Tsunami Warning and Preparedness in Indonesia after the 2004 Indian Ocean Tsunami

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1. INTRODUCTION

Wake Up Call from Indian Ocean

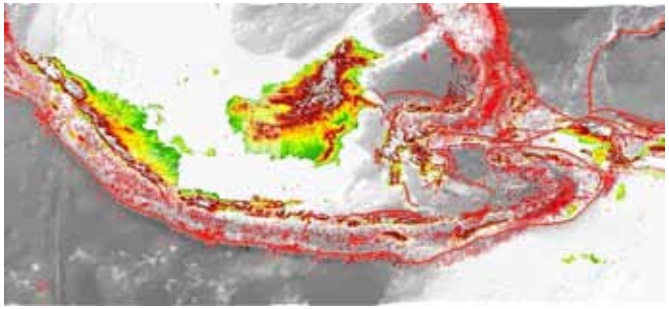
- Size
  - Earthquake Mag: M=9.1
  - Ruptured Zone: ~ 1000 km
  - Wave highest: 30 m
  - Inudation: 5 km
- Fatalities
  - More than 200.000 victims
  - $

Inauguration of InaTWS

- Inauguration of InaTWS was conducted in November 11, 2008 and declared by President of Republic of Indonesia.
- To celebrate, an International Seminar on Tsunami was conducted in Bali in November 12-14, 2008.

Photos: BMKG

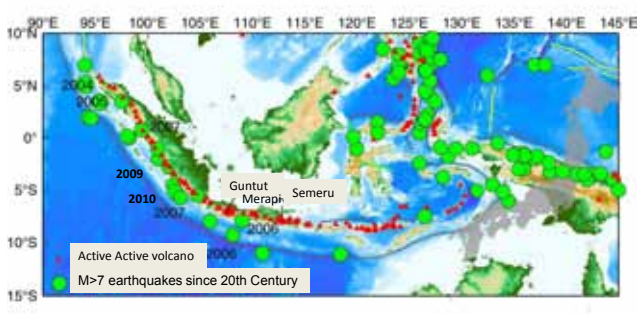
Active Tectonics of Indonesia and Earthquake Distribution



- Indonesia is in a junction of the Eurasia, Hindia-Australia and Pacific plates. Tectonically , the eastern part is more complicated compare to the western one.
- Crustal deformations occur along the plate boundaries that manifested by earthquakes, volcanoes and vertical movements phenomena

Source: Natawidjaja (2011)

Destructive Earthquake and Volcanoes Distribution



- Destructive earthquakes since 2004: Aceh, Sumatra (2004, with tsunami), Nias (2005), Pangandaran (2006, with tsunami), Jogjakarta (2006), Mentawai (2007), Tasikmalaya (2009), Padang (2009), and Mentawai (2010)
- Severe volcanic eruption: Merapi (2006, 2010)

Source: Satake (2010)

Tsunami History in Indonesia

Source: Latief

Earthquakes with > 1,000 fatalities in last decade

Date	Region	M	Fatalities
2011/3/11	Tohoku, Japan	9.0	20,896
2010/1/12	Haiti	7.0	222,570
2009/9/30	Padang, Indonesia	7.5	1,117
2008/5/12	Sichuan, China	7.9	87,587
2006/5/26	Java (Jogjakarta), Indonesia	6.3	5,749
2005/10/8	Kashmir, Pakistan	7.6	86,000
2005/3/28	Sumatra (Nias), Indonesia	8.6	1,313
2004/12/26	Sumatra (Aceh), Indonesia	9.1	227,898
2003/12/26	Bam, Iran	6.6	31,000
2003/5/21	Algeria	6.8	2,266
2002/3/25	Afghanistan	6.1	1,000
2001/1/26	Bhuj (Gujarat), India	7.6	20,023

