# PACE (Promoting Activities in Continuing Education)

## 2007 Second Series

Date: Sunday, 30 September 2007
Time: 2.30 – 4.30 p.m.
Venue: Penang Caring Society Complex
(Kompleks Masyarakat Penyayang)

# Title: Tsunami Warning, Mitigation and Public Preparedness in Malaysia

by

Prof. Dato' Dr. Dick Ho Sinn Chye
Wawasan Open University

## Synopsis

On Wednesday 12 September 2007 a powerful sub-sea quake of magnitude 7.9 on the Richter scale occurred off the southwest coast of Indonesia's Sumatra, triggering tsunami warnings in Indonesia, Malaysia, India and Sri Lanka.

Malaysian authorities issued a tsunami warning for citizens to stay away from beaches. The alert was directed at four coastal States: Perlis, Kedah, Penang and Perak, the same region hit by the December 26 2004 Indian Ocean tsunami which was also generated by an Indonesian sub-sea quake.

Shortly after the Indian Ocean Tsunami incident of Dec 2004, Malaysia has put in place a tsunami early warning system. What are the components and limitations of Malaysia's tsunami early warning system? Who are the main players? What lessons have we learned from such natural disasters? What else needs to be considered or put in place?

The above are some of the questions that will be addressed by Prof. Ho who was a member of the Malaysian team which was involved actively in establishing the national tsunami early warning system of Malaysia.

## The Speaker

Prof. Dato' Dr. Dick Ho Sinn-Chye currently serves as the Dean of the School of Science & Technology at Wawasan Open University. He was the founding Director of the National Oceanography Directorate (NOD), Ministry of Science, Technology & Innovation (MOSTI). Prior to his last two appointments, he served as a faculty member of Universiti Sains Malaysia (USM) for 30 years. He was a Professor and former Dean of the School of Biological Sciences at USM. Prof. Ho obtained his PhD degree from the University of Kiel, Germany in 1979. His PhD work was conducted at the Max-Planck Institute in Germany.

*Title of Talk*

# Tsunami Warning, Mitigation and Public Preparedness in Malaysia

*By Prof. Dato' Dr. Dick Ho Sinn-Chye*

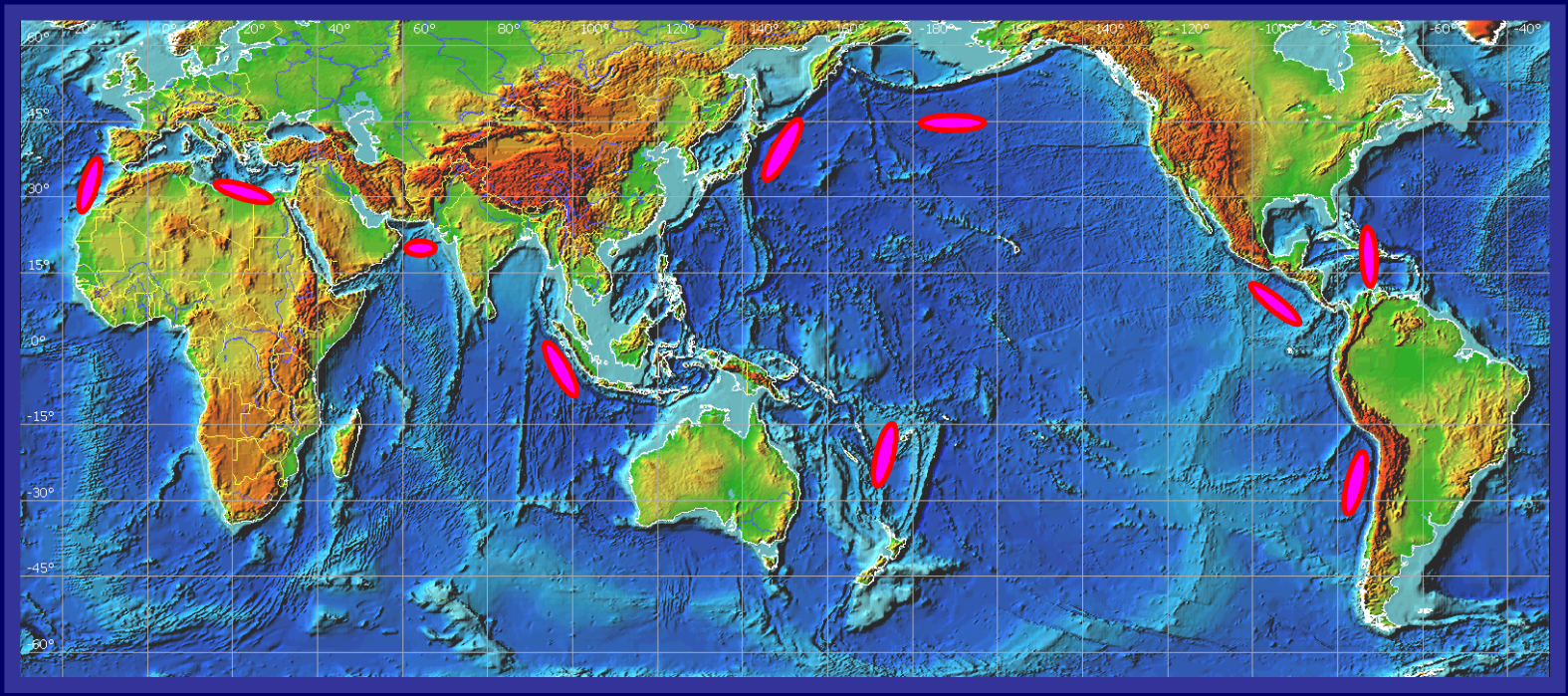
## *Talking Points*

1. Tsunami Early Warning System of Malaysia
2. Tsunami Mitigation and Disaster Response Programme
3. Public Education, Awareness and Preparedness

