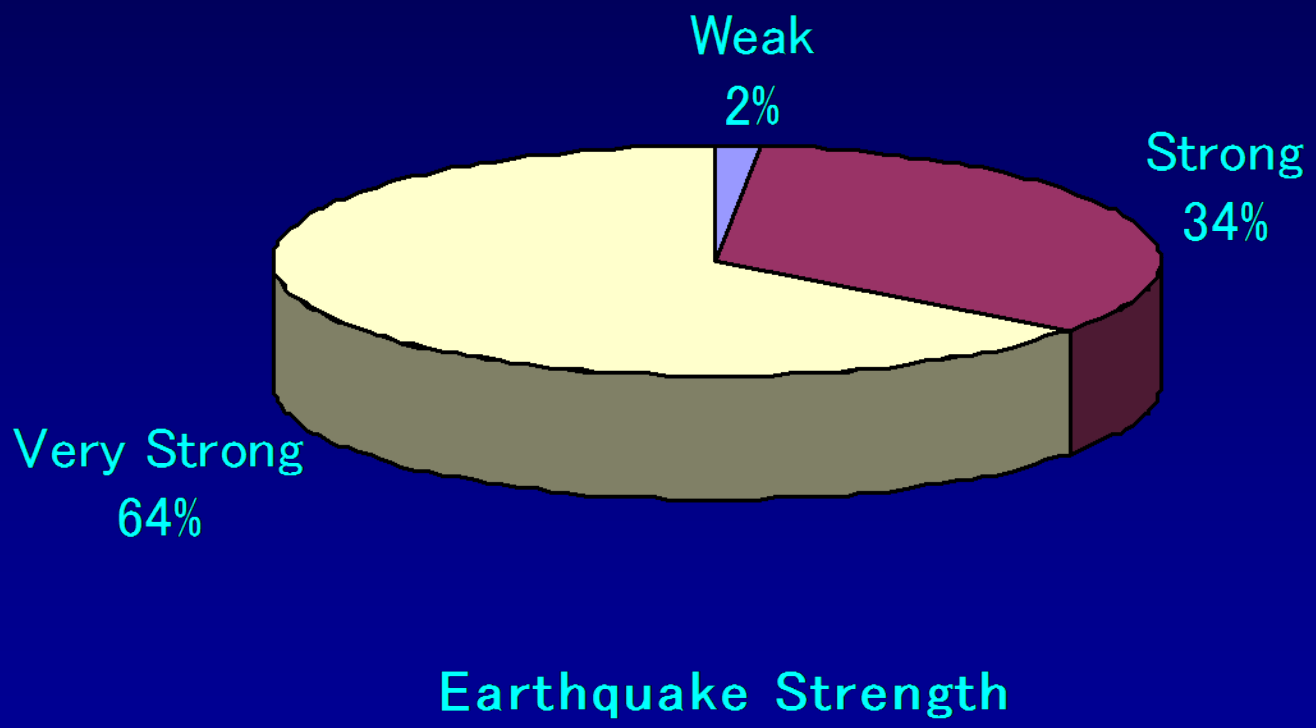
- Typical type of questions:
  - Feel the quake?
  - Where were you?
  - Duration?
  - Could you move?
  - Structures were damaged?
  - Hanging stuff swinging?
  - Unstable stuff falling?
  - Heavy stuff moving?
  - Other 27 items.

Zoning in Banda Aceh City



- 市内で7ヶ所，
他4ヶ所でゾーニング
- A～Cはメインストリート沿い(Jl. Mohammad Daud Beureueh）で津波浸水域
- D～Gは津波被害甚大地域
- HはGrand Mosque周辺（津波による被害少、地震被害のためのレファレンスポイント）