!2 events occured in the last decade that were 10 in Asia and 4 in Indonesia

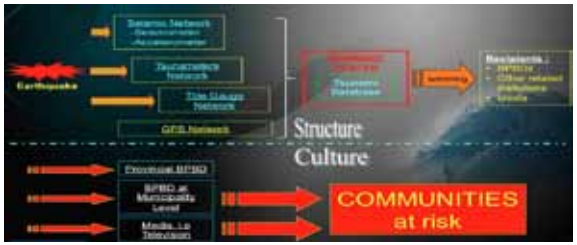
Source: Satake (2010)

2. InaTEWS

- 12 National Institution and 7 Foreign Countries and 2 UN orngaizations have collaborated in establishment of Indonesia Tsunami Early Warning System

Source: Pariatmono (2011) , BMKG

Development of InaTEWS

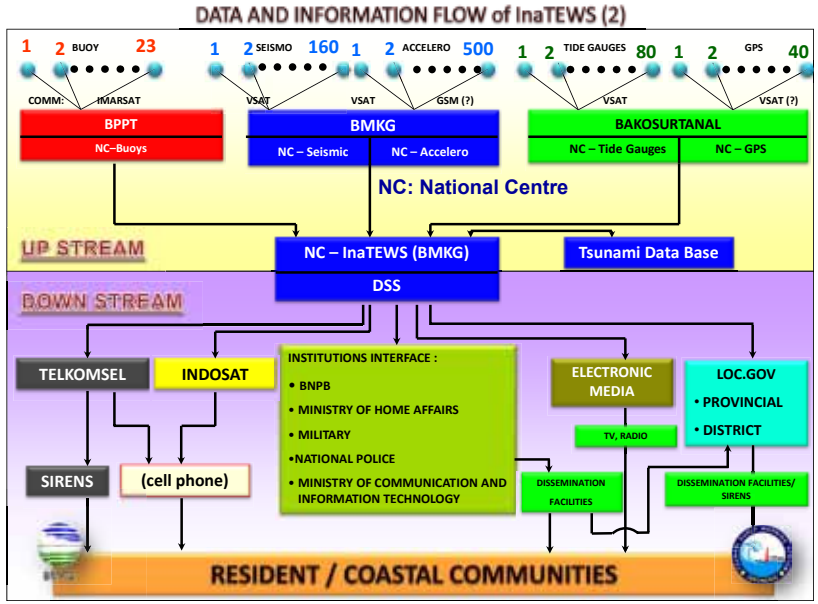


- InaTEWS consists of two main components: structural and cultural components. *Structural components* include the installation of various types of equipment. Data from these tools then sent to the National Center for Tsunami Early Warning (National Tsunami Warning Center, NTWC) located in BMKG. The data is processed to become a warning and sent to interface institution in 5 minutes. The message flow to *cultural component*, which convey the message to public in areas threatened by disaster to evacuate either through local governments or through the media. Even though seems simple, this part is the hardest part in a tsunami early warning system. *Source: Pariatmono/Ristek*

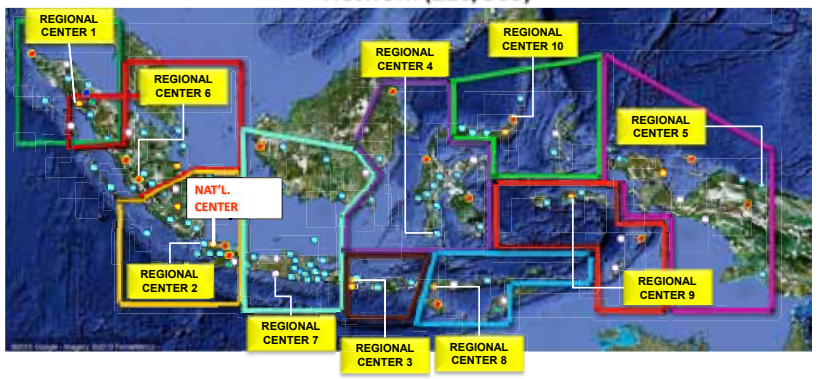
Data and Information Flow of InaTWES (1)

