Indian Tsunami Early Warning System

T. Srinivasa Kumar (srinivas@incois.gov.in)

Indian National Centre for Ocean Information Services, Hyderabad

CSI Annual Convention

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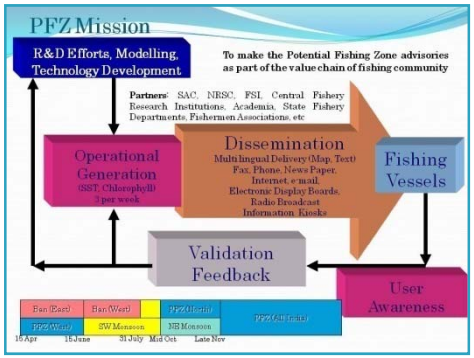
Indian National Centre for Ocean Information Services
Ministry of Earth Sciences

INCOIS

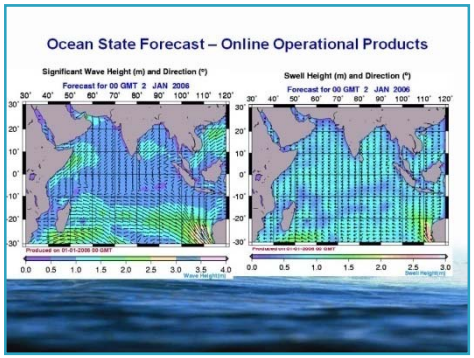
Mission

Provide Ocean Information and Advisory Services to Society, Industry, Government Agencies and Scientific Community through Sustained Ocean Observations and Constant improvements through Systematic and Focussed Research

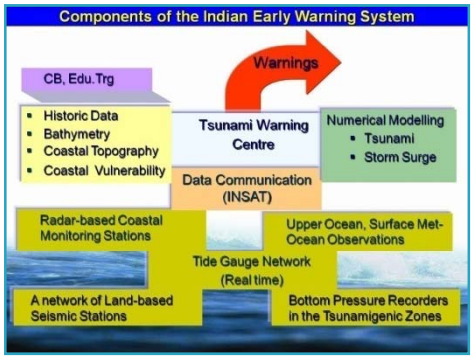
Operational Services to User community



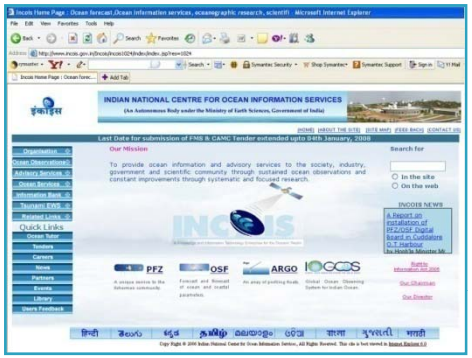
Marine Fishery Forecast



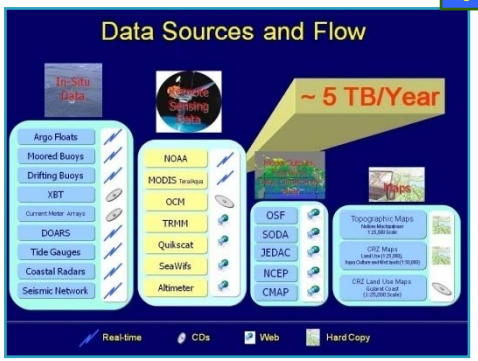
Ocean State Forecast



Tsunami Early Warning Information



Web-based Dissemination

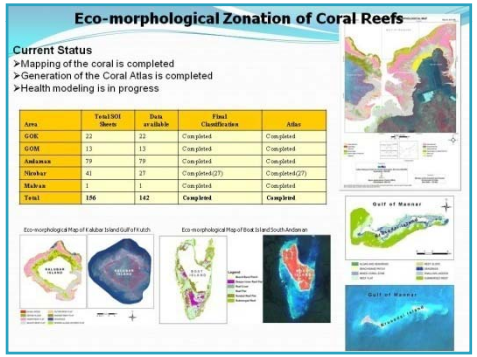


Ocean Information Bank

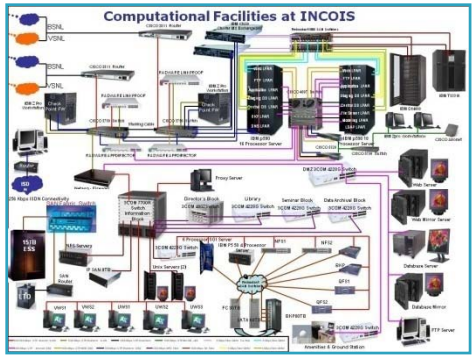
To Users

- Fishing Community
- Coastal States
- IMD, Navy, NHO,
- Coast Guards
- Ports and Harbours
- Off-shore and Shipping
- Research Institutions
- Academia