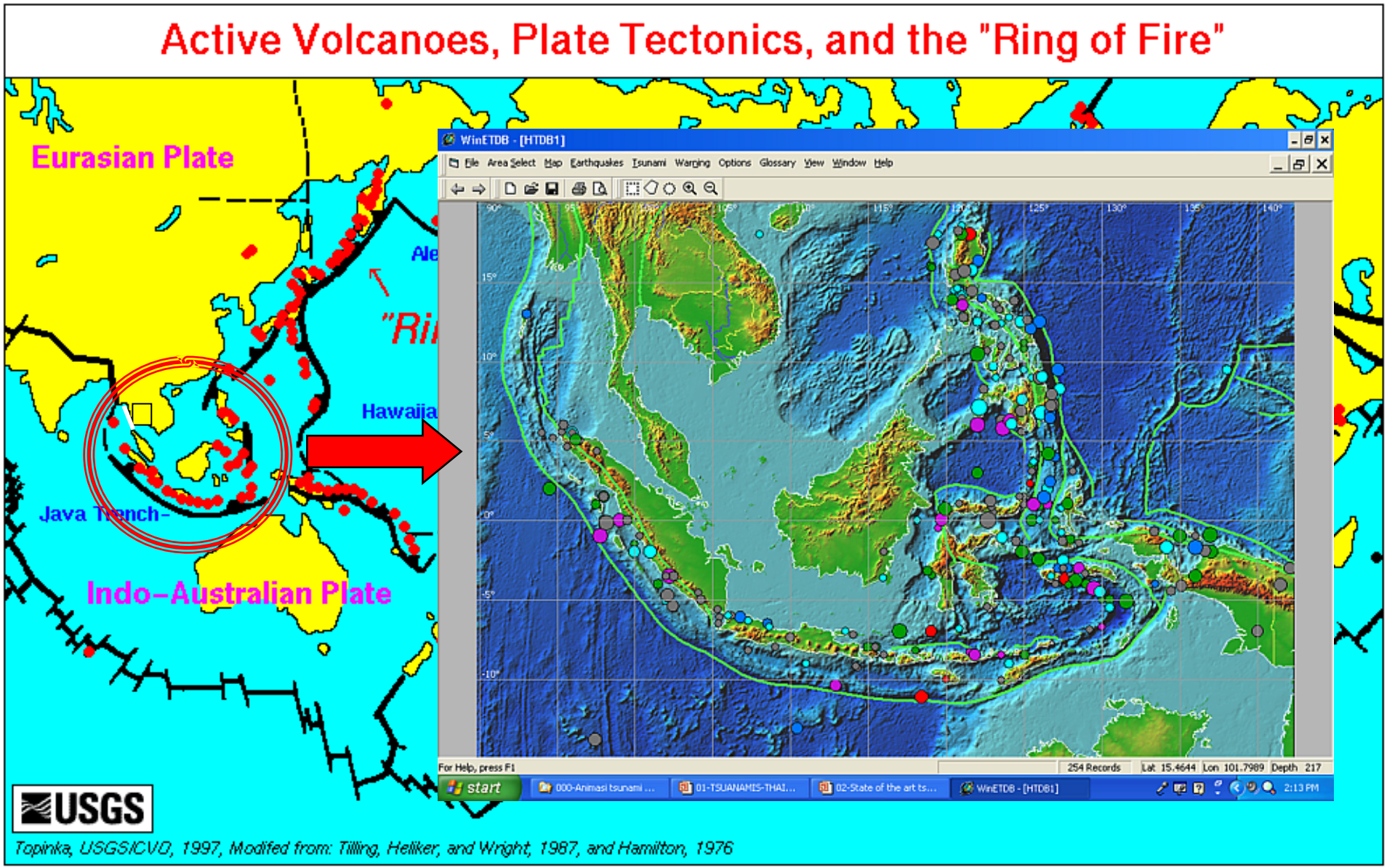
# BACKGROUND INFORMATION

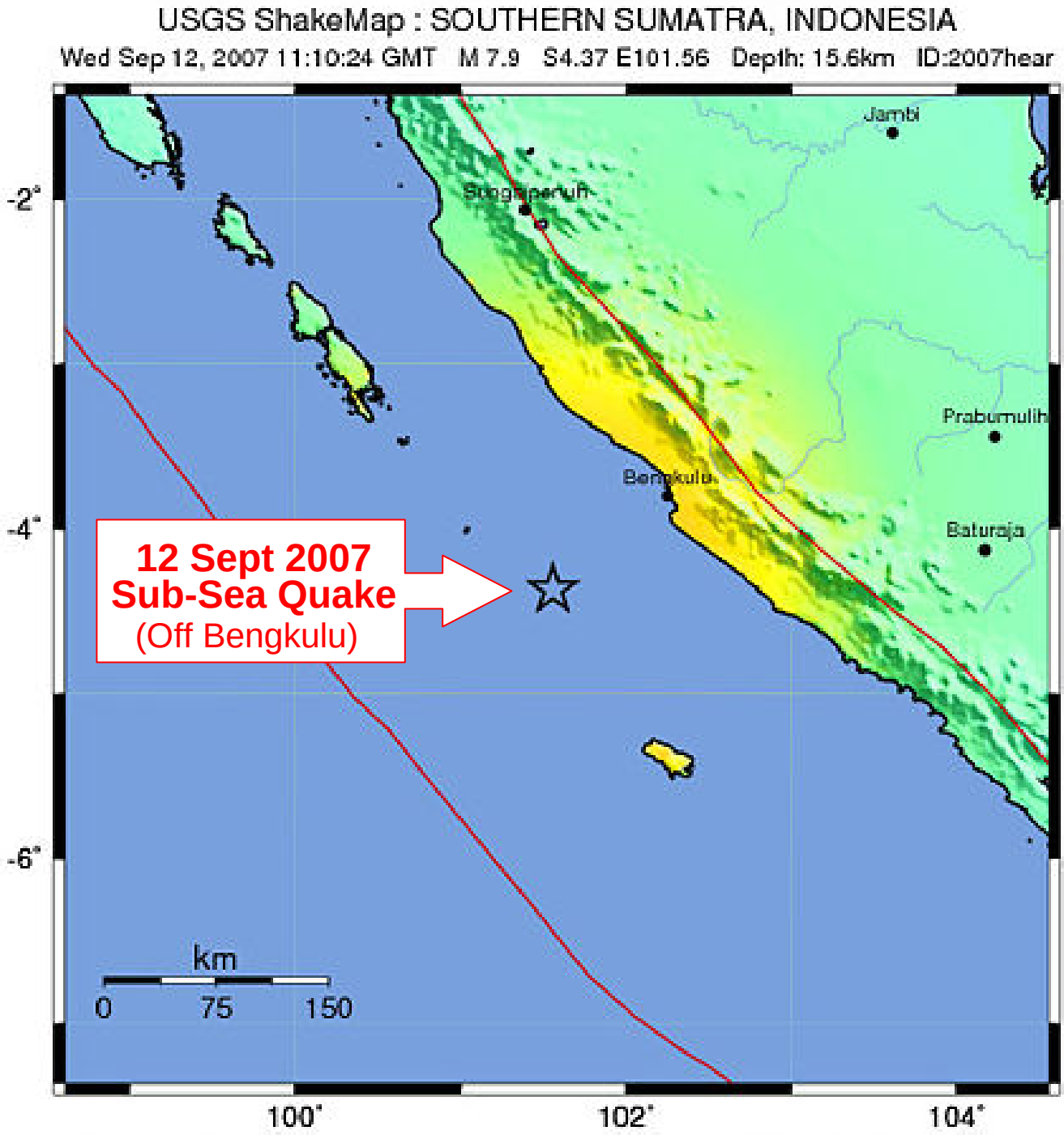
# SOME FACTS

- **Every Ocean Basin and Sea** can be impacted
- Next tsunami can occur **anywhere** and at **any time**
- Some countries have coasts on **two or more** basins
- **Few Early Tsunami Warning System** outside Pacific



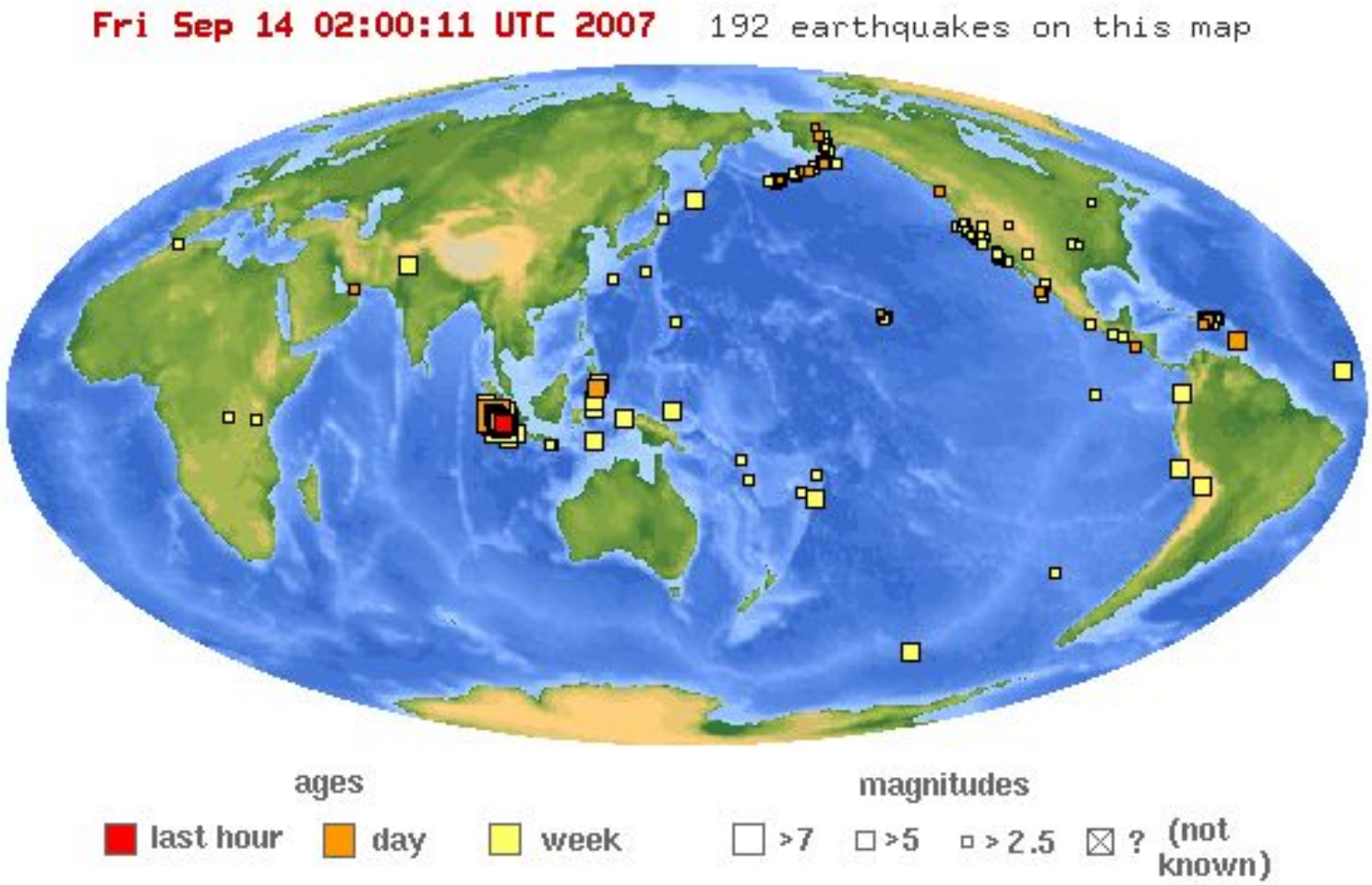
# No Longer in the Comfort Zone




USGS ShakeMap : SOUTHERN SUMATRA, INDONESIA
Wed Sep 12, 2007 11:10:24 GMT M 7.9 S4.37 E101.56 Depth: 15.6km ID:2007hear
Jambi
Prabumulih
Bengkulu
Baturaja
-2°
-4°
-6°
12 Sept 2007
Sub-Sea Quake
(Off Bengkulu)
km
0
75
150
100°
102°
104°

# Latest Earthquakes in the World - Past 7 days

Worldwide earthquakes with M4.0+ located by USGS and Contributing Agencies.
(Earthquakes with M2.5+ within the United States and adjacent areas.)

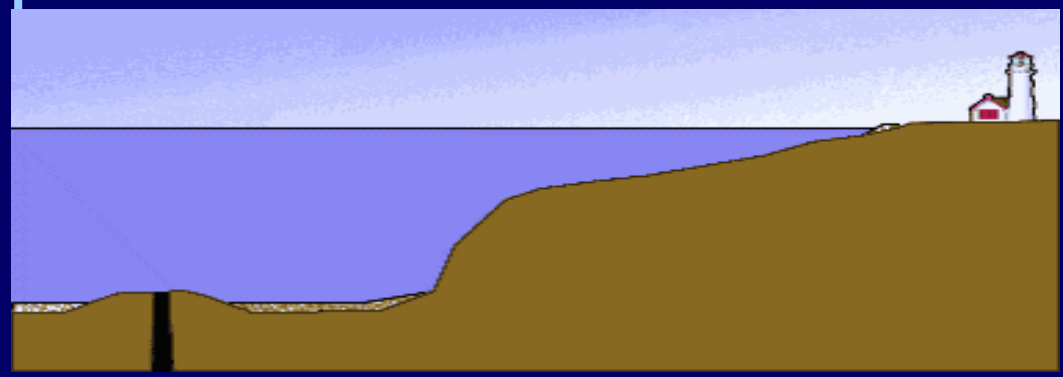


## CHARACTERISTICS OF TSUNAMIS

- Long wave periods
- Can achieve extreme heights
- Are rare events
- At open sea, they travel extremely fast, reaching velocities of 700 Km/H

## THE IMPACT ON HUMANS

- Tsunamis are catastrophic events
- They are very difficult to predict
- The death tolls of an attack can reach tens of thousands



# WHY IS A TSUNAMI A HAZARD?

**WAVE HEIGHT INCREASES IN SHALLOW WATER**

**Best Case: Quickly Rising Tide**

**Worst Case: Wall of water with rocks and debris**

**Runups > 30 m**

*July 12, 1993, Japan Sea*

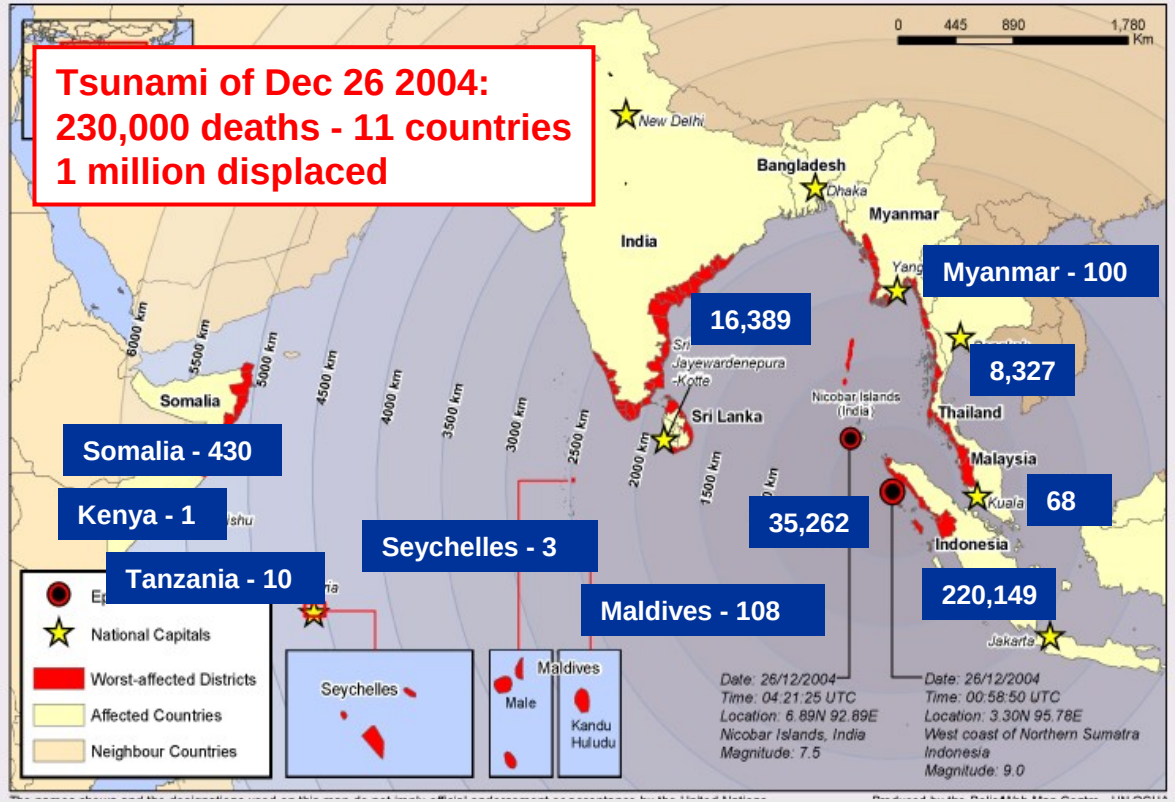
*December 26, 2004, Sumatra*

# WHY IS A TSUNAMI A HAZARD?

- **DANGER CONTINUES FOR MANY HOURS**
- **IT CAUSES HIGH FATALITY**
- **GLOBAL IMPACT BLIND TO POLITICAL BOUNDARIES**

***Local:*** ***arrives in minutes***

***Distant:*** ***travels hours across ocean***




*Casualties Data source: International Federation of Red Cross and Red Crescent Societies, 9 March 2005*