- **Upstream :**
  - Data flow from sensors to National Center for each Monitoring System and to InaTEWS – National Centre
  - Processing and Analyzing System :
  - Seismic Data to generate Tsunami Warning
  - DSS prepares comprehensive warning and update Downstream Dissemination of Tsunami Warning through multi mode of communications and interface institutions.
- **Downstream :**
  - Dissemination of Tsunami Warning Institutions Interface : BNPB, National Police, military, Ministry of Home Affairs, Ministry of Comm. and Inform technology, Provincial Government, Regency/City Government, Media : television, Radio, Citizen band, Sirens, and limited at several Prov. Gov

Source: BMKG



Equipments (1): Broadband Seismic Network (160/160) and Accelerometer Network (220/500)



INDONESIA (108) JAPAN (15) CHINA (10)
GERMANY (21) CTBTO (6)

Extended to 200 up to 2014

Equipments (2): Tide gauges and GPS

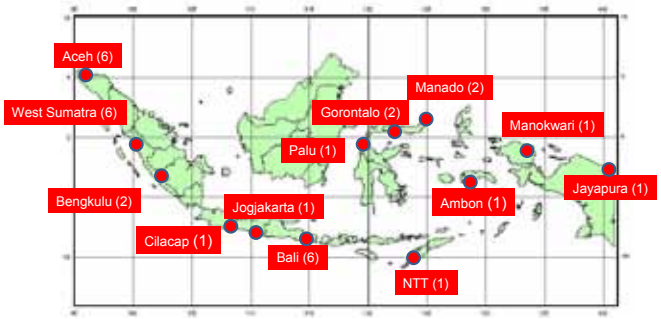
- Near real time tide gauges data and GPS operated by Bakosurtanal.
- Expected 20 more in 2014

Source: Bakosurtanal

Equipments (3): Digital Video Broadcasting (DVB)

- Distribution of DVB all over Indonesia (145 sites). The system development and installation was supported by NOAA-USA and BMKG.
- It is targeted to 500 units up to 2014.

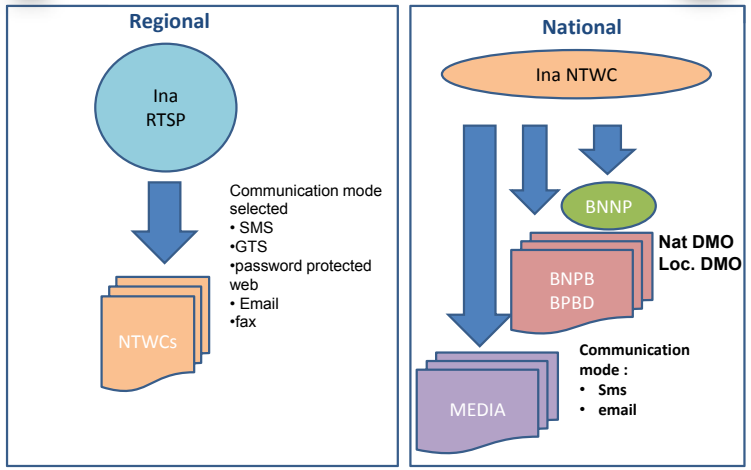
Equipments (4): Sirens



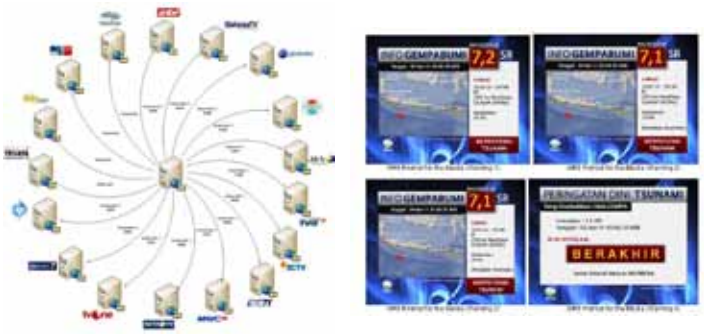
Currently, 29 sirens have been installed throughout the coastal area of Indonesia. Considering the lenght of the Indonesian coastal area that 80 thousand miles and more than the half of it is tsunami hazard, the number is certainly still far from adequate.