Value-Added Services



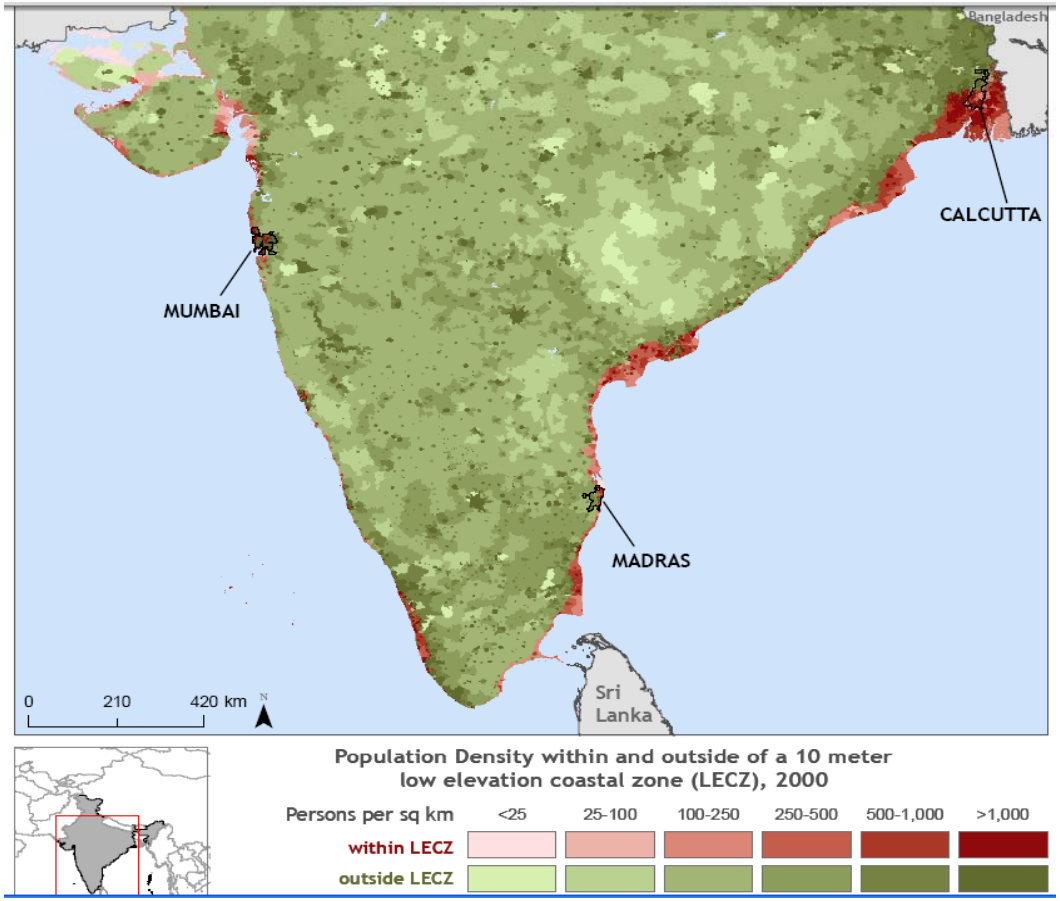
IT Infrastructure of INCOIS



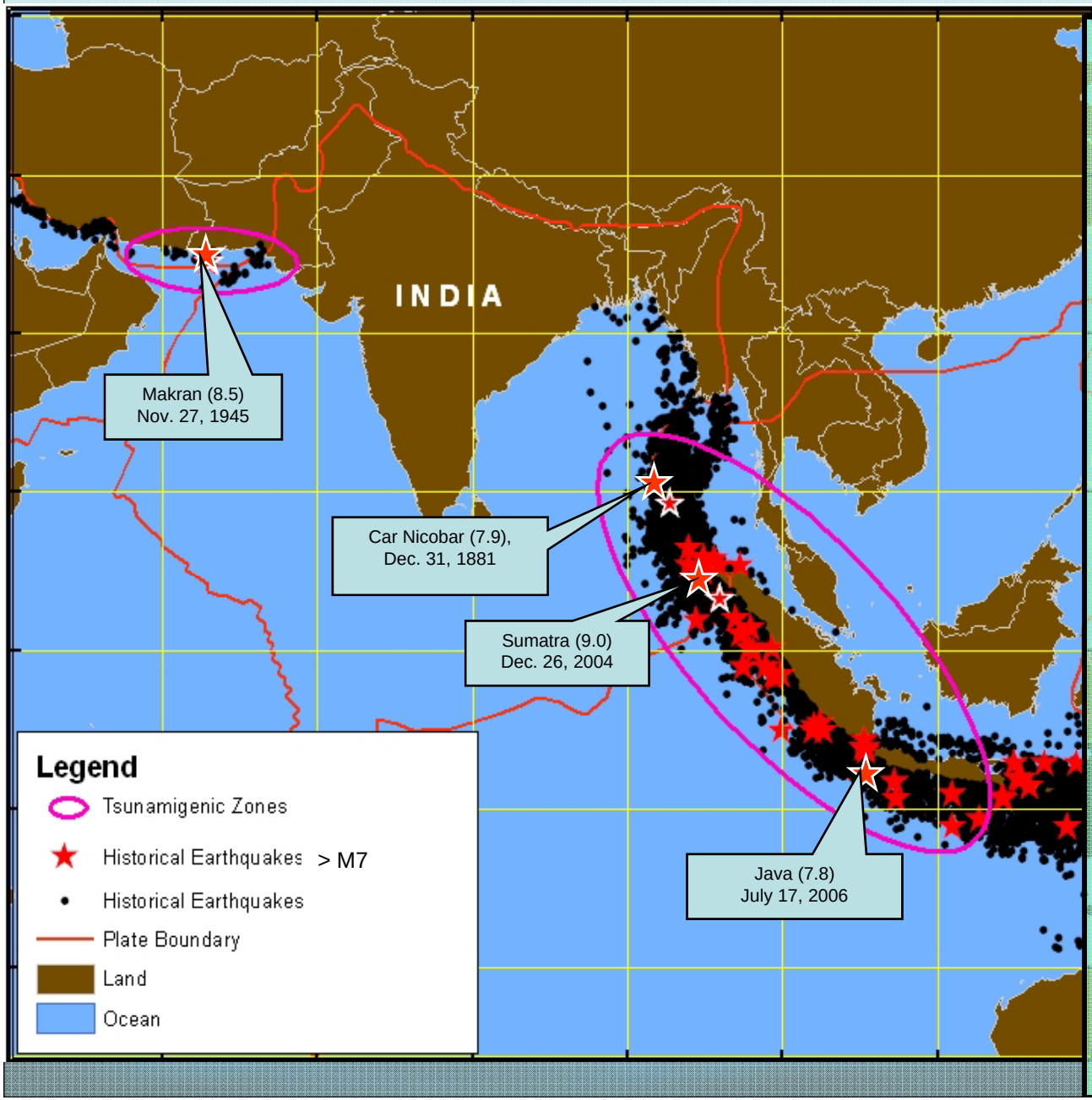
Vulnerability of the Indian Ocean Coastline

- More than 50 Nations around
- Many are Developing Countries
- More than1.5 Billion Population
- More than 66,500 km coastline

- 26 % of Indian Population live within 100 Km from the shoreline
- Most of the coastal areas are low lying and vulnerable to oceanogenic disasters such as Tsunamis, Storm Surges, Sea-level rise
- Dec 26, 2004 Tsunami resulted in a loss of 18, 045 deaths and 6,47,599 persons displaced



Risk Assessment - Historical Earthquakes & Tsunamis



Tsunamis are primarily caused due to large undersea Earthquakes.