# TWO CATEGORIES OF TSUNAMI THREATS

## 1. LOCAL / REGIONAL

- ***Generated nearby***
- ***Strikes shore quickly (in minutes)***

  ***=> NO TIME for official evacuation***

➢ ***Education, Awareness***

➢ ***People-centered response – recognize / act immediately***

*July 12 1993, Japan Sea*

## 2. DISTANT / OCEAN-WIDE

- ***Generated far away, instr. detection***
- ***Strikes shore later (2+ hours)***

  ***=> TIME for official evacuation***
- ***Widespread Damage***

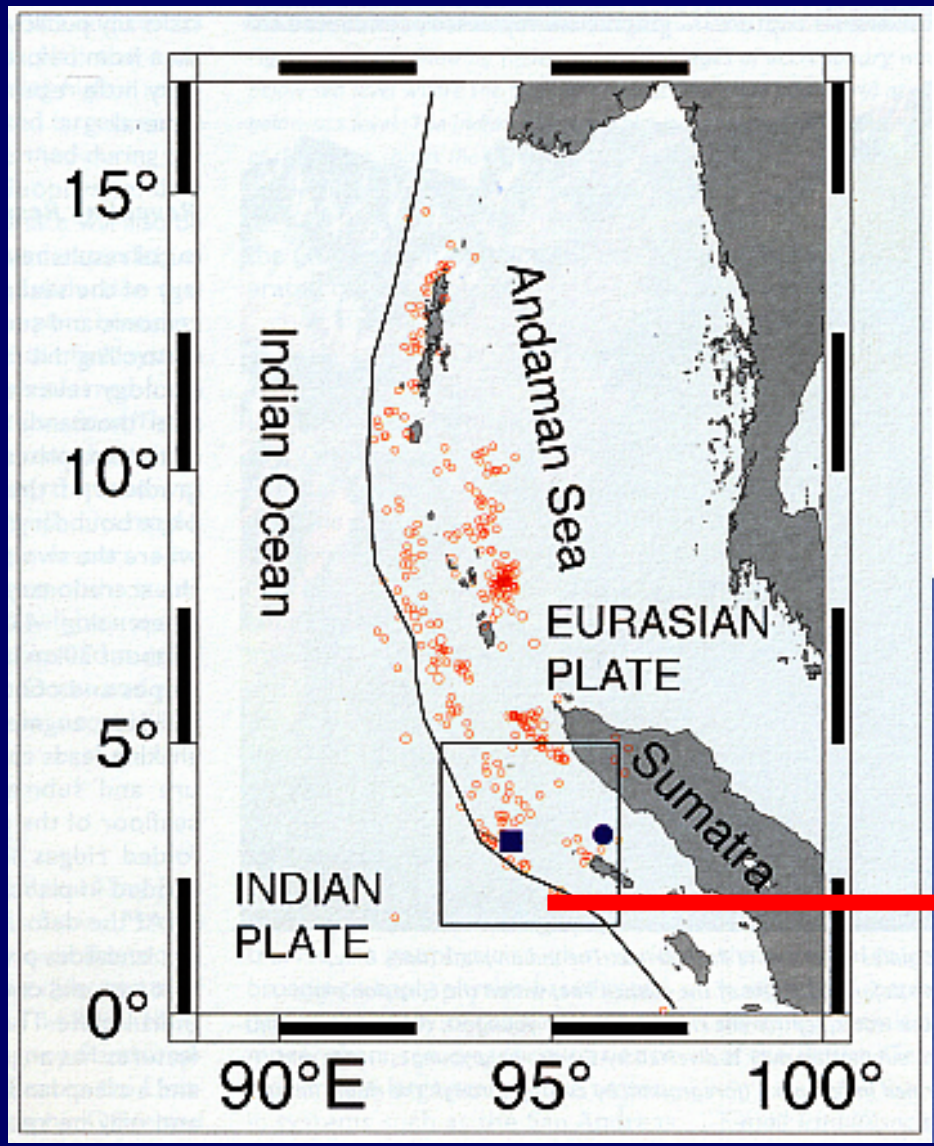
➢ ***Tsunami Warning Center, then***

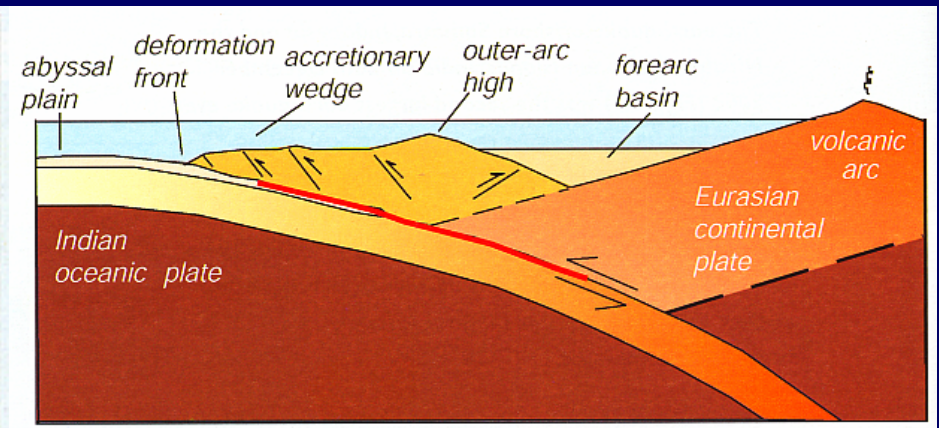
➢ ***People-centered response – locally-guided safety actions***

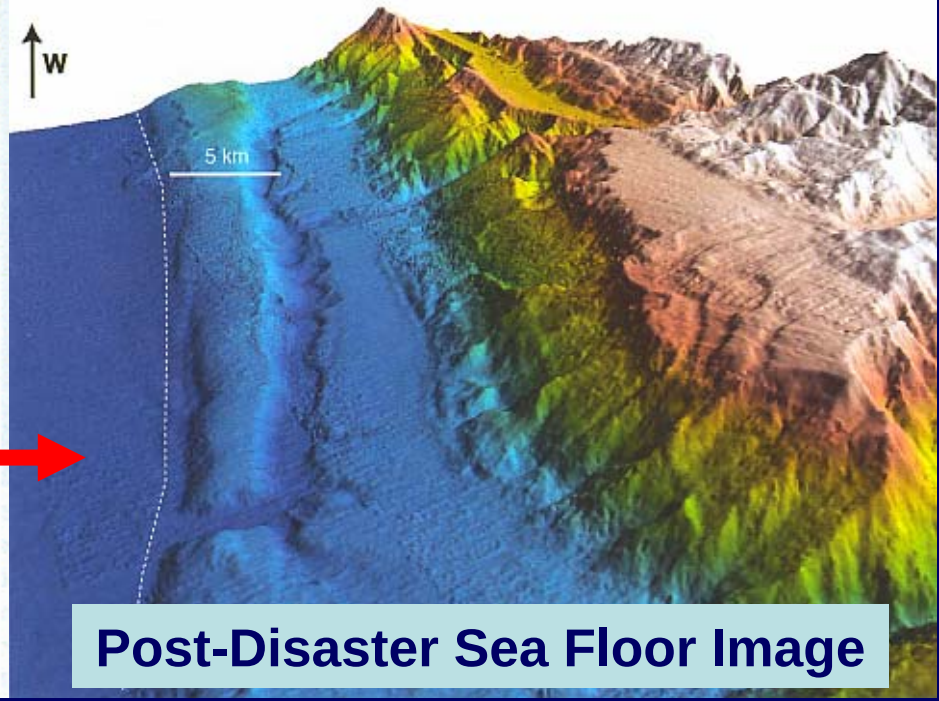
*May 22 1960, Chile tsunami in Hilo*

# Tsunami Fury Against PENANG ISLAND

# The Eastern Indian Ocean Earthquake and Tsunami




*Source: McNeill, Henstock and Tappin ( pages 7-9 of Hydro International, Vol. 9 No. 4, May 2005)*