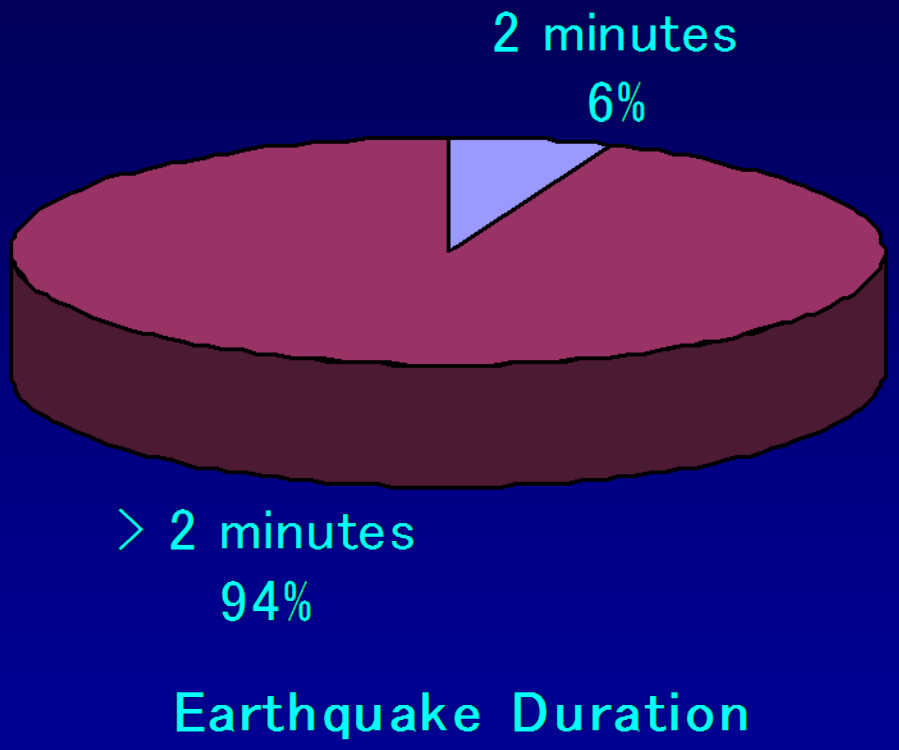
Earthquake Strength



Respondent saying “weak” was at Mata Ie, a hilly area South of BA

Iemura et al., 2005

Earthquake Duration

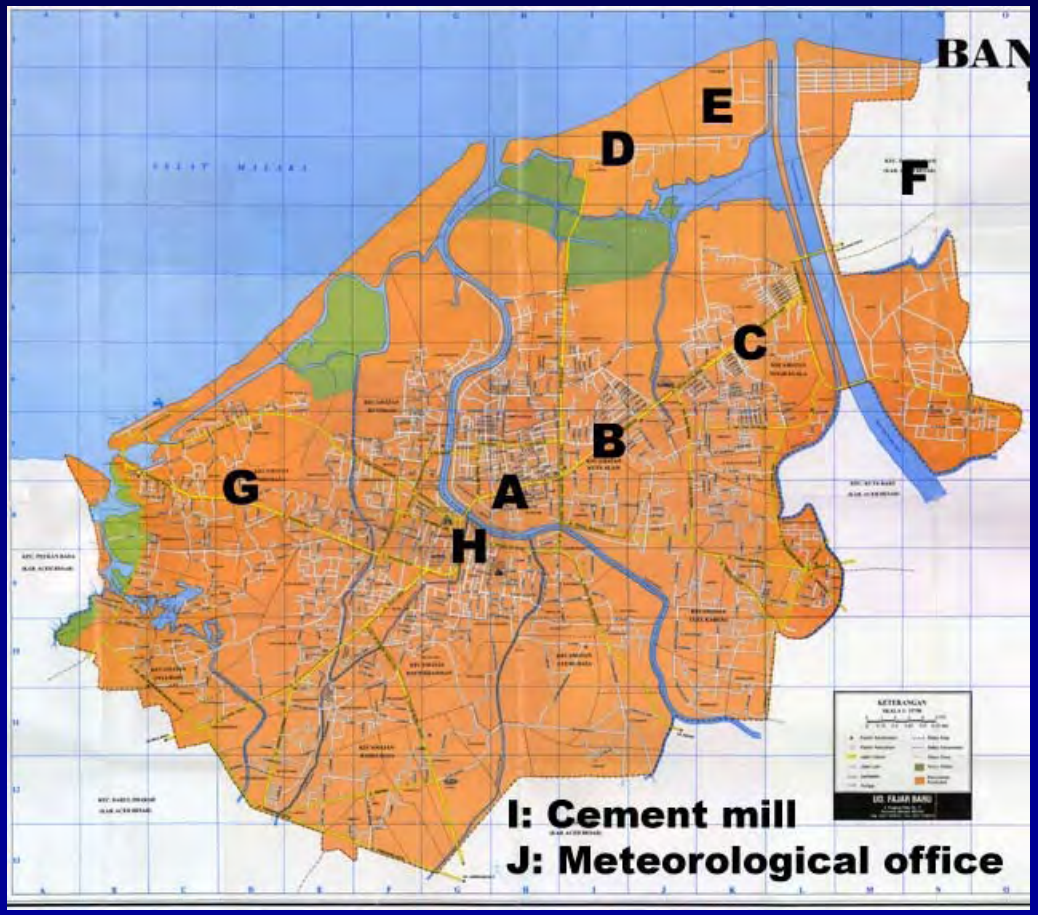


According to a Syiah Kuala Univ. Staff, the duration of shaking is around 15 minutes