For a tsunami to hit Indian coast, it is necessary that a tsunamigenic earthquake occurs and its magnitude should be larger than M 7. Possible locations of such events are enclosed in ellipse

Earthquakes with Slow Rupture Velocities are most efficient Tsunami Generators

75% of earthquake energy is released in the circum-Pacific belt – 900 Tsunamis in 20th Century

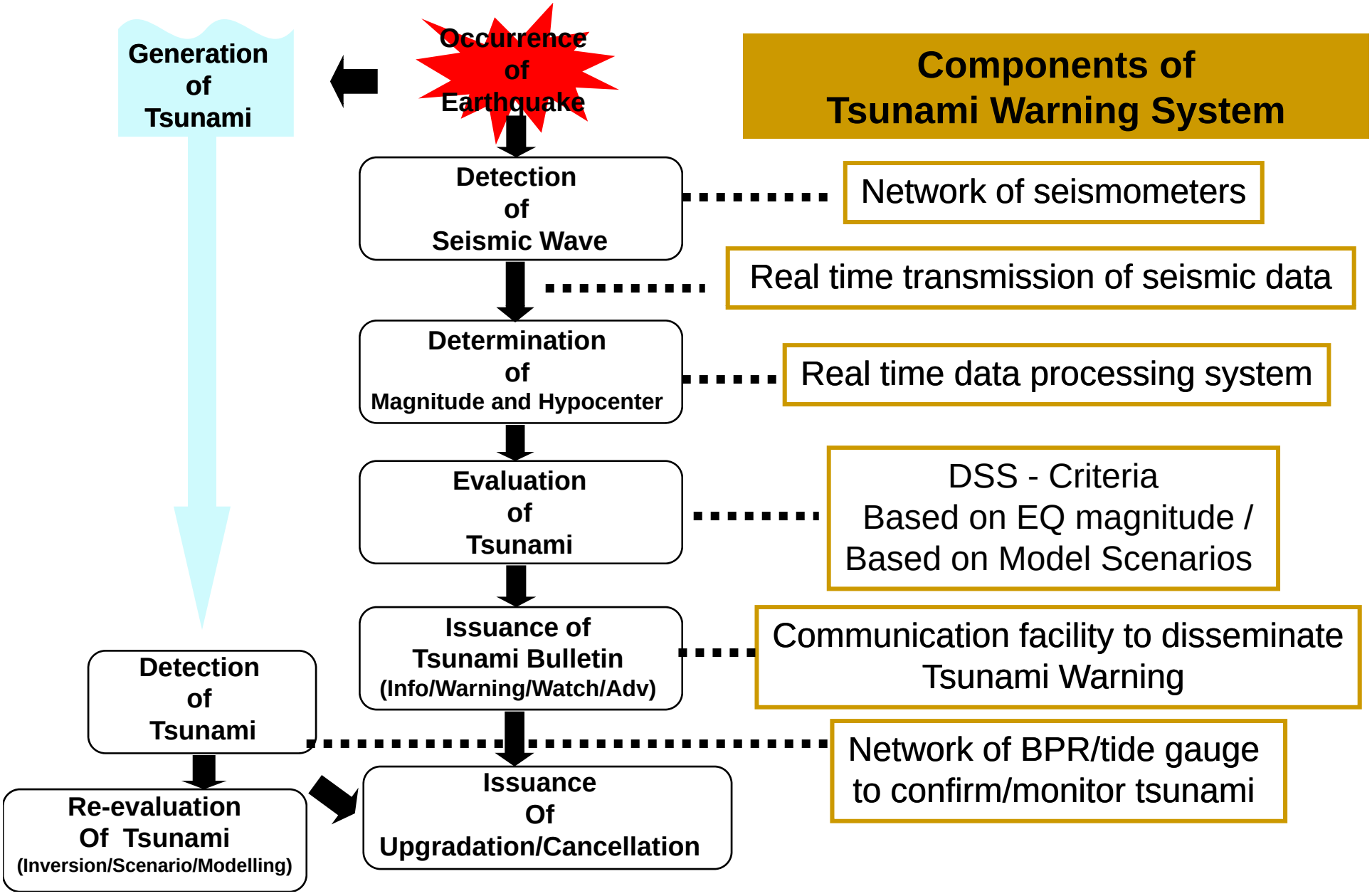
20% in the Alpine-Himalayan belt – 6 Tsunamis in 20th Century

Historical Tsunami in India

12 Apr, 1762 (BoB EQ) – 1.8 M
31 Dec, 1881 (Car Nicobar EQ)
27 Aug, 1883 (Krakatoa) – 2 M
26 Jun, 1941 (Andaman EQ)
27 Nov, 1945 (Makran EQ) – 12 M
26 Dec, 2004 (Sumatra EQ)