# TSUNAMI EARLY WARNING SYSTEM OF MALAYSIA

# National Tsunami Warning System

1. It consists of a series of seismic monitoring stations and a network of coastal tide gauges that measure sea level.

2. When a seismic disturbance is detected, its location and magnitude are computed.

3. Warnings are issued if the magnitude is above a certain threshold.

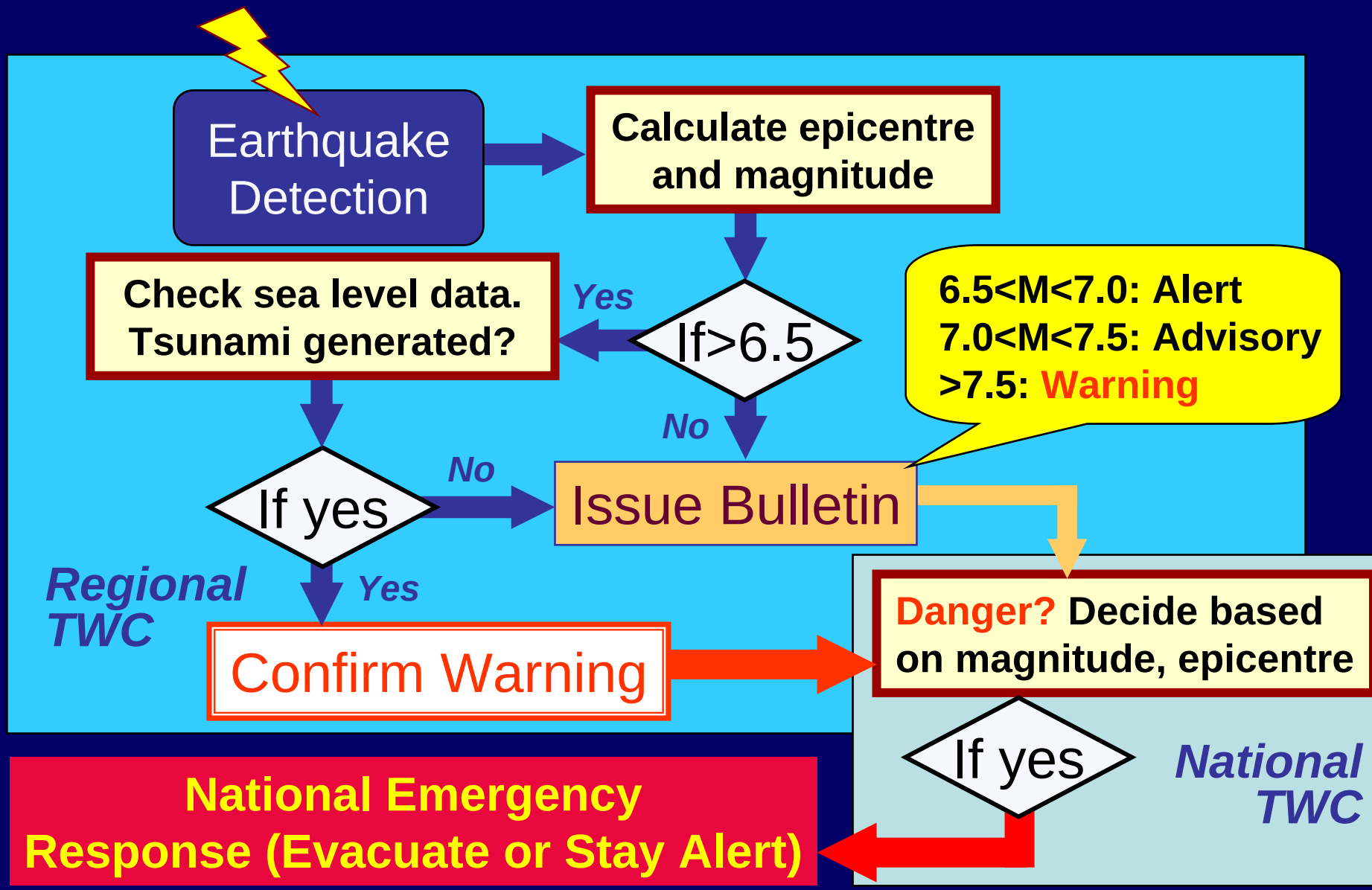
# National Tsunami Warning System

4. Then the gauging stations are monitored for abnormal changes in sea level.

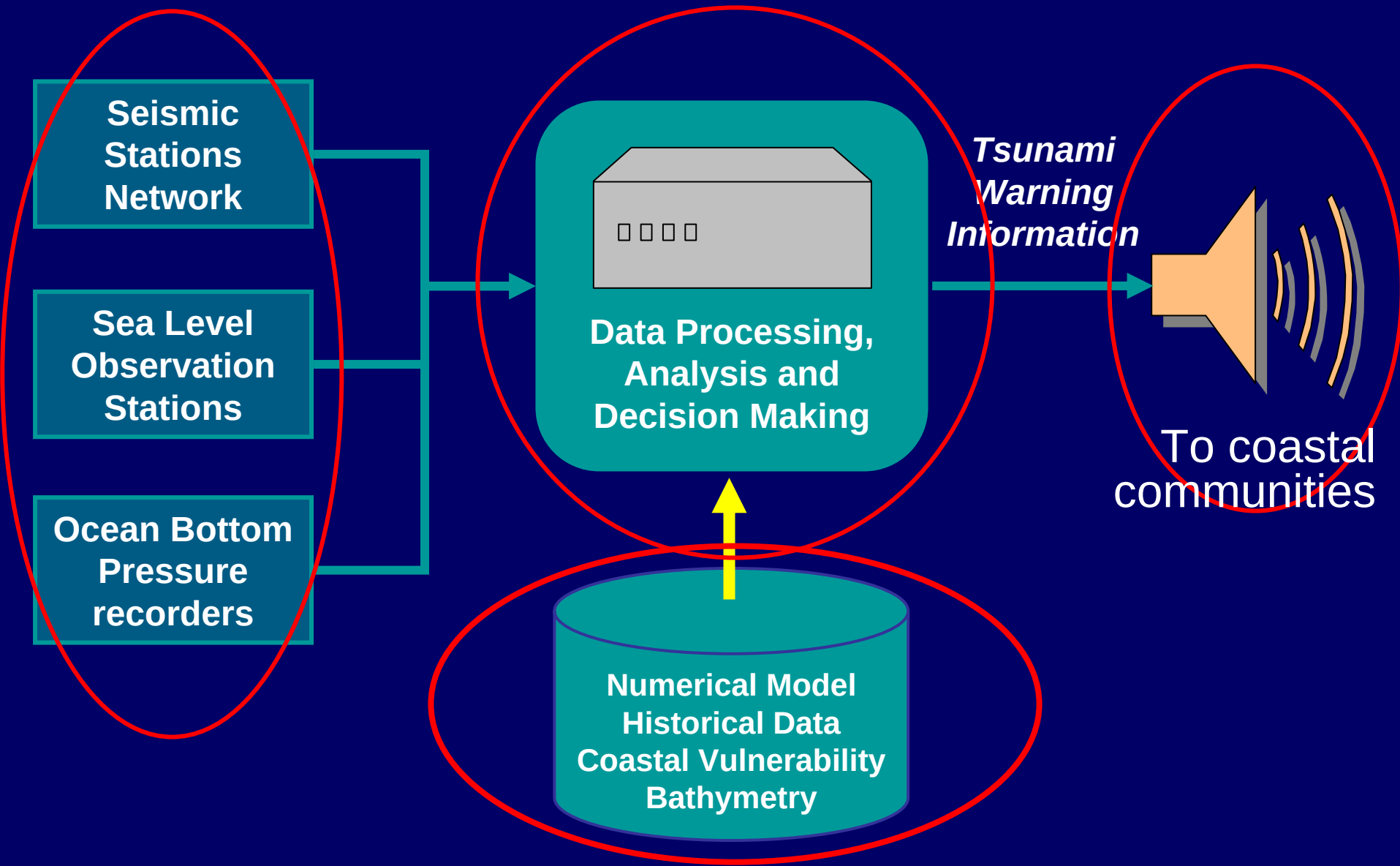
5. If a tsunami is detected, computer-based mathematical models are used to calculate its speed and direction.

