The Challenge of Earthquake Disaster in Indonesia

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INTRODUCTION
The 2004 Giant Sumatran-Andaman Earthquake/Tsunami

Type of Natural Disaster in Asia 2000-2012
(Source: EMDAT, 2012)

- Earthquake 66%
- Storm 23%
- Mass movement wet 1%
- Flood 7%
- Extreme temperature 1%
- Epidemic 2%

Number of Killed more than 10,000 in Asia from 2000-2012
Total: 710,792 (Source: EMDAT, 2012)

China P Rep: 105,875.00
India: 62,033.00
Indonesia: 181,393.00
Iran Islam Rep: 28,651.00
Japan: 21,036.00
Myanmar: 139,218.00
Pakistan: 80,114.00
Philippines: 12,743.00
Sri Lanka: 36,493.00
Thailand: 10,673.00

The March 2011 Tohoku Tsunami (Photo: Triono 2010)
World Tectonics Setting

DIGITAL TECTONIC ACTIVITY MAP OF THE EARTH
Tectonism and Volcanism of the Last One Million Years

DTAM
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

LEGEND
- Mainly oceanic crust
- Active spreading ridges and transform faults
- Total spreading rate; only 1-year NOVEL-1 model
- Major active rift or rift zone; dashed where location or activity uncertain
- Normal fault or rift; hachures on downthrown side
- Reverse fault (upthrust, subduction zones); generalized, surface on upthrown side
- Volcanic centers active within the last one million years; generalized. Minor basaltic centers and domes omitted.

Robinson Projection
October 1996
Japan and Indonesia: Two Earthquake Countries
-Short Profile-

• JAPAN
  • Island Arc, Northern part of “Ring of Fire”
  • Pacific Plate subducts beneath Eurasian plate
  • Active faults on land
  • More than 100 volcanoes and 50 are actives
  • The Big One was the March 2011 Tohoku Mw-9.0 event (followed by tsunami) and fatalities were around 19,000 people and damage: US$210,000,000.-

• INDONESIA
  • Island Arc, Southern part of “Ring of Fire”
  • Indo-Australian plate sinks under Eurasian plate
  • Active faults on land
  • More than 400 volcanoes, which 128 are actives
  • The Big One was the Dec 2004 Sumatran Mw-9.2 earthquake (followed by giant tsunami), and > 165,000 people were killed, damage: US$4,451,500.-
Active Tectonic Setting of Indonesia

Source: USGS
Destructive Earthquakes and Tsunami: Largest Earthquakes Since 1900

- 5 events in Indonesia, 1 event in Japan, but mostly in the Asia-Pacific region.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date UTC</th>
<th>Magnitude</th>
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</thead>
<tbody>
<tr>
<td>1. Chile</td>
<td>1960 05 22</td>
<td>9.5</td>
</tr>
<tr>
<td>3. Off the West Coast of Northern Sumatra</td>
<td>2004 12 26</td>
<td>9.1</td>
</tr>
<tr>
<td>4. Near the East Coast of Honshu, Japan</td>
<td>2011 03 11</td>
<td>9.0</td>
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<tr>
<td>5. Kamchatka</td>
<td>1952 11 04</td>
<td>9.0</td>
</tr>
<tr>
<td>6. Offshore Maule, Chile</td>
<td>2010 02 27</td>
<td>8.8</td>
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<tr>
<td>7. Off the Coast of Ecuador</td>
<td>1906 01 31</td>
<td>8.8</td>
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<tr>
<td>8. Rat Islands, Alaska</td>
<td>1965 02 04</td>
<td>8.7</td>
</tr>
<tr>
<td>9. Northern Sumatra, Indonesia</td>
<td>2005 03 28</td>
<td>8.6</td>
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<tr>
<td>10. Assam - Tibet</td>
<td>1950 08 15</td>
<td>8.6</td>
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<tr>
<td>11. Off the west coast of northern Sumatra</td>
<td>2012 04 11</td>
<td>8.6</td>
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<tr>
<td>12. Andreanof Islands, Alaska</td>
<td>1957 03 09</td>
<td>8.6</td>
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<tr>
<td>13. Southern Sumatra, Indonesia</td>
<td>2007 09 12</td>
<td>8.5</td>
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<tr>
<td>14. Banda Sea, Indonesia</td>
<td>1938 02 01</td>
<td>8.5</td>
</tr>
<tr>
<td>15. Kamchatka</td>
<td>1923 02 03</td>
<td>8.5</td>
</tr>
<tr>
<td>16. Chile-Argentina Border</td>
<td>1922 11 11</td>
<td>8.5</td>
</tr>
<tr>
<td>17. Kuril Islands</td>
<td>1963 10 13</td>
<td>8.5</td>
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Source: USGS, 2012
# Largest Earthquakes since 2000