Landslides, Volcanoes & Meteor Impacts can also generate Tsunamis

Sequence & Components of Tsunami Warning System



An end-to-end System Design

Warnings

CB, Edu.Trg

Tsunami Warning Centre

INCOIS, TCS

R & D

- Historic Data
- Bathymetry
- Coastal Topography
- Coastal Vulnerability

NRSC, INCOIS, NHO

Numerical Modelling

- Tsunami
- Storm Surge

ICMAM, INCOIS, WAPMERR

Data Communication

ISRO

Coastal Radars

NIOT

Upper Ocean, Surface Met-Ocean Observations

Tide Gauge Network

SOI

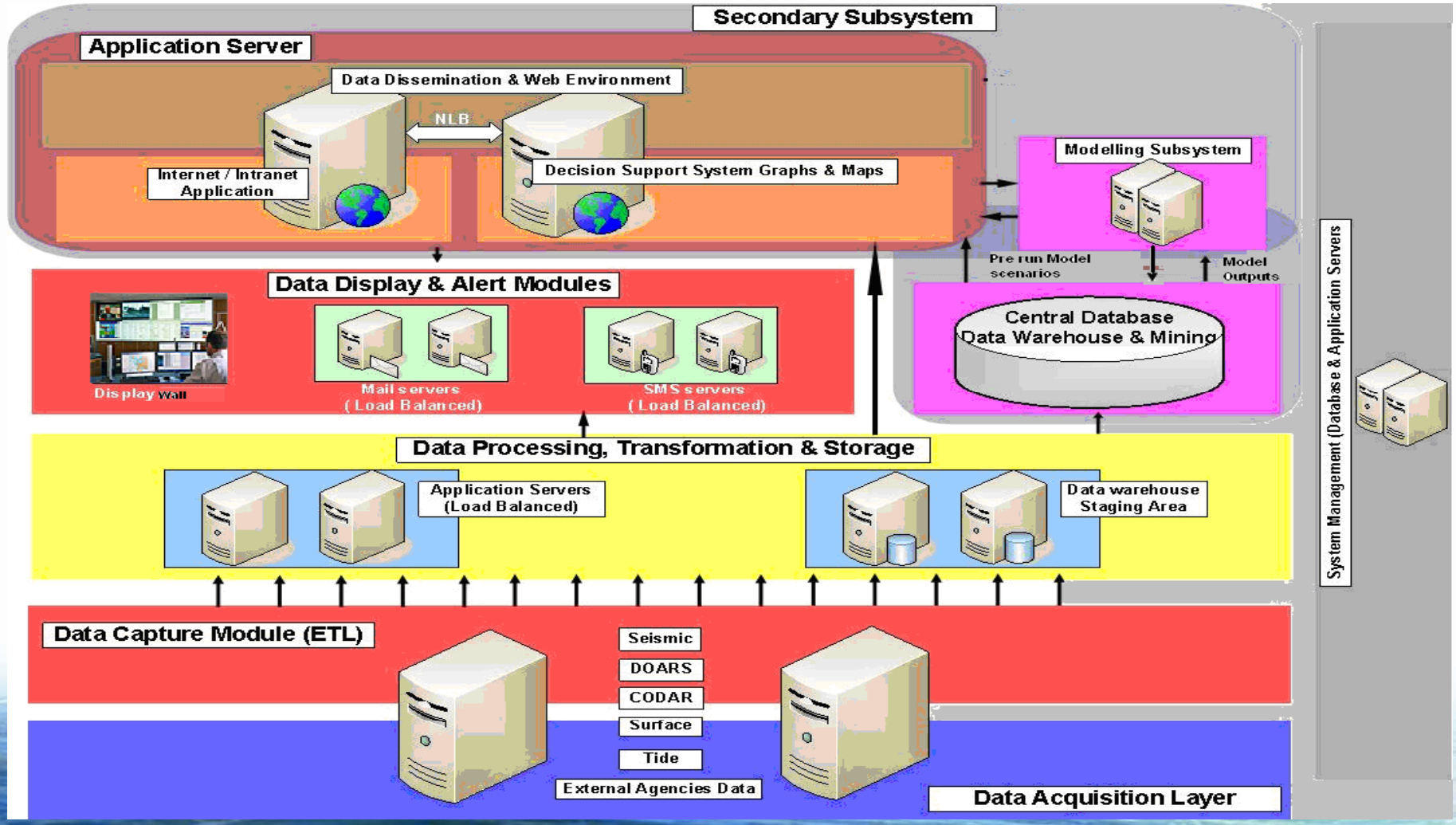
Network of Seismic Stations

IMD

Bottom Pressure Recorders

NIOT

Solution Architecture



Heterogeneous Real-Time Data from a variety of Sensors

•Data Acquisition, Display, Processing, Archival

Numerical Modeling and Decision Support

Generation of Advisories and Dissemination

•Mission Critical - Infrastructure to be highly available

Mission-Critical Data Centre Facilities

24 x 7 operations

Hardware

- Two high-end server consolidations & network components of active-active clustering in load balanced environment in Primary Site
- One high-end server consolidation in DR Site