6. Coastal populations located in the predicted path of the tsunami are warned of the approaching wave train.

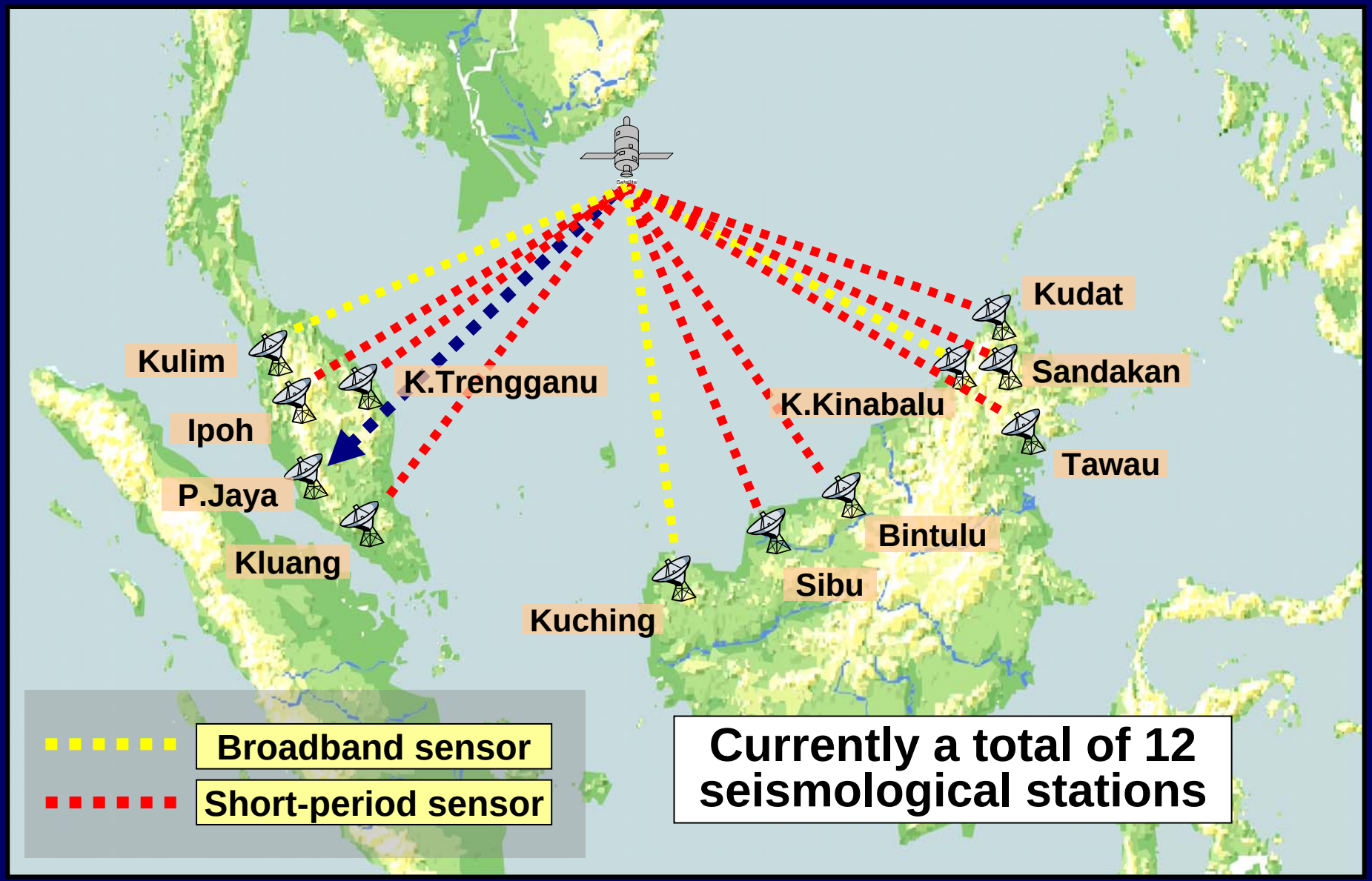
# Tsunami Warning Pathway



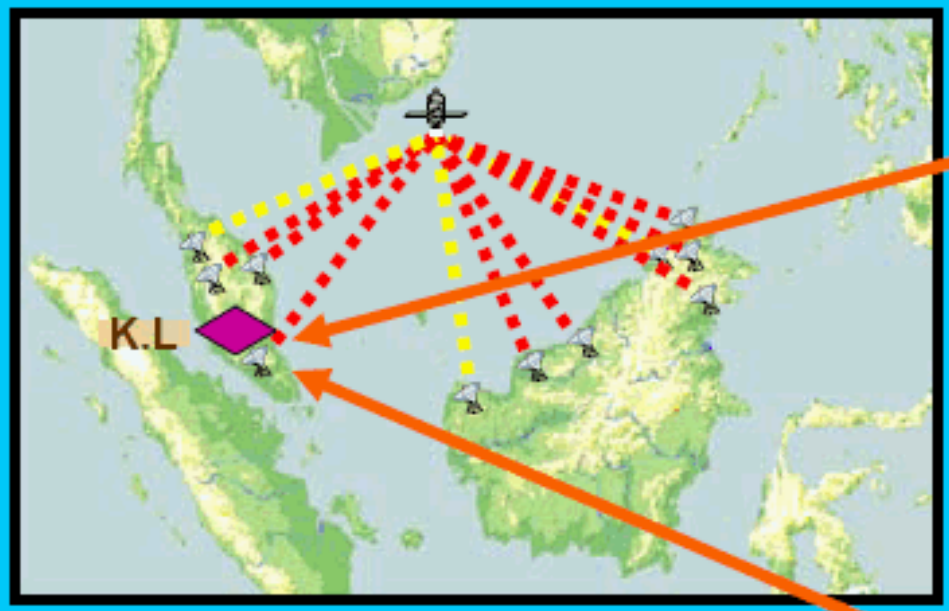
# Tsunami Warning System Design



# EXISTING NATIONAL SEISMIC NETWORK



# Linkage with IRIS/USGS/Australia





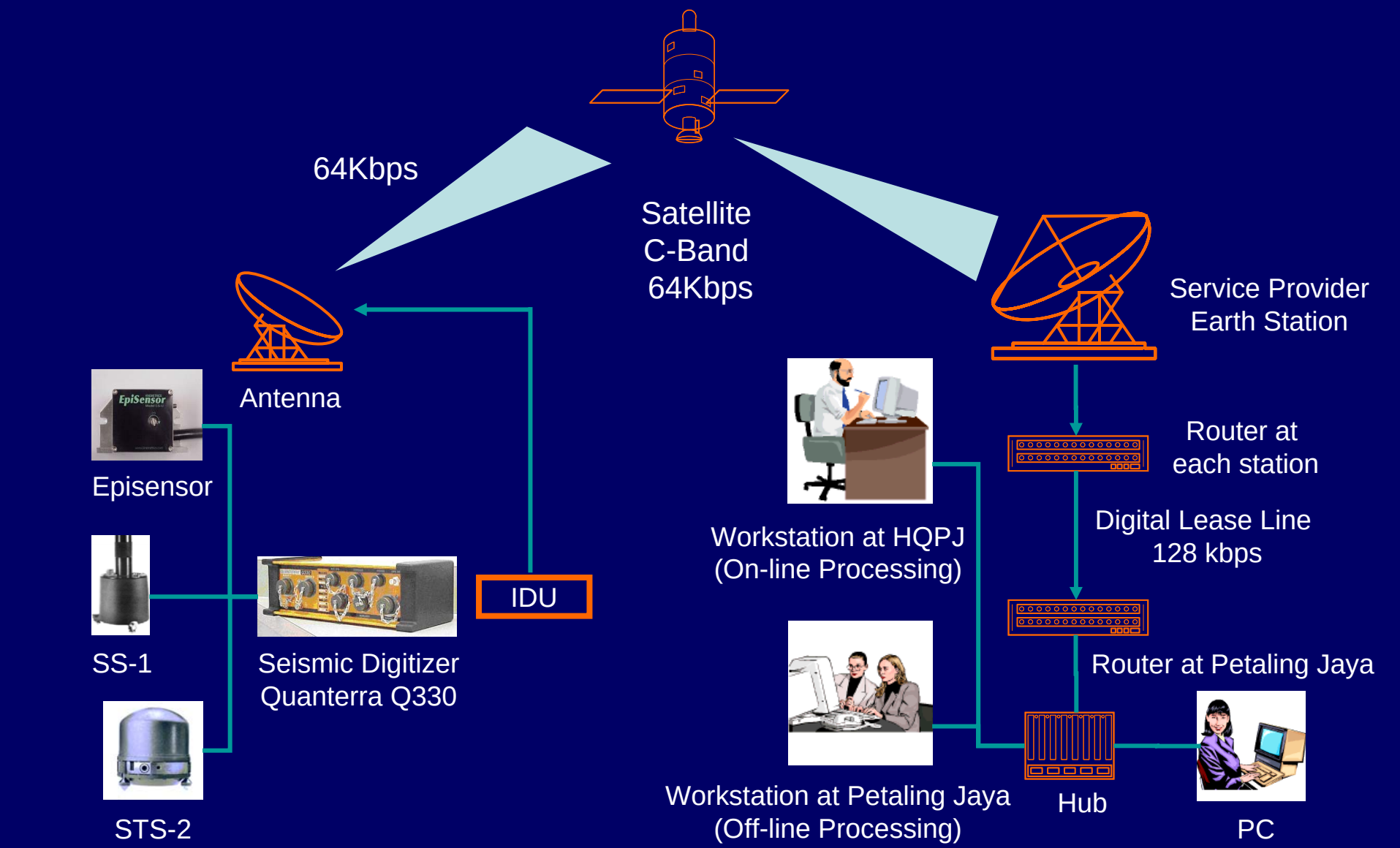

Malaysia

IRIS/USGS

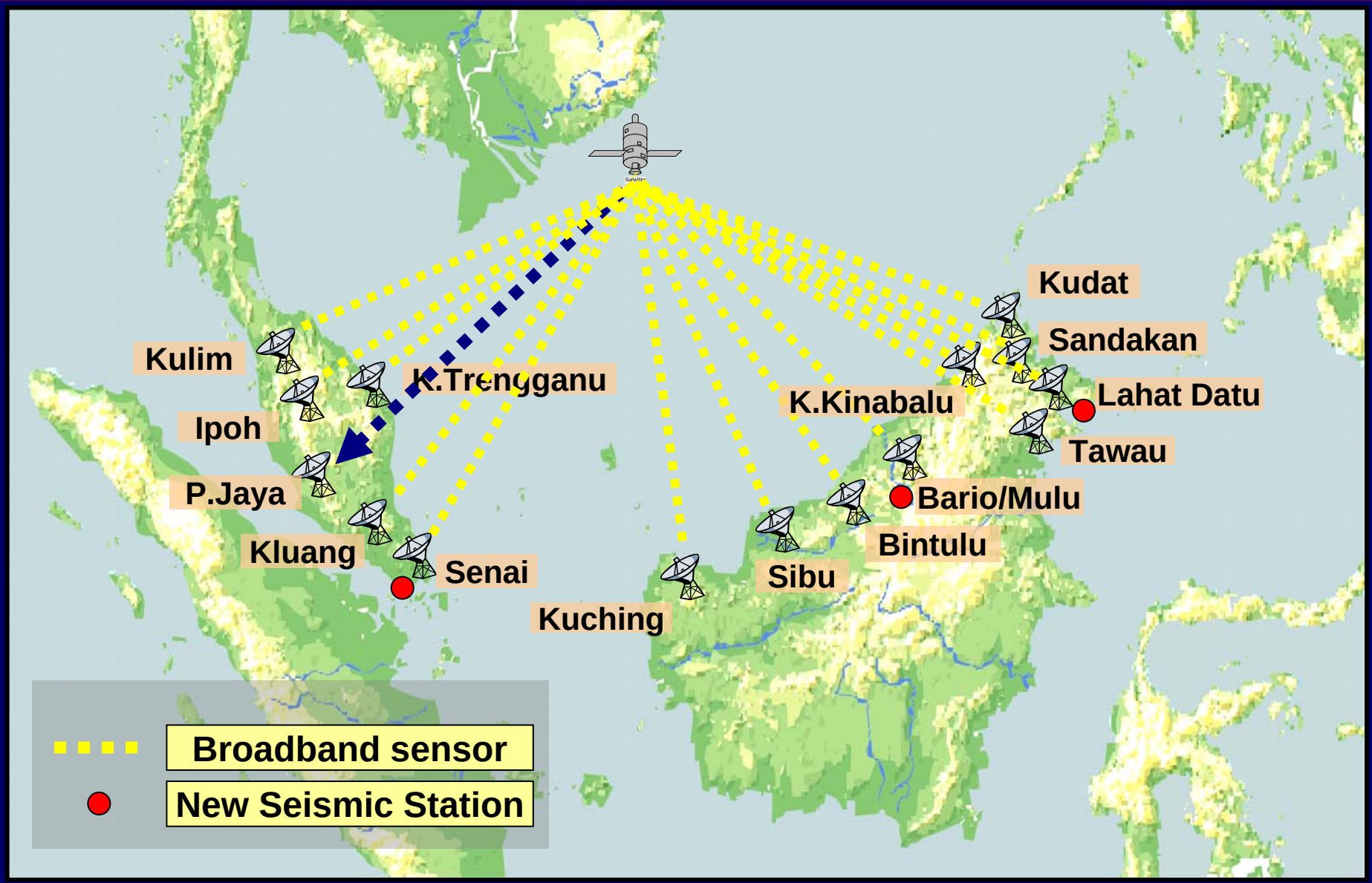
Geoscience Australia

Internet Exchange
Seismic Data

# SEISMIC MONITORING SYSTEM USING VSAT TELECOMMUNICATION



# PROPOSED UPGRADING OF THE NATIONAL SEISMIC NETWORK



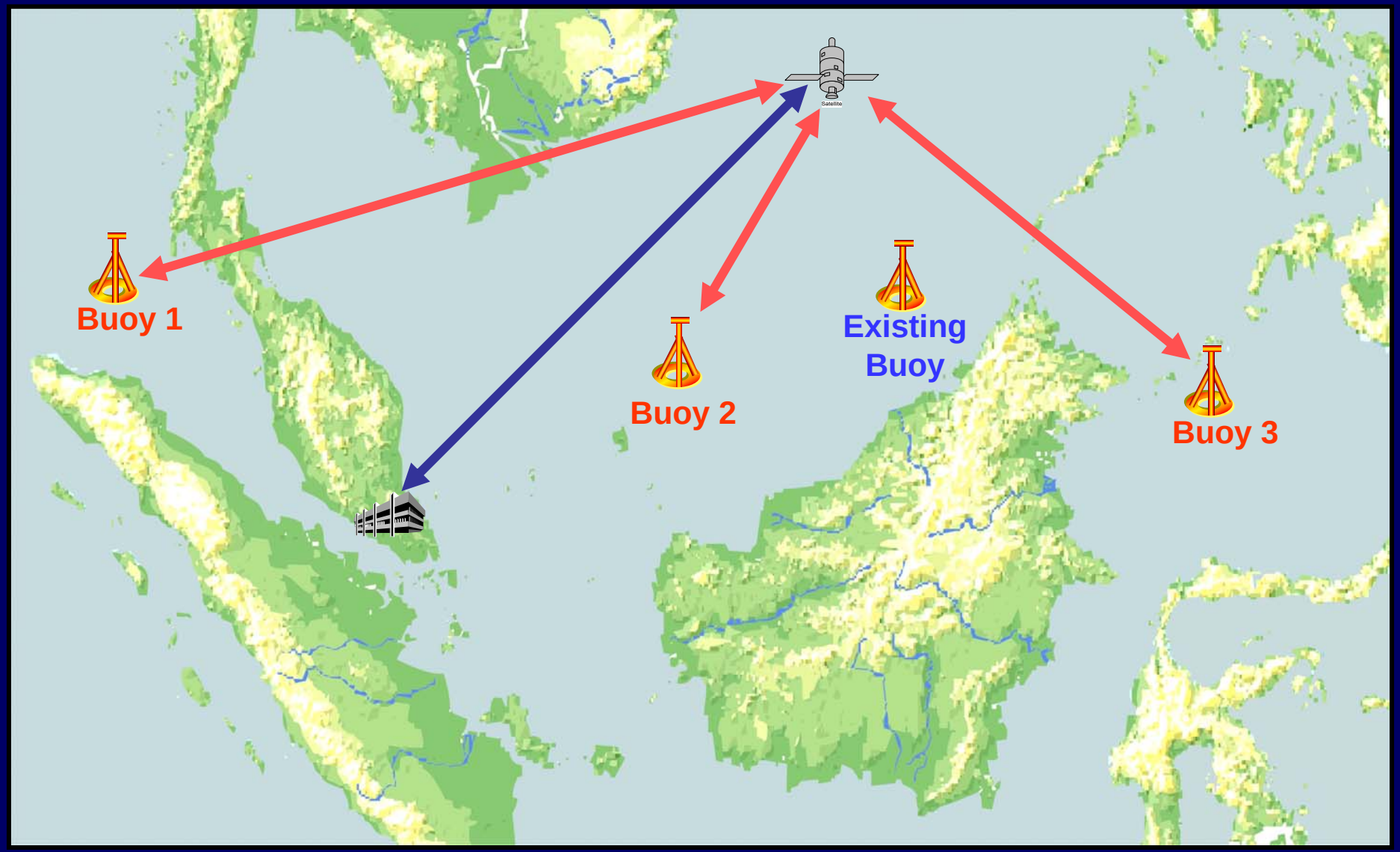
# NETWORK OF EXISTING TIDAL GAUGES

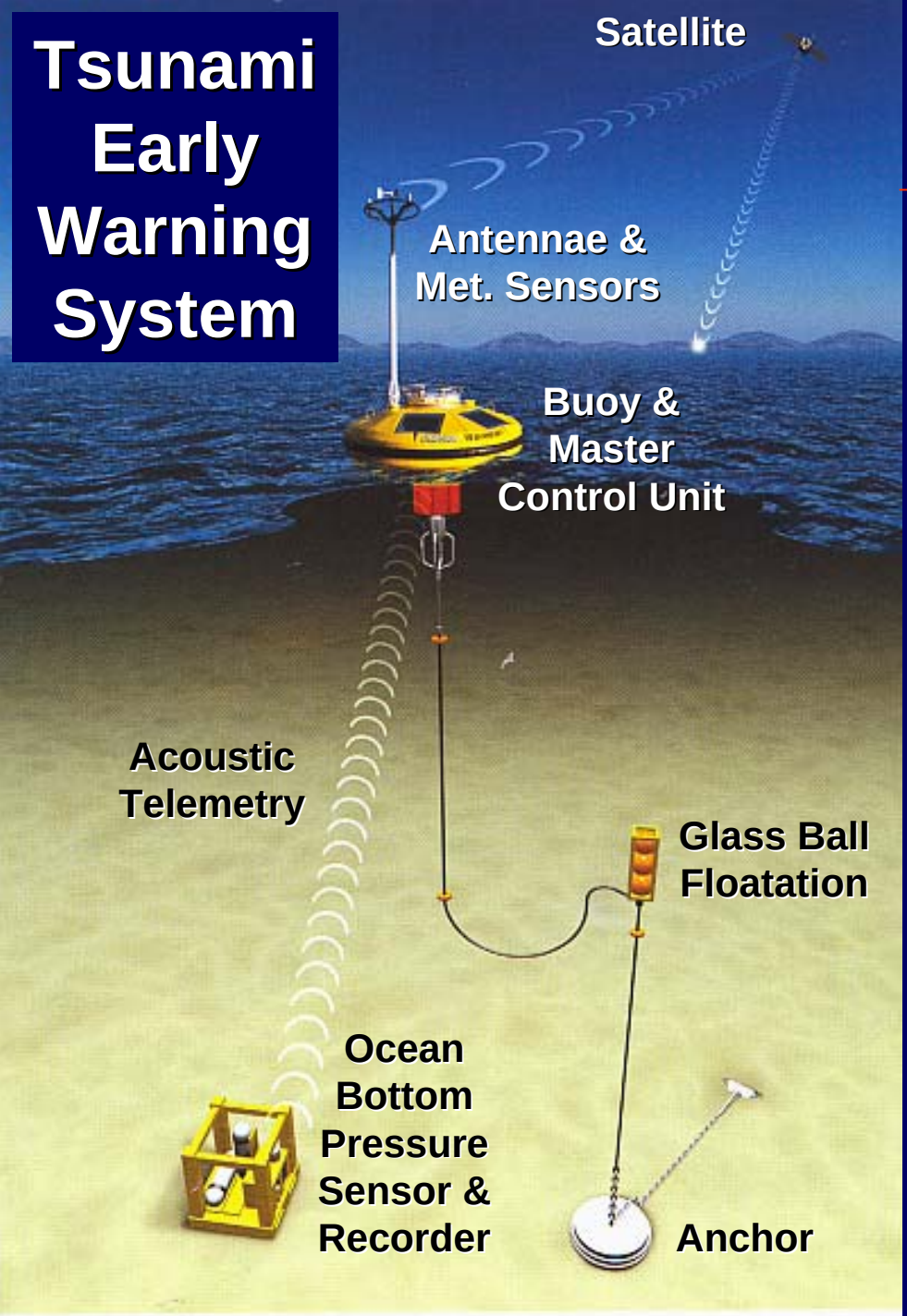

- MMS ( 5 Port Meteorological Stations )
- RMN ( 12 Locations )
- JUPEM ( 22 Locations )

# PROPOSED NEW TIDAL GAUGES


A total of 6 new water level and tide monitoring stations will be installed on 6 selected outpost islands by the end of 2005.

# PROPOSED NEW DEEP OCEAN BUOYS






# TSUNAMI DETECTION

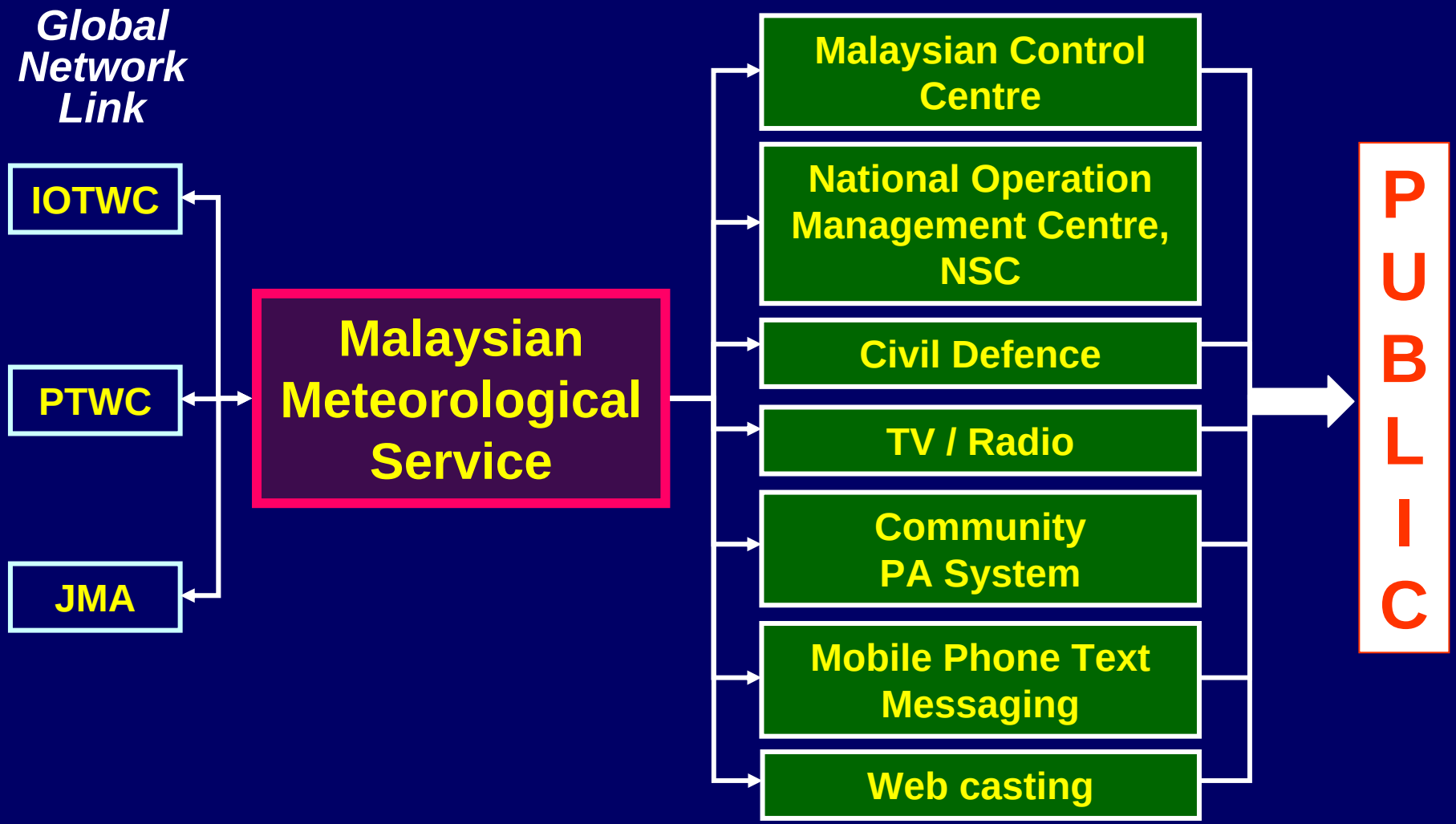
Equipments on the buoy will detect any undersea earthquake and relay this information via satellite communication to the server in the National Tsunami Early Warning Center in MMS, Petaling Jaya.

**Other Surveillance Sensors**: seismometers, hydro-acoustic sensors, sea-height buoys, tide gauges, satellite altimetry & images


SAATNM

# Buoy Deployment off Pulau Layang-Layang


# DISSEMINATION OF TSUNAMI WARNING TO THE PUBLIC



# EMERGENCY COMMUNICATIONS

Sirens

Emergency Alert System

Radio & TV

Telephone/Hotlines

Data Systems