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<thead>
<tr>
<th>Year</th>
<th>Date</th>
<th>Magnitude</th>
<th>Fatalities</th>
<th>Region</th>
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<tbody>
<tr>
<td>2012</td>
<td>04/11</td>
<td>8.6</td>
<td></td>
<td>Off the west coast of northern Sumatra</td>
</tr>
<tr>
<td>2011</td>
<td>03/11</td>
<td>9.0</td>
<td>20,896</td>
<td>Near the East Coast of Honshu, Japan</td>
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<tr>
<td>2010</td>
<td>02/27</td>
<td>8.8</td>
<td>507</td>
<td>Offshore Maule, Chile</td>
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<td>2009</td>
<td>09/29</td>
<td>8.1</td>
<td>192</td>
<td>Samoa Islands region</td>
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<tr>
<td>2008</td>
<td>05/12</td>
<td>7.9</td>
<td>87,587</td>
<td>Eastern Sichuan, China</td>
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<tr>
<td>2007</td>
<td>09/12</td>
<td>8.5</td>
<td>25</td>
<td>Southern Sumatera, Indonesia</td>
</tr>
<tr>
<td>2006</td>
<td>11/15</td>
<td>8.3</td>
<td>0</td>
<td>Kuril Islands</td>
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<td>2005</td>
<td>03/28</td>
<td>8.6</td>
<td>1,313</td>
<td>Northern Sumatra, Indonesia</td>
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<td>2004</td>
<td>12/26</td>
<td>9.1</td>
<td>227,898</td>
<td>Off West Coast of Northern Sumatra</td>
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<tr>
<td>2003</td>
<td>09/25</td>
<td>8.3</td>
<td>0</td>
<td>Hokkaido, Japan Region</td>
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<tr>
<td>2002</td>
<td>11/03</td>
<td>7.9</td>
<td>0</td>
<td>Central Alaska</td>
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<tr>
<td>2001</td>
<td>06/23</td>
<td>8.4</td>
<td>138</td>
<td>Near Coast of Peru</td>
</tr>
<tr>
<td>2000</td>
<td>11/16</td>
<td>8.0</td>
<td>2</td>
<td>New Ireland Region, P.N.G.</td>
</tr>
</tbody>
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BRIEF HISTORY OF INDONESIAN EARTHQUAKE
Brief Indonesian Earthquake History