Source: BMKG, Ristek

InaTEWS as RTSP and NTWC



Dessimination Through Electronic Media (1)

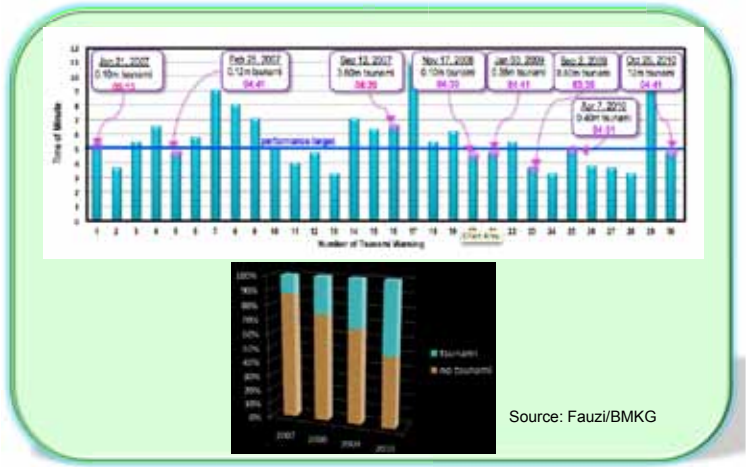


Tsunami warning issued by BMKG and sent out to televisions, radios, and media online to be broadcasted

Dessimination Through SMS (2)

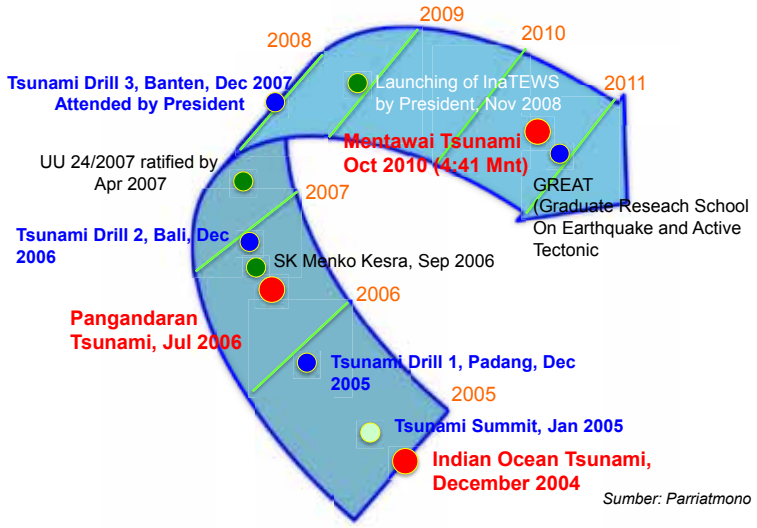
- Warning Tsunami: Siaga di SUMBAR; Waspada di BENGKULU, JABAR, LAMPUNG, Gempa Mag:7.1SR, 20-Dec-10 18:42:00WIB, Lok:3.46LS/100.20 BT, Kdlm: 12km::BMKG
- Tsunami Warning : Warning in SUMBAR; Advisory in BENGKULU, JABAR, LAMPUNG,
- EQ Mag:7.1SR, 20-Dec-10 18:42:00WIB,
- Loc:3.46 S/100.20 E, Depth: 12km::BMKG

Performance of Ina-TEWS (2010)



Source: Fauzi/BMKG

Milestones in InaTEWS Development



Sumber: Parriatmono

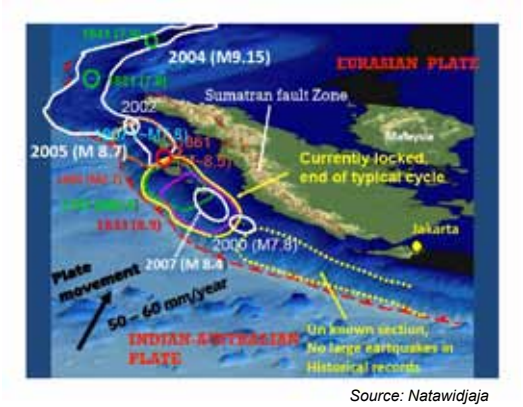
3. Preparedness

- As a part of *Culture* component
- More hardest in InaTEWS
- It covers:
  - Research/Surveys
  - Risk Assessment
  - Vulnerability Assessment
  - Community Preparedness
    - Public Education
    - School Preparedness
    - Local Government