Satellite

Mobile Phone Text Messaging


# TSUNAMI MITIGATION & DISASTER RESPONSE PROGRAMME

# Tsunami Preparedness Checklist

- ✓ Need to put in place the necessary hardware components for a reliable tsunami early warning system.
- ✓ Need to develop an intelligent tsunami disaster management system.
- ✓ Need to enhance public awareness and education on tsunami with emphasis on public safety and survival during a tsunami disaster.

# Tsunami Preparedness Checklist

- ✓ Need to select and fine-tune a numerical shallow-water tsunami propagation model based on a well-tested model used by IOC and USGS for application in the Straits of Malacca, Sulu-Sulawesi Sea and the South China Sea.

# Tsunami Research Needs

- Need to understand the propagation and amplification of a tsunami in shallow and confined waters.
- Need to forecast and provide information on arrival time, estimated wave height, wave force and inundation distances at vulnerable locations along the coast.
- Need to perform risk assessment to identify vulnerable coastal areas and produce a tsunami-prone vulnerability index map.

# What do we have to do?

1. Data collection and field verification of the seabed bathymetry and coastal topography plus examination of the global seismic data sets to identify the likely sites in the Straits of Malacca, Sulu-Sulawesi Seas and the South China Sea where tsunamis can occur.
2. The adaptation of an existing numerical non-linear shallow water ocean model for application to the Straits of Malacca, Sulu-Sulawesi Seas and South China Sea.

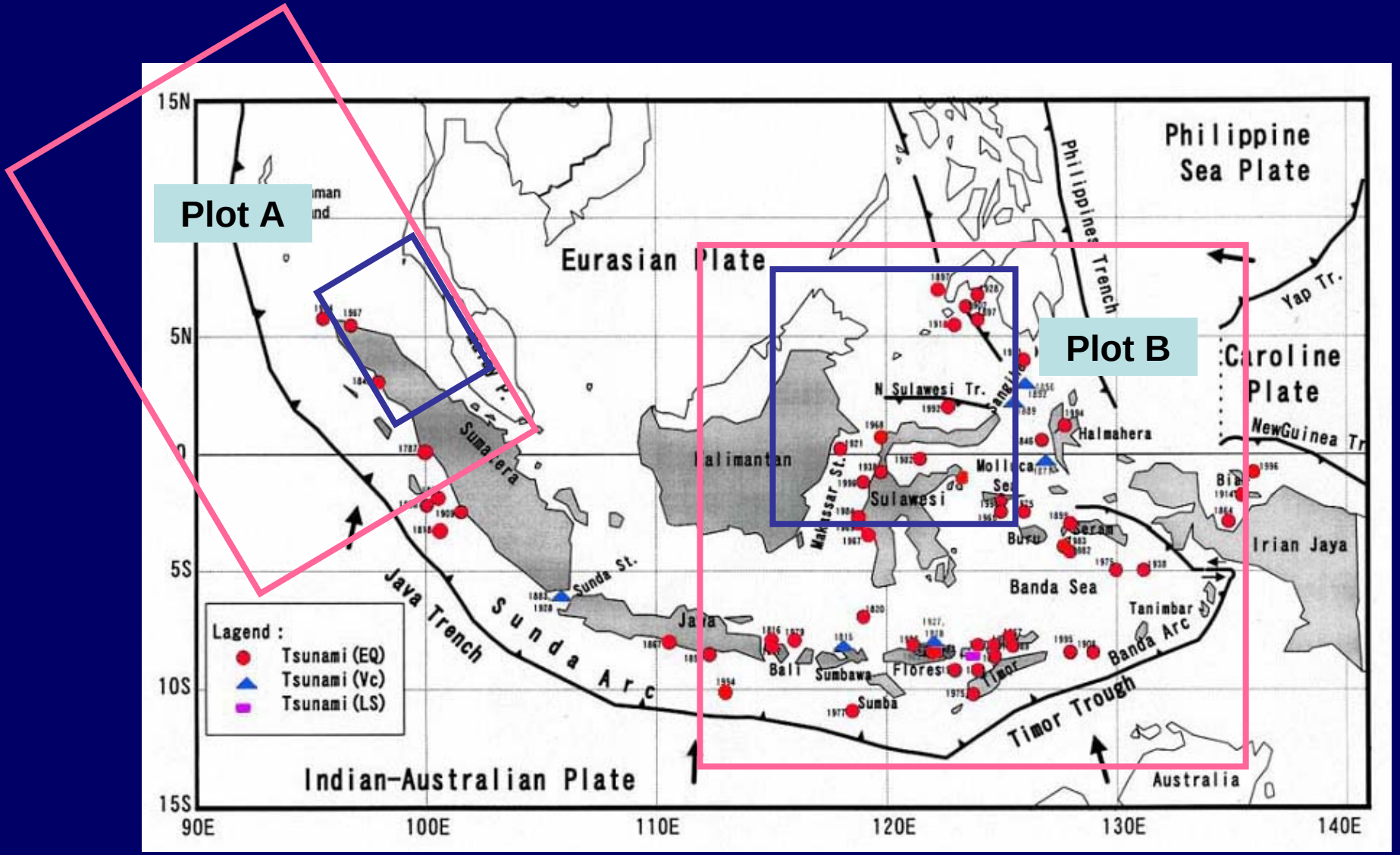
# What do we have to do?