Iemura et al., 2005

Calculated JMA Intensity from the questionnaires in Banda Aceh

- A: 5.56
- B: 5.48
- C: 5.52
- D: 5.49
- E: 5.51
- F: 5.79
- G: 5.36
- H: 5.60
- I: 4.92



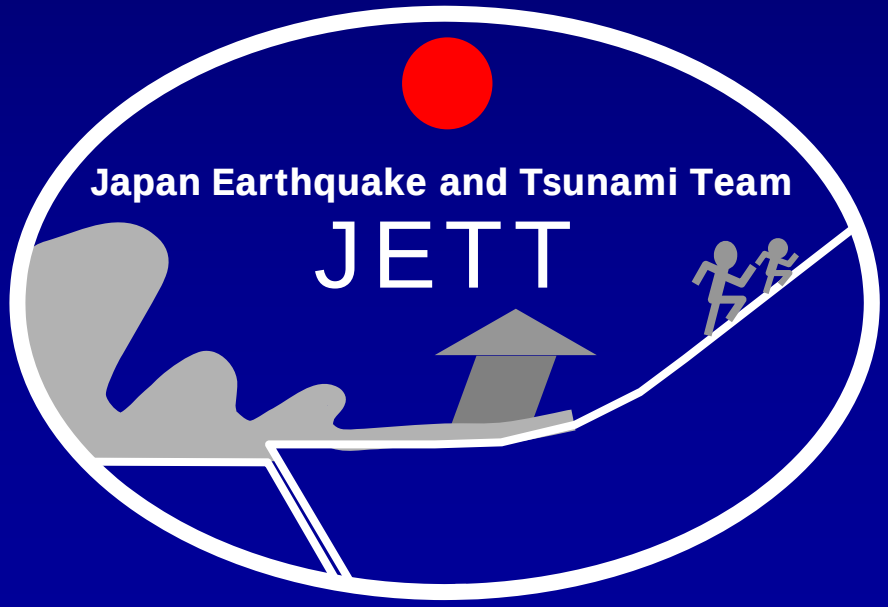
Corresponds to MMI VII - VIII

Relatively uniform value of seismic intensity

Results and Lessons Sumatra Earthquake Dec. 26, 2004

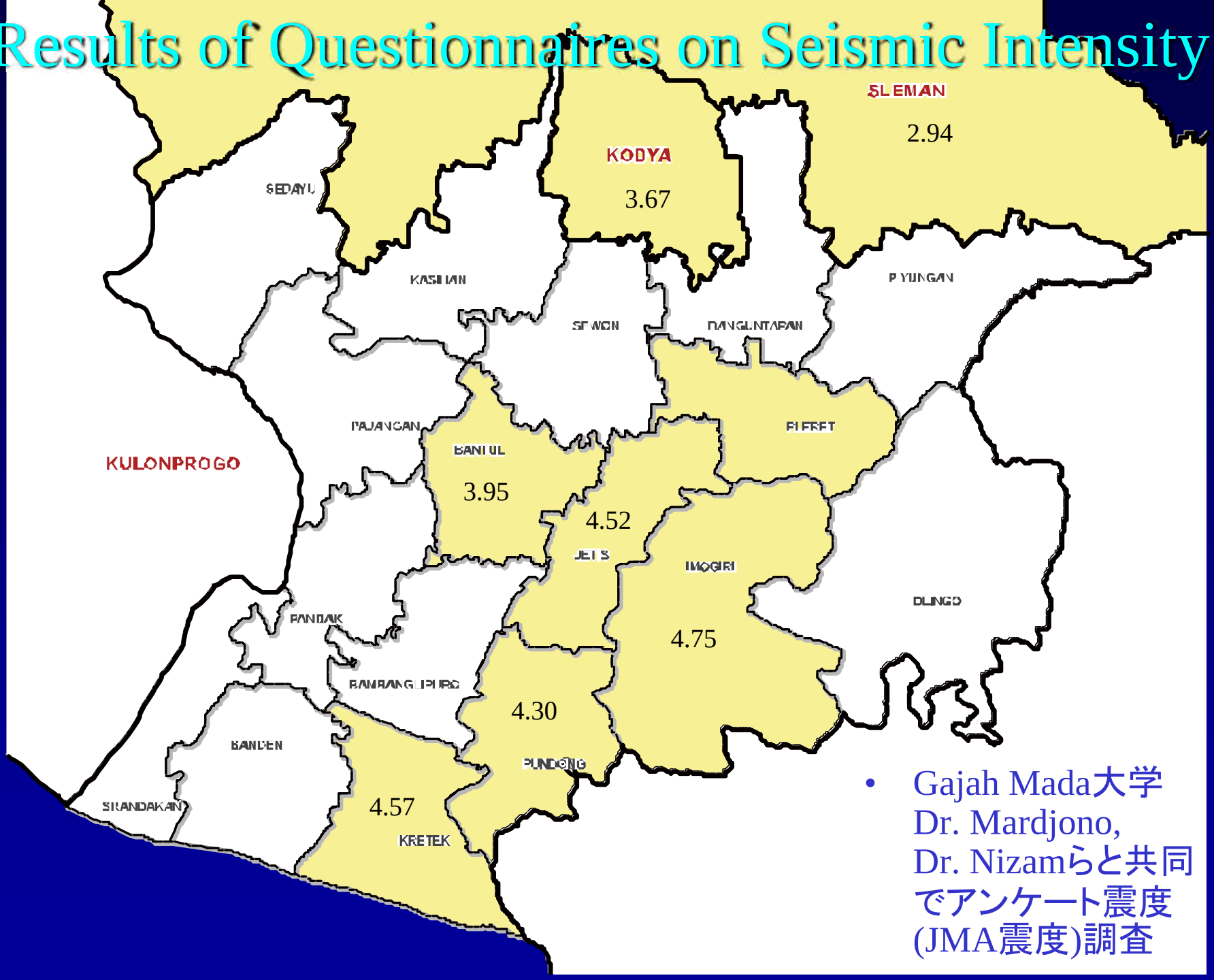
- Relatively large scale modern buildings, water tanks, and mosque tower suffered severe damage due to long period component of ground motion
- Seismic design of these structures has to be carefully reviewed