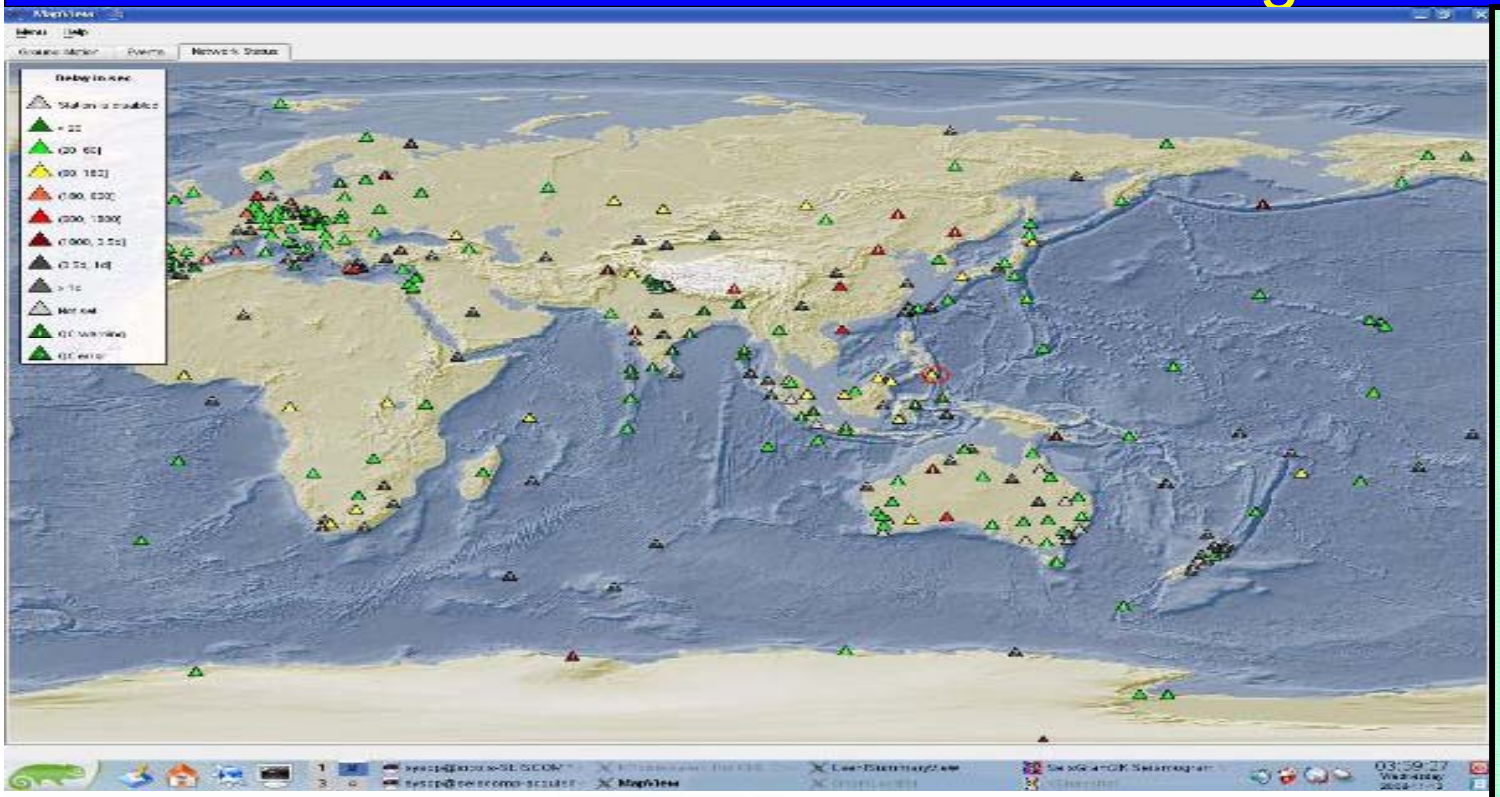
Software

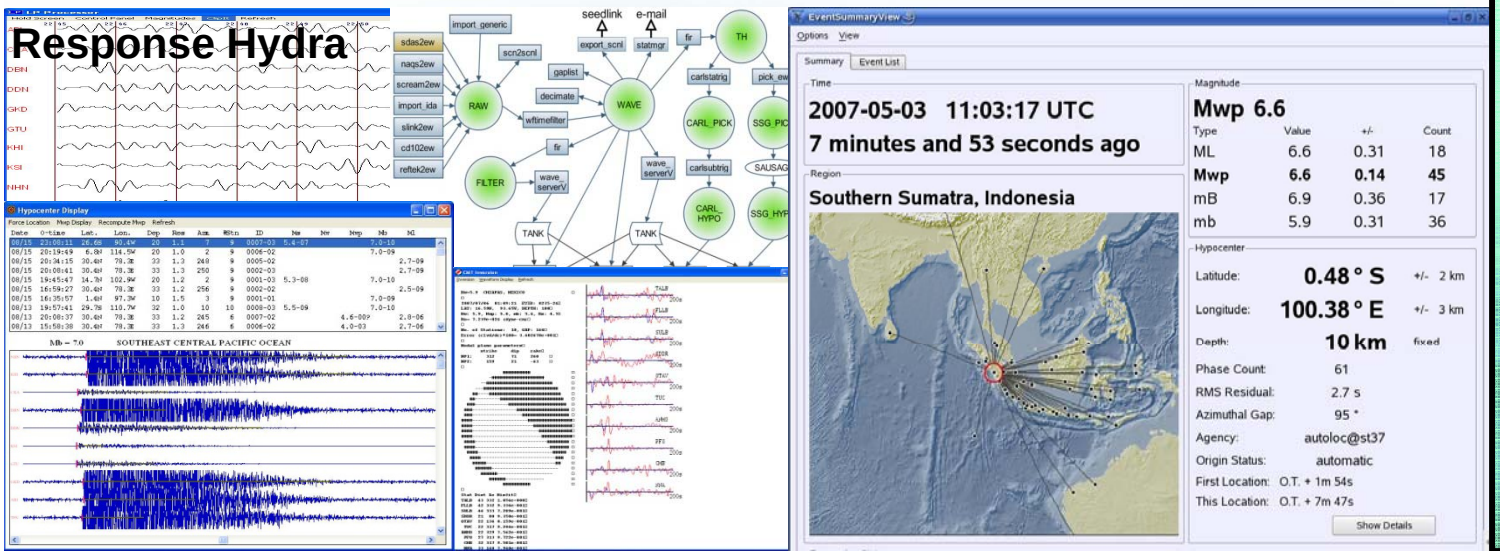
- ETL, Staging & Central Databases
- Web Application Server
- GIS software
- Spatial data of model outputs.
- Application Software for real time data reception, display, analysis and generation of bulletins based on the SOP.

Technical support facilities

- UPS for 2 Hr Back up, 2 DG Sets, TVSS, STS
- Fire detection system, FM 200-based Fire Suppression, VESDA system, Fire rated walls and doors,
- WLDS, Rodent Repellent System,
- CCTV system, Access control systems, Building Management System