3. Conduct numerical simulation experiments on tsunami generation and propagation in the Straits of Malacca, Sulu-Sulawesi Seas and South China Sea.
4. Examination of simulated tsunami characteristics (wave height and run-up) along the coasts of Indonesia and Malaysia and to assess the possible impacts on coastal structures and inland waterways.

# What do we have to do?

5. Conduct of risk assessments for areas along the coastline in order to develop a Tsunami Zoning Map for use in a Hazard Management Decision Support System.
6. Implementation of a public awareness programme on tsunamis by dissemination of information through the mass media, seminars, conferences, short courses, etc.

# Proposed Grid Plots for Computer Modelling (Coarse, Medium and Fine Grid Models)



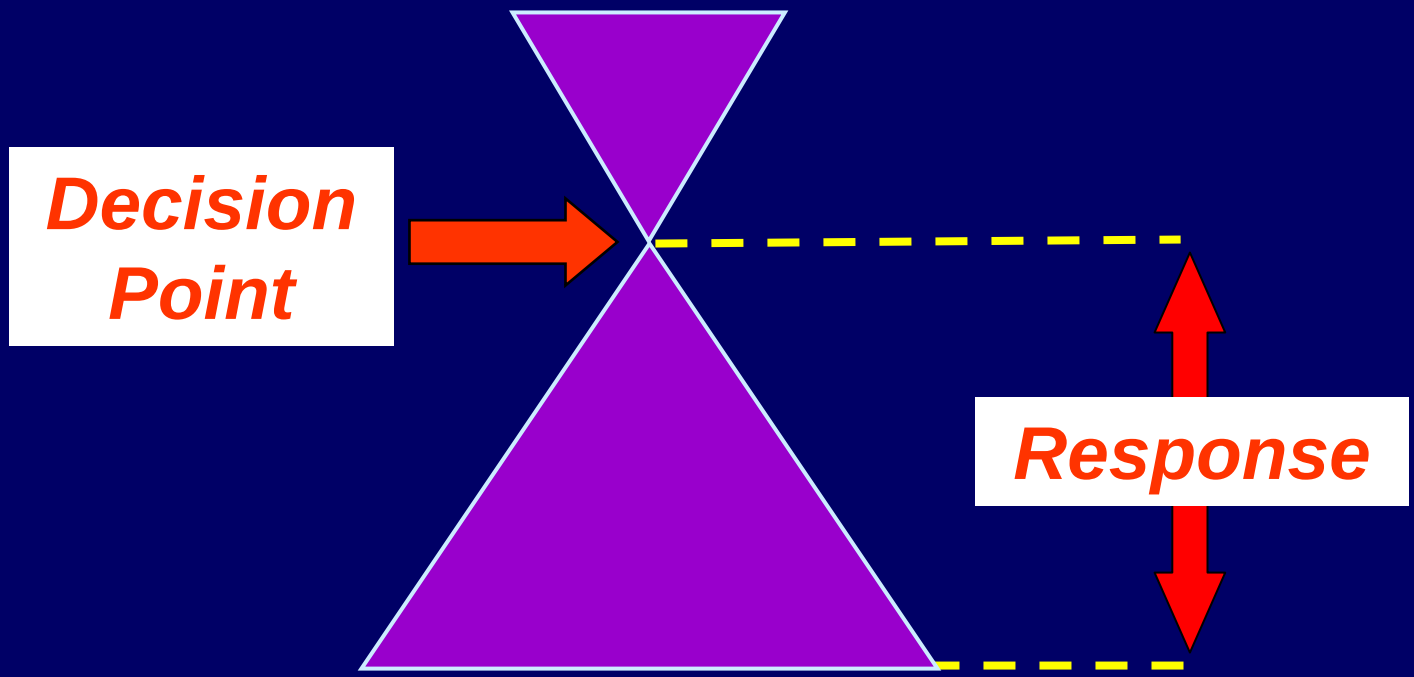
# Tsunami Programme Needs

- Improve event detection, characterization, evaluation (seismic, water level)
- Improve real-time data density (seismic, water)
- Improve telecommunications bandwidth and speed
- Improve historical database
- Improve numerical modeling and forecasting

# Towards Tsunami Preparedness

WARNING SYSTEM

Science, Technology, Prediction




COMMUNITIES

Save Lives, Properties & Reduce Damage

# EFFECTIVE TSUNAMI WARNING AND MITIGATION SYSTEM

**An EFFECTIVE system means:**

**All persons in vulnerable coastal communities are prepared, thus able to respond appropriately, and in a timely manner upon recognition that a potentially destructive tsunami may be approaching.**

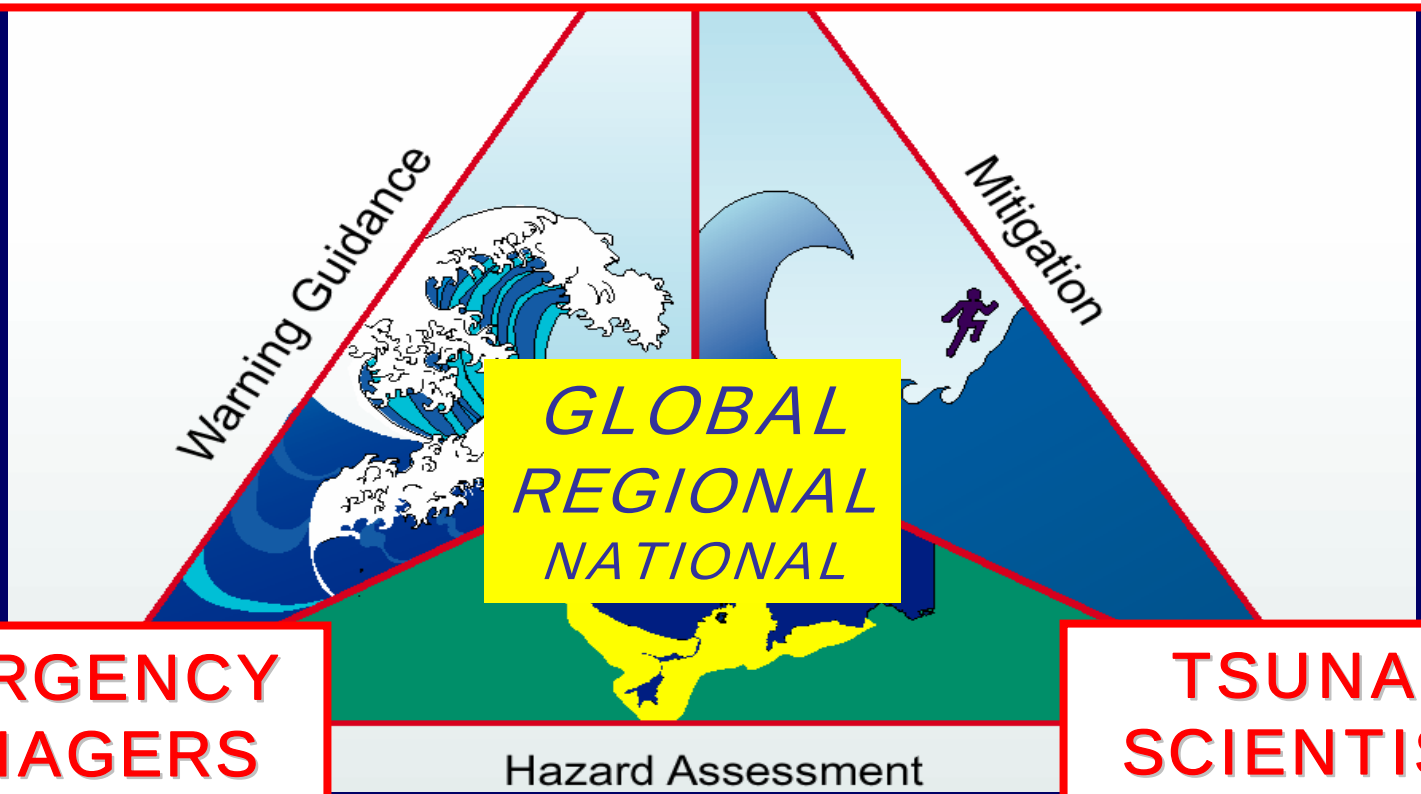
# TSUNAMI HAZARD MITIGATION

IOC

ITIC

## WARNING CENTER OPERATORS

***Pacific, Indian Ocean, National Tsunami Warning Centers***




## EMERGENCY MANAGERS

***Civil Defense***
***Local Authorities***

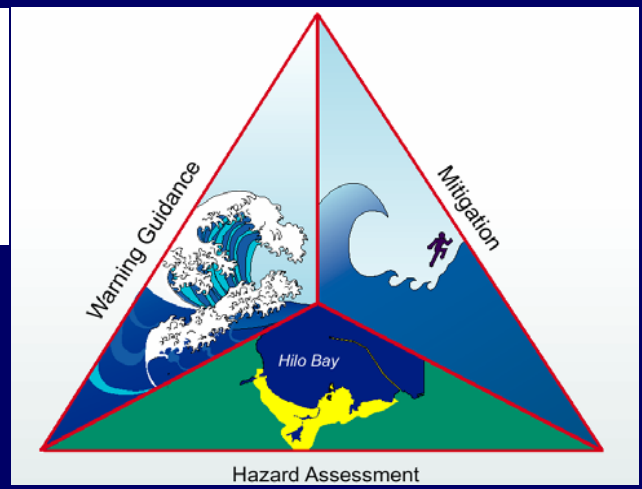
## TSUNAMI SCIENTISTS

***University and Gov't Researchers***

# TWS SYSTEM OBJECTIVES

*END-TO-END SYSTEM MUST EXIST!*

## Develop National and Regional Capacity to:




1. **Assess** national tsunami risk **(Hazard Assessment)**
2. Establish national / regional **warning centers** against local and regional tsunamis **(Warning Guidance)**
3. Promote **education/preparedness** and **risk reduction** against tsunami hazard **(Mitigation and Public Awareness)**

# Other Needs of Tsunami Warning System

- Actual transmission of the warning information to the threatened population must be interfaced with automated , satellite-based information gathering network, and the human decision making process.
- Warnings are virtually worthless without a local civil-defence infrastructure to receive and act on them.
- The need for a public awareness programme on tsunami to ensure that the threatened population knows how to respond for the sake of their own safety.