Features of Structural Damage in Jogjakarta Central Java Earthquake May 27, 2006



Structural Damages Central Java Earthquake May 27, 2006

Results of Questionnaires on Seismic Intensity



- Gajah Mada大学 Dr. Mardjono, Dr. Nizamらと共同でアンケート震度(JMA震度)調査

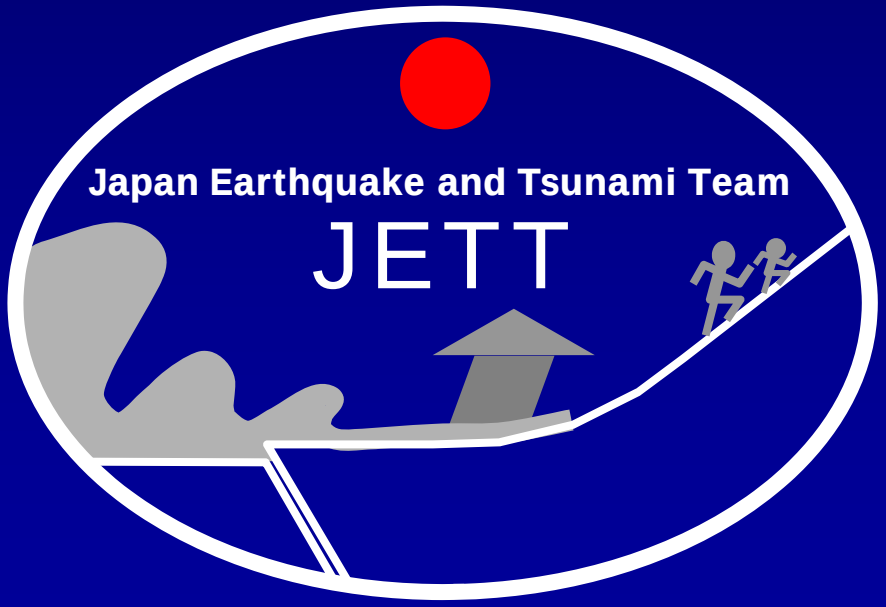
Results and Lessons Central Java Earthquake May 27, 2006

- Non-engineered adobe or redbrick houses are severely damaged
- Seismic intensity is not high and differs a lot depending on the locations

Our Research and Implementation Activities

- Questionnaires for Earthquake Intensity
- Questionnaires for Tsunami Height and Actions
- International Collaboration
- Estimation of Tsunami Force from Bridge Damage
- Water Channel Experiments of Tsunami Attack
- Tsunami Height Memorial Poles and Education

Features of Tsunami Damage of Buildings in Banda Aceh Sumatra Earthquake Dec 26, 2004