Research and Survey (1)

- To mitigate the geological disaster i.e earthquake and tsunami we must:
  - To understand deeply the character of the sources
  - translate to engineering and social responses
  - transfering knowledge to the society
  - working closely with the government

Research and Survey (2)



Source: Natawidjaja

The locked Mentawai segments have been studied since 1991. Several earthquakes have occured in in the segments however the large part of the segments are still locked and it is potential to generate earth-quake with magnitude M=8.8

Base on such scientific finding and other studies some cities along the coast of West Sumatra are preparing the hazard map and evacuation map.

Several actions such as public education, tsunami drills etc have been conducted

Sources: Febrin (2010), Muhari (2012)

Research and Survey (3)

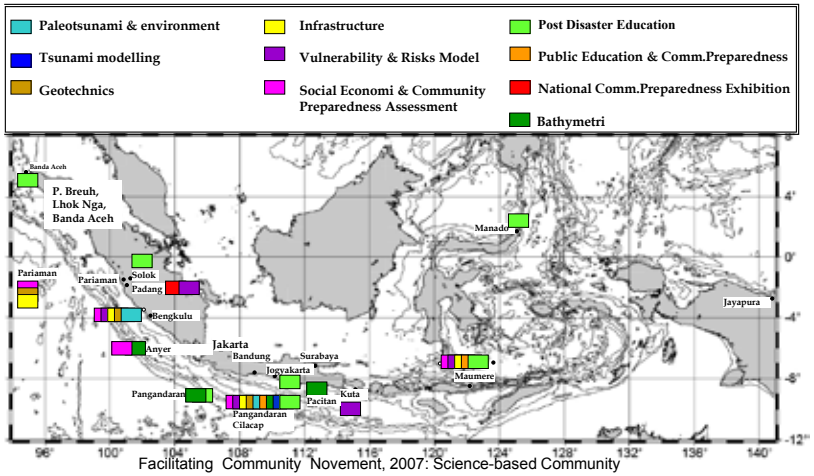
- After the 2004 Giant Sumatran-Andaman Earthquake and Tsunami , a lot of research and surveys have been conducted. Among them are:
  - Germany , Japan, France, Australia, UK, and US.
  - Covering Geology (Paleoearthquake, Paleotsunami), Geophysics (including space geophysics), Geodesy, Marine Geophysics, Seismology,...
  - Japan through SATREP Scheme have collaborate with Indonesia on Multi – Disciplinary Hazard Reduction from Earthquake and Volcanoes in Indonesia. This 3 years project is supported by scientists, engineers, social scientists as well as beurocrat

Photo: Yulianto

Community Preparedness (1)

- ManyIndonesian people are living in coastal area that close to the source of tsunami. The tsunami could arrive less than an hour or event less that 30 minutes
- In order to reduce the risks, we conduct community preparedness through public education, school preparedness by establishing School based disaster preparedness, and strengthened the local government
- The Idonesian Institute of Science (LIPI) collaborates with other institutes such as Ristek, BMKG and Unesco connducted such activity,

Community Preparedness (2)



Facilitating Community Novement, 2007: Science-based Community Preparedness

Source: LIPI

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.

Source: Satake(2000)

Media Campaign

Conclusion

- Despite the InaTEWS has capability to announce the warning less than 5 minutes, we must consider that we are living near the source.
- So, the challences for the structural is how to better establish communication system with the people in coastal area.
- To increase our activity on Community Preparedness along the coastal area masively.

Thank you.....

Uplift in Semeulue after the 2004 earthquake

Photo: Sieh