• 1600: Oldest earthquake identified by Visser (1922)
• 1833: Tsunami in Padang-Bengkulu, Sumatra.
• 1867: Jogjakarta earthquake
• 1883: Krakatau Volcano eruption, and triggered tsunami (killed >36,000).
• 1992: Flores earthquake and tsunami (killed > 2000).
• 2004: The Sumatran-Andaman earthquake and tsunami (killed >200,000). International collaboration in DRR
• 2005: Nias earthquake (killed > 5000)
• 2006: Pangandaran Tsunami (killed > 600), and Jogjakarta Earthquake (killed >5,000)
• 2007: Disaster Management Law is enacted
• 2008: BNPB (National Disaster Management Agency) is established. InaTEWS Inagourate by President.
• 2009: Padang earthquake (killed >1000)
• 2010: Mentawai earthquake and tsunami (killed > 400). Evaluation of InaTEWS
• LIPI and ITB establish Graduate Research School on Earthquake and Active Tectonics (GREAT)
• 2012: Indian Ocean earthquake (M=8.6), panic situation in Banda Aceh and Padang. Evaluation of InaTEWS
1833: Tsunami in Padang-Bengkulu, Sumatra.
1883: Krakatau Explosion, tsunami (fatalities: 36,000).
1908: First earthquake observation
1920: Geologie Minjbow, THS (Institut Teknologi Bandung)
1921: Pangandaran tsunami
1815: Tambora explosion
1907: Simeulue earthquake, tsunami
1867: Jogjakarta earthquake
1992, Flores earthquake, tsunami (killed >2,000)
2000: Discovery of Mentawai Segment
1921: Pangandaran tsunami
1994, Liwa earthquake, Sumatra (killed >200)
2000: Discovery of Mentawai Segment
1990: BAKORNAS PB (Coordinating Agency for Nat Dis. Relief)
1994: BP2BAP (Nat Com for Nat Disaster Relief)
1866: Magnetisch en Meteorologisch Observatorium
1908: First earthquake observation
1907: Simeulue earthquake, tsunami
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1833: Tsunami in Padang-Bengkulu, Sumatra.
26 Dec 2004, Sumatran-Andaman earthquake/tsunami (killed >200,000).
March 2005: Nias earthquake (killed >1,000)

26 June 2006, Pangandaran earthquake (killed >500),
July 2006, Jogjakarta earthquake (killed >6000), Sidiarjo Mud Volc.

2007: Disaster Management Law,
26 Sept 2007, Mentawai earthquake

26 June 2006, Simeulue earthquake

29 Sept 2009, Padang earthquake (killed >1,000)
2009 Tassik Malaya earthquake (west Java)
Sinabung eruption (after >600 dormant)

2010, New Building Code

29 Sept 2010, severe eruption Merapi (killed >1100)
25 Oct 2010, Mentawai earthquake/tsunami (killed >400)
Reassessment of InaTEWS

2011: GREAT (Graduate Research School on Earthquake and Active Tectonics)-ITB/LIPI, supported by BNPB and AIDFR Australia

11 March 2012 Indian Ocean earthquake (Panic situation in Banda Aceh and Padang), Reassessment of InaTEWS
LAST EVENTS
Shifting to the South: MENTAWAI?
Mentawai 2010
LESSON LEARNED
Lesson Learned From Flores

The 1992 Flores earthquake/tsunami

20 year after in the same place

• She stays with her family in the coastal village (that were totally damage in 1992).

• She said: “I was born as fisherman family, I will stay near the sea.... And please don’t talk about tsunami anymore....

One of the 1992 survivors
Facts

• School is 50 m from shore
• Tsunami arrived 10 minutes after the earthquake
• The children need less than 10 minute to arrive at elevated area.
Lesson learned from Simeuleu

The 26 December 2004

- 100% safe from tsunami
- Simeuleu was just 8 menit from the source of the 2004 giant tsunami
- Hilly area
- They have local knowledge that called “SMONG “ (receding sea water) after the 1907 tsunami, and told the young generation

Photo: Sieh, 2005
The Mentawai Case

- The M=8.1 Mentawai Earthquake 2007 did not create tsunami.
  - The people of Mentawai who living only 15 minutes rely on that event.

- The M=7.4 Mentawai Earthquake in Oct 25, 2010 was tsunami earthquake.
  - Official warning from BMKG reached the Mentawai local govt office, but caused by lack communication, the warning did not reach the coastal area.
  - The people felt weak shaking compared to the 2007 or 2009 (Padang) events.
  - Many of them lost their “precious” time and 400 were killed..

- Such phenomena must be taken account in the material for public education.