MILIK H.HANAN
LAMPRIT

Electric Plant Vessel
2005年3月2日

600トンの船が津波により3キロ内陸部へと流された

Putri House, November 7, 2005

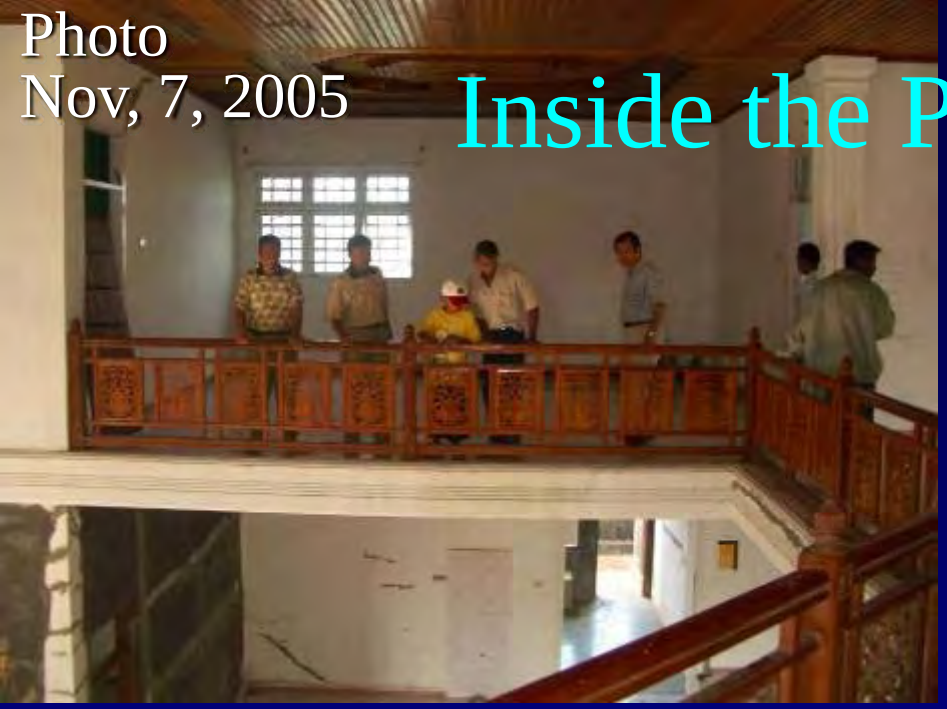
The video* was shot from this balcony

From the Balcony

Video shot from Putri House during the 2004 Tsunami

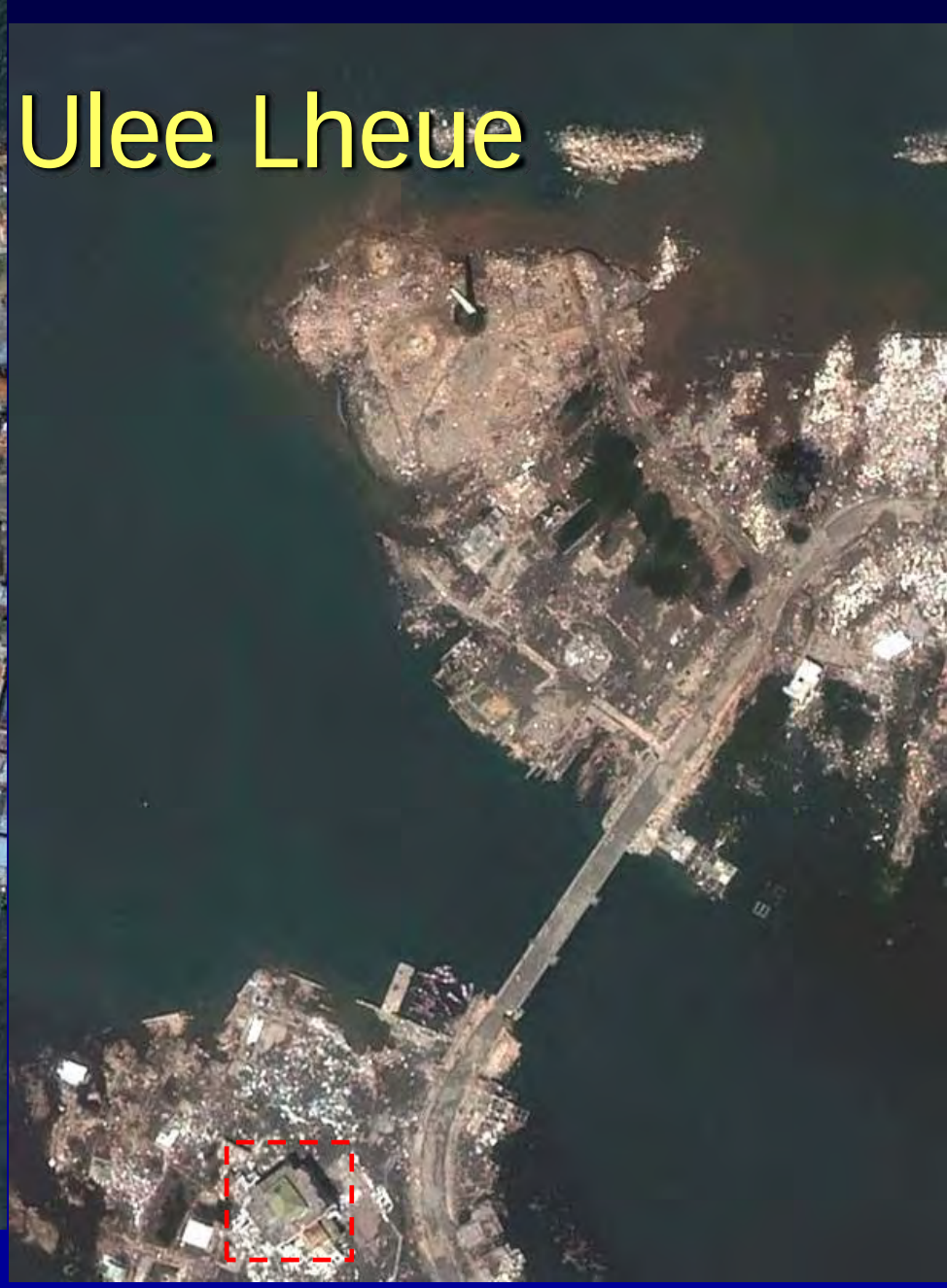
Inside the Putri House

Photo
Nov, 7, 2005



Video
Dec, 26, 2004

Mosque in Ulee Lheue



Mosque

Mosque in Ulee Lheue

Questionnaires on Tsunami Features

- Typical question on tsunami : tsunami height, sequence, how long after the quake, and other 10 questions