# CRITICAL SYSTEM ENTITIES

TWO ENTITIES MUST BE IN PLACE

1. NATIONAL TSUNAMI WARNING CENTER provides warning guidance including basin-wide warnings, sub-regional warnings
2. NATIONAL DISASTER MANAGEMENT CENTER communicates hazard and risk, provides preparedness guidance, works to ensure effective sustainable system
3. Important considerations:
    - Both entities must work closely together
    - Adopt an all-hazards approach
    - Coordination and data sharing essential

# Key Government Agencies

- Malaysian Meteorological Department
  - Responsible for issuing earthquake and tsunami warning information
- National Security Division
  - Responsible for coordinating all relevant agencies for tsunami and flood evacuations
- Department of Irrigation and Drainage
- Malaysian Centre for Remote Sensing
- Department of Survey and Mapping Malaysia
- Hydrographic Directorate, Royal Malaysian Navy
- Department of Minerals and Geoscience
- National Oceanography Directorate

# NATIONAL PLATFORM FOR DISASTER REDUCTION

1. National Disaster Management Committee headed by the Hon. Deputy Prime Minister is responsible for policies, management and aid related to all disasters in the country.
2. State Disaster and Relief Committee (SDARC) headed by the State Secretary.
3. District Disaster and Relief Committee (DDARC) headed by the District Officer.

*(Membership includes Police, Army, State Public Defence Department, PWD, MMS, DID, and other relevant government agencies.)*

# Hazard Reduction Strategy
## Assessment

| COMPONENT | TECHNOLOGY | PRODUCT |
|---|---|---|
| 1. Assessment | • Historical studies<br>• Field surveys<br>• Numerical simulations | • Historical data base<br>• Inundation maps<br>• Evacuation maps |

# Hazard Reduction Strategy
## Warning Guidance

| COMPONENT | TECHNOLOGY | PRODUCT |
|---|---|---|
| 2. Warning guidance | • Measurement<br>• Telecommuni-cations<br>• Numerical simulations | • Early detection<br>• Real-time seismic and sea-level data<br>• Wave forecast<br>• Warning dissemination “to the last kilometer” |

# Hazard Reduction Strategy
## Mitigation & Preparedness

| COMPONENT | TECHNOLOGY | PRODUCT |
|---|---|---|
| 3. Mitigation | • Education<br>• Communication | • Brochures, Textbooks<br>• Community Meetings<br>• Public Service Messages<br>• Museums, Memorials<br>• Awareness Events |
| | • Planning and Preparedness | • Emergency Response Plans<br>• "Table-top" Exercise, Drill<br>• Tsunami-ready community<br>• Land-Use Policy |
| | • Engineering (Structural and Non-Structural) | • Building Codes<br>• Vertical Evacuation<br>• Safe Shelters<br>• Sea Walls, Vegetation |

IOC

# LESSONS LEARNED

## Early Warning System Saves Lives

ITIC

1. Proper Instruments detect early
2. Warning informs
3. Awareness enables
4. Preparedness guides
5. Planning means faster response
6. Strong buildings and safe structures assist
7. Stakeholder coordination essential
8. High-level advocacy sustains

*VERY RELIABLE COMMUNICATION ESSENTIAL*

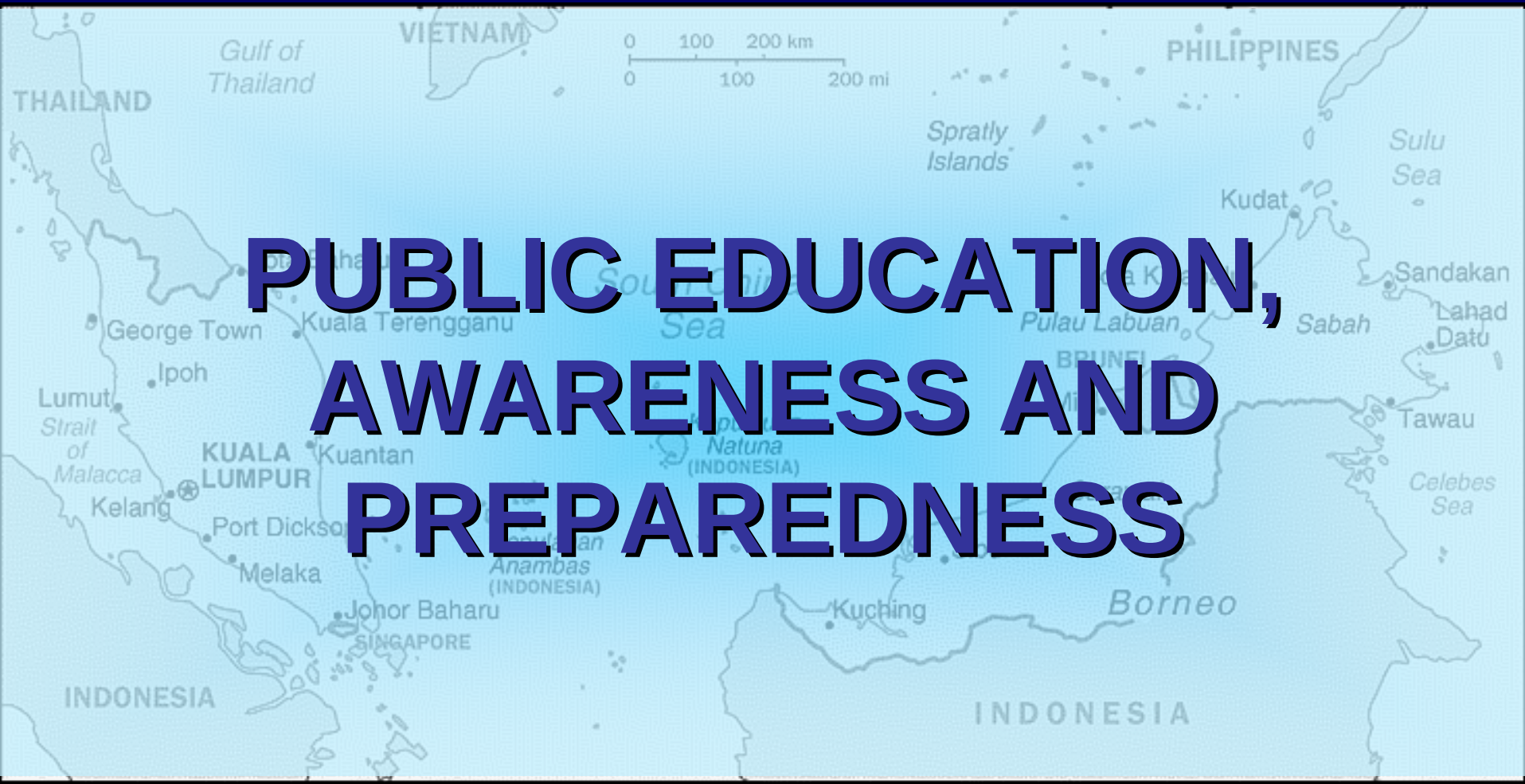
IOC

# EWS System Must Be Sustainable, Enduring, Effective

ITIC

Success depends on:

- Political commitment
- Scientific determination
- Data sharing
- Capacity building
- National coordination
- Local empowerment



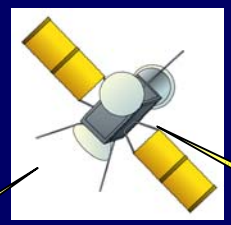

# PUBLIC EDUCATION, AWARENESS AND PREPAREDNESS

# TSUNAMI Early Warning Overview

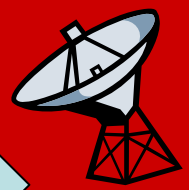
Earthquake
Tsunami

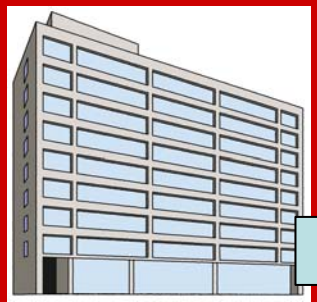
JAPAN

Tsunami Warning Center

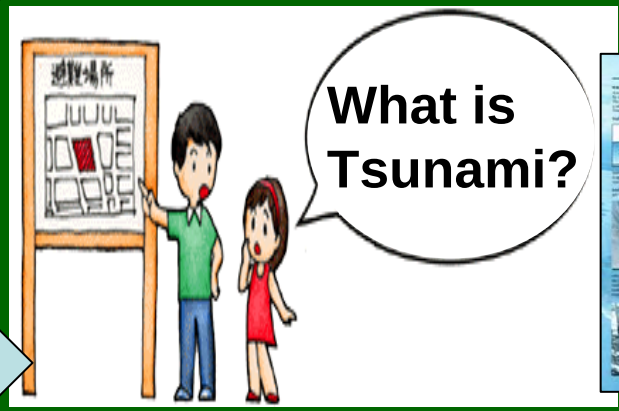


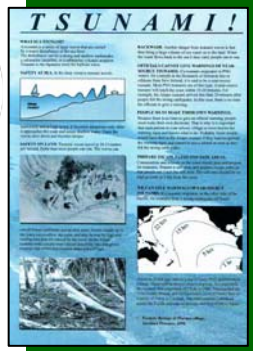
National Government → Local Government



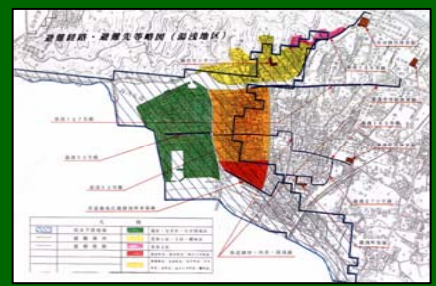


Mass Media




Where is Evacuation Route?



International - Regional Framework

National Warning System

Public Awareness

*Cabinet Office Japan*

# STAKEHOLDER COORDINATION IS ESSENTIAL


*ITIC, Cabinet Office Japan*

# Sensing a Tsunami

| TOUCH | SIGHT | SOUND |
|---|---|---|
| Strong local earthquakes may cause tsunamis. | As a tsunami approaches shorelines, water may recede from the coast, exposing the ocean floor and reefs. | Abnormal ocean activity, a wall of water and approaching tsunami waves create a loud 'roaring' sound similar to that of a train or jet aircraft. |
| FEEL the ground shaking severely? Immediately evacuate low-lying coastal areas and move inland to higher ground! | SEE an unusual disappearance of water? Immediately evacuate low-lying coastal areas and move inland to higher ground! | HEAR the roar? Immediately evacuate low-lying coastal areas and move inland to higher ground! Do not wait for official evacuation orders |

# Keys to System Effectiveness


***Warning System Design:***

- ✓ ***Feedback Loop –***
  ***is it working – if not, why?***
- ✓ ***S… …blic interaction***

***…tem must be:***

***…try***

***…sed:***

***…mpact***

***…s-women, poverty***

- ✓ ***Ea… com…unity unique***
- ✓ ***They are the first responders***
- ✓ ***Community-based Training***

# *The Tsunami Teacher Kit*

The overall aim of *Tsunami Teacher* is to help the capacity of people and governments to respond effectively to tsunamis and mitigate their impacts.

The *Tsunami Teacher* is designed to be both a resource and training kit.

The primary audiences for the *Tsunami Teacher Kit* are:

- The Media
- Schools
- The Public & Private Sectors (governments, businesses and community groups)

# Team of Experts from UNESCO

- Mr. Bernardo Aliaga (IOC, Team Leader)
- Dr. Laura Kong (ITIC)
- Dr. Walter Mooney (USGS)
- Mrs. Haleh Kootval (WMO)
- Mrs. Christel Rose (ISDR)
- Mr. Akihiro Teranishi (ADRC)

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**IOC** Intergovernmental Oceanographic Commission, UNESCO

**ITIC** International Tsunami Information Centre

**USGS** United States Geological Survey

**WMO** World Meteorological Organization

**ISDR** International Strategy for Disaster Reduction

**ADRC** Asian Disaster Reduction Centre

*… the calm after a storm*

*Thank You*