Satake et al, 2010
INDIAN OCEAN EARTHQUAKES
April 11, 2012

11 APRIL 2012, People heavy traffic, evacuate hazardous areas and move to safe location

TSUNAMI DRILL, People move away from the beaches and river banks and to designated safe locations

Source: Indonesian Joint Rapid Assessment 2012, Suharjono, BMKG
FUTURE CHALLENGE
Preparing Padang
Population In Padang

Imamura et al., 2012
Worst Case Scenario

• only 37.7% of the population reach the save area during 45 minutes.
• Inundation area move farther the official evacuation map
• Need vertical evacuation building
• Note: A lot of high buildings were collapses during the 30 Sept Padang Earthquake
  (Imamura et al, 2012)
Problem: Evacuation

- Dense population
- Many buildings collapsed in the 2009 event
- Limited space to build the vertical evacuation building

- Need vertical evacuation building in predicted inundation area
- Green belt
- Community Preparedness

Imamura et al (2012)
WALIKOTA PADANG

PERATURAN WALIKOTA PADANG
NOMOR 14 TAHUN 2010

TENTANG
PELAKSANAAN SISTEM PERINGATAN DINI TSUNAMI
DENGAN RAHMAT TUHAN YANG MAHA ESA

WALIKOTA PADANG

Menimbang:

a. bahwa Kota Padang terletak pada pertemuan Lempeng Eurasia dan Indo-Australia dan secara geologi dilalui oleh Bukit Barisan, merupakan daerah yang sangat rawan gempa bumi yang dapat disusul dengan tsunami;

b. bahwa untuk mengurangi dampak resiko yang akan ditimbulkan oleh bencana tsunami, perlu dipandu bagi Pemerintah dalam melaksanakan sistem dan memberikan layanan peringatan tsunami bagi masyarakat di Kota Padang;

c. bahwa berdasarkan pertimbangan sebagaimana dimaksud pada huruf b perlu menetapkan Peraturan Walikota tentang Pelaksanaan Sistem Peringatan Dini Tsunami.

Mengingat:

1. Undang-Undang Nomor 9 Tahun 1956 tentang Pembentukan Daerah Otonomi Kota Besar Dalam Lingkungan Daerah Propinsi Sumatera Tengah (Lembaran Negara Tahun 1956 Nomor 20);

2. Undang-undang Nomor 10 Tahun 2004 tentang Pembentukan Peraturan Perundangan-undangan (Lembaran Negara Tahun 2004 Nomor 63, Tambahan Lembaran Negara Nomor 4386);

3. Undang-undang Nomor 32 Tahun 2004 tentang Pemerintahan Daerah (Lembaran Negara Tahun 2004 Nomor 125, Tambahan Lembaran Negara Nomor 4437); Sebagaimana telah diubah beberapa kali terakhir dengan Undang-undang Nomor 12 Tahun 2008 (Lembaran Negara Tahun 2008 Nomor 59, Tambahan Lembaran Negara Tahun 4844);

Mayor Regulation on Tsunami Warning System

Courtesy: Irina Rafliana

OFFICIAL EVACUATION MAP
OF PADANG CITY (2010)

Courtesy: Muharam
UNDERSTANDING
JAVA EARTHQUAKES
Center of activities and the small but most populated island: more than 100 million

Active Tectonic and earthquake history:
- Less known than Sumatra. Only the Lembang fault in west Java that mapped in detail by Indonesian-Japan collaboration through SATREP Project)
- Last earthquakes were the 2006 Jogjakarta earthquake with casualties more than 6000 people and the 2006 Tsunami at Pangandaran (West Java) that killed more than 500 people.
LESS DATA
IN EASTERN INDONESIA
Tectonically more complex compared to the western part of Indonesia. We have good coverage of GPS network but lack of detail map of active faults (we just start to map more detail the Palu-Koro active faults in Celebes.)
Concluding Remarks

• Earthquake and tsunami are rare events, and recurrent time of the large earthquake often more than tens or even more than hundreds years. It causes people forgot the past.
• We observe how the people forgot the past disaster. But from Simeulue we learn how they convey the past experiences from generation to generation.
• Despite the InaTEWS has capability to announce the warning less than 5 minutes, but last event of April 11, 2012 show how the continuous public education and preparedness efforts at all level are needed especially for City of Padang
• Java relatively has limited data compared to Sumatra. Eastern part of Indonesia is more worst. It needs the detail work.
Thank you