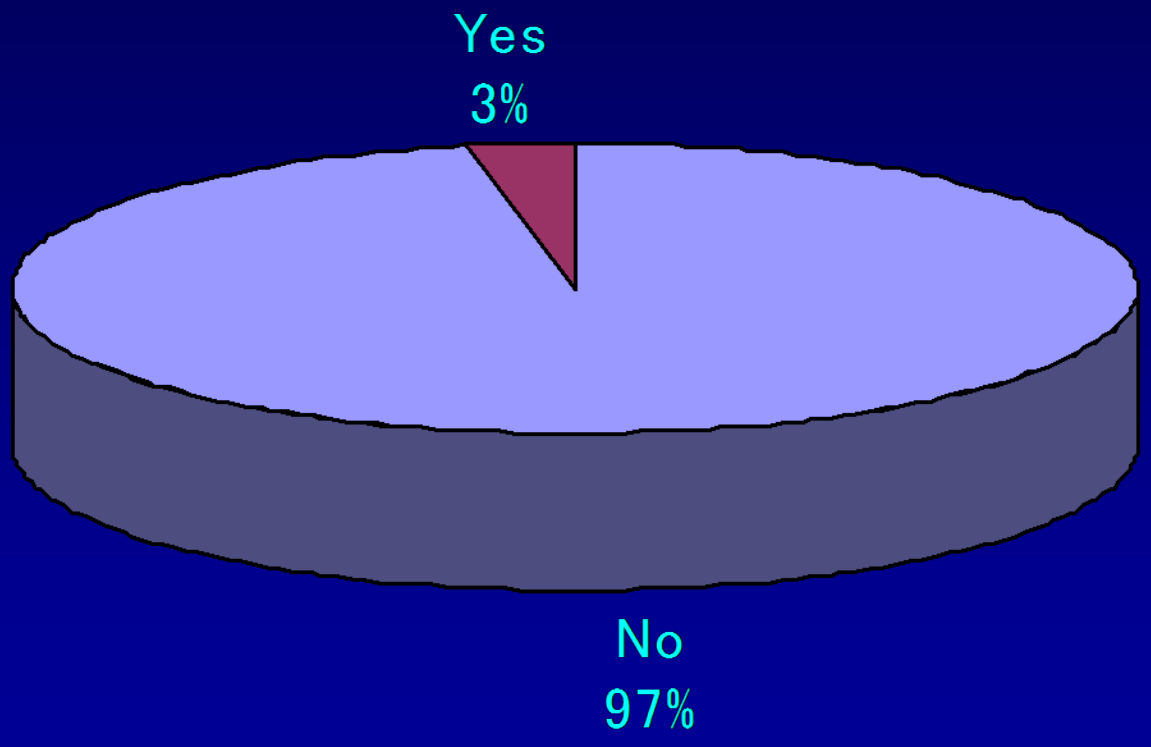
Syiah Kuala Cemetery
2005年3月2日

生存者

Syiah Kuala Cemetery

Syiah Kuala Cemeteryにおいて生存者にアンケート調査

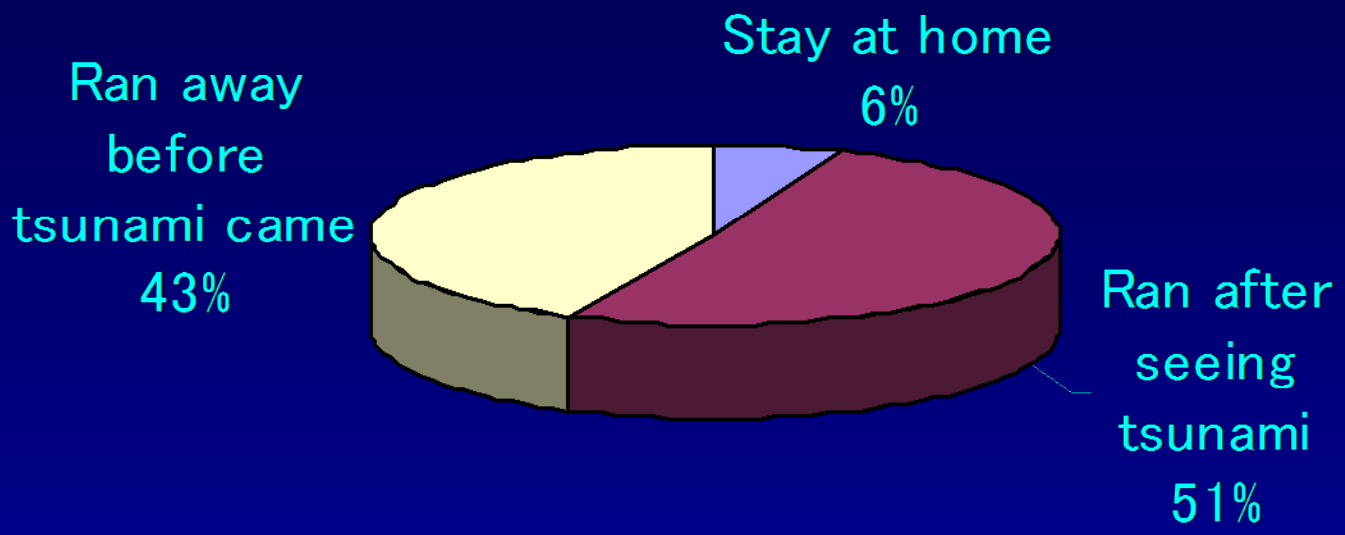
Knowledge about tsunami



Iemura et al., 2005

Knowledge on tsunami was low

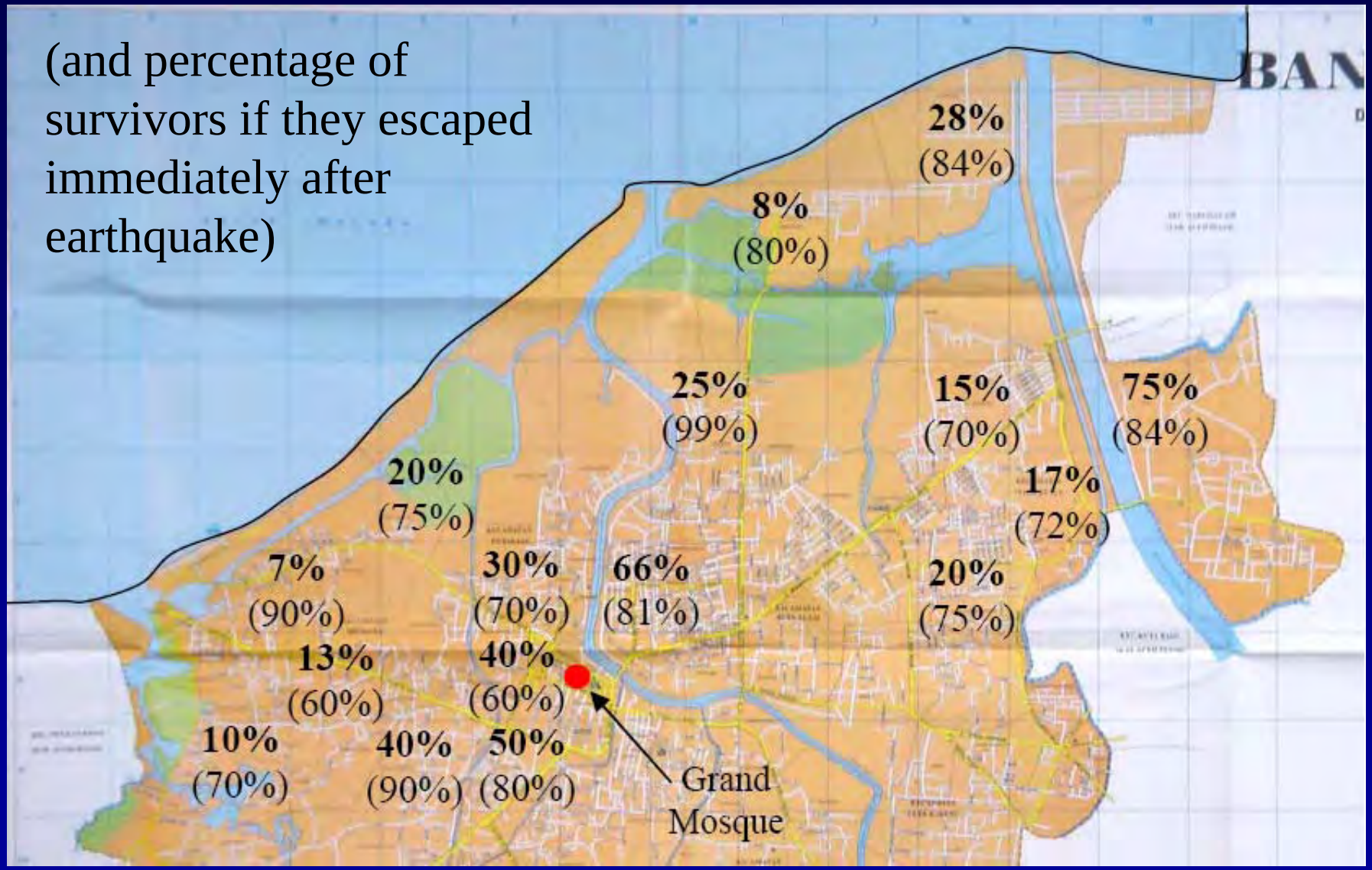
When they knew tsunami was coming...



Tsunami came 19.1 minutes (average) after the big earthquake

Iemura et al., 2005

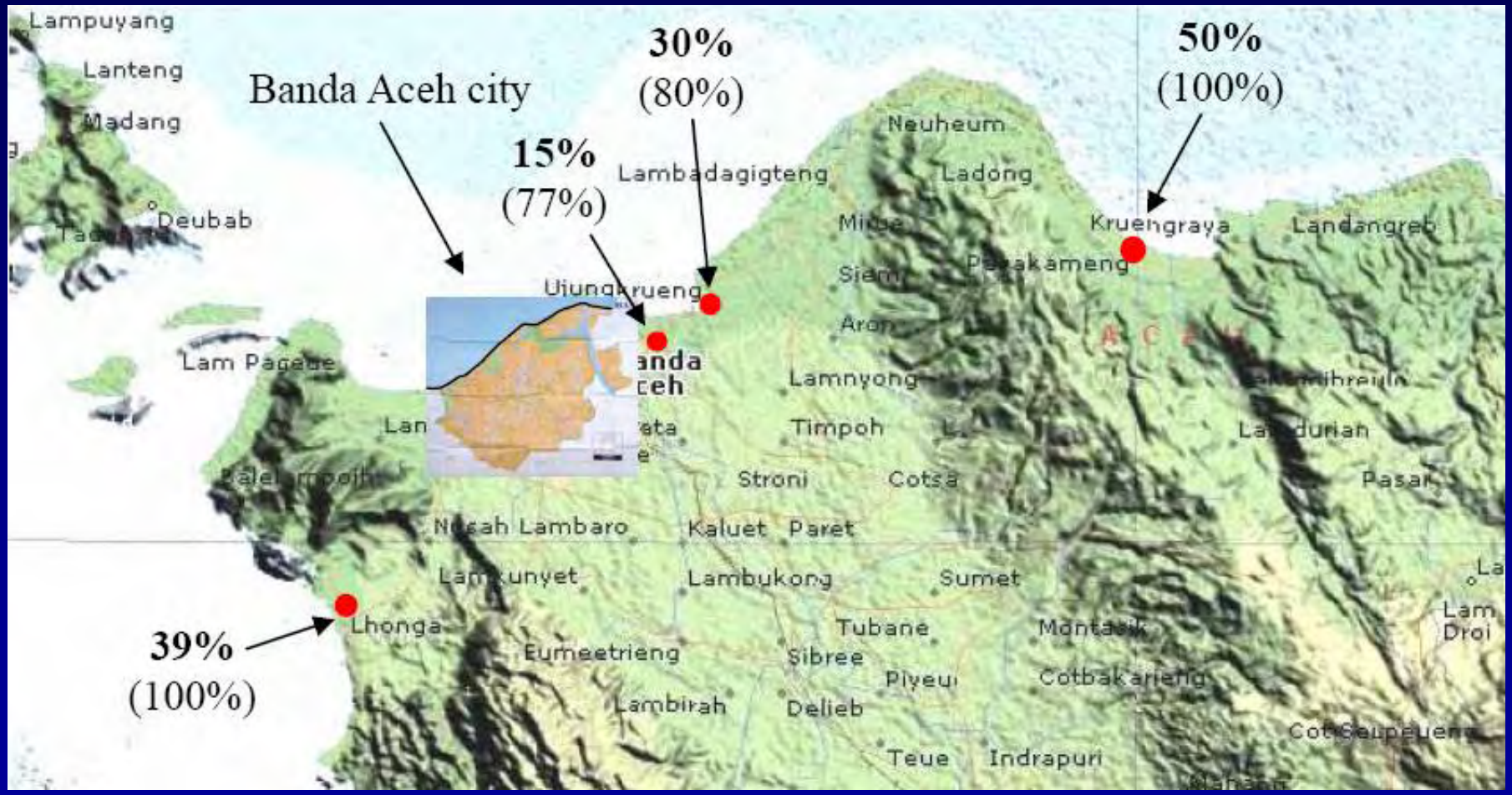
Percentage of survivors



Iemura et al., 2005

Percentage of survivors outside BA

(and percentage of survivors if they escaped immediately after quake)



Iemura et al., 2005