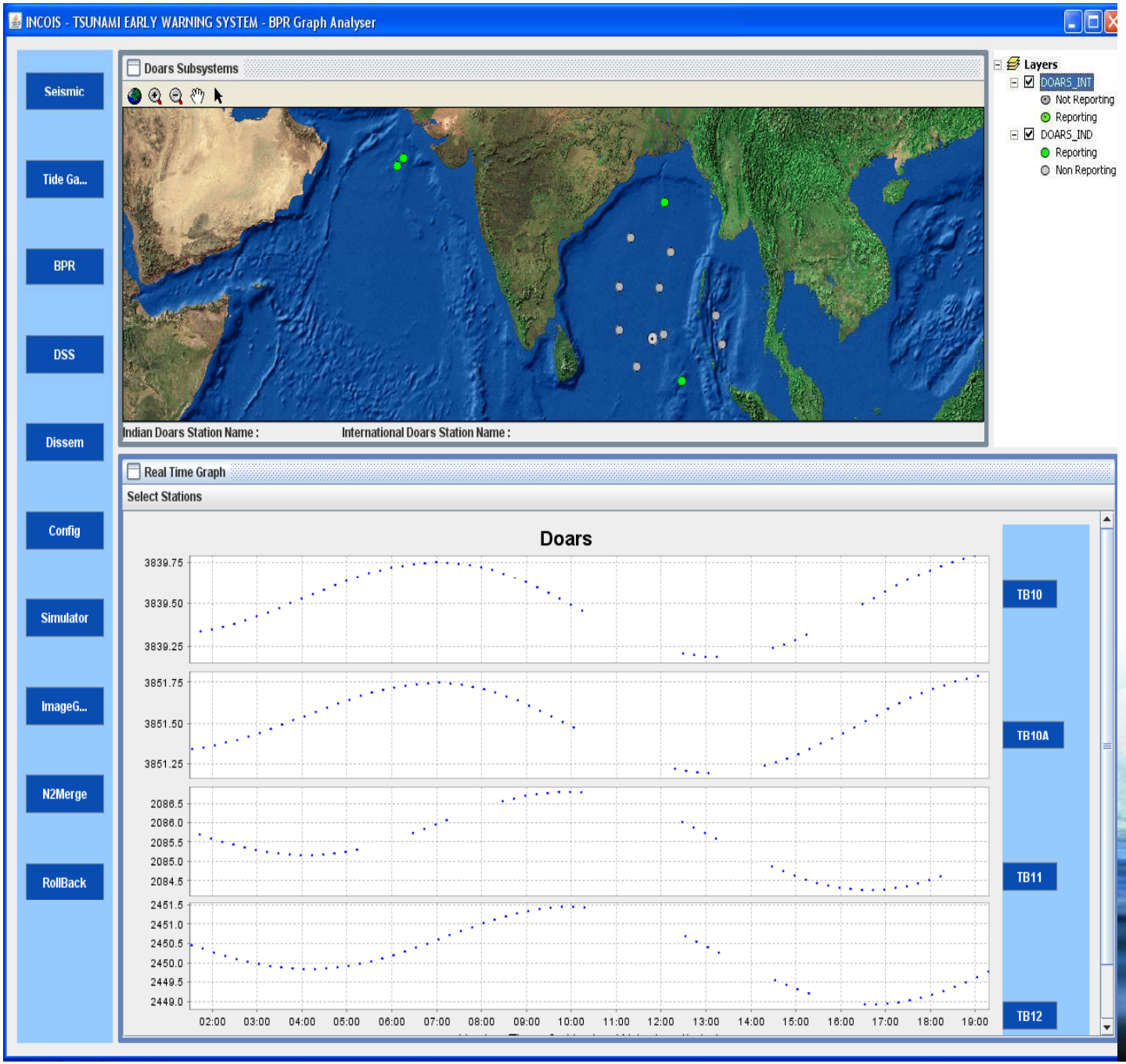
Real Time Seismic Monitoring Network



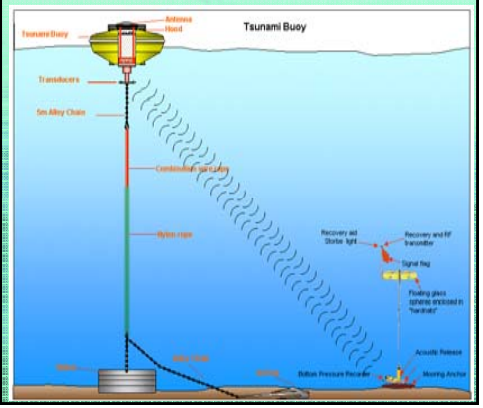


- Network of 27 Indian broadband seismic stations
- Data from International stations
- Data Acquisition, Processing, Auto location and Archival using Response Hydra as well as SESICOMP 3
- TWC reported and monitored 140 earthquakes of M > 6.0 (Jul 08 to July 09)
- 32 under-sea events of M > 6.5
- Earthquakes of > M6 are being auto-located within 5 - 12 Min of Occurrence
- EQ parameters conform well with those put out by USGS / GEOFON
- Upgrades to Seiscomp System - Mwp algorithm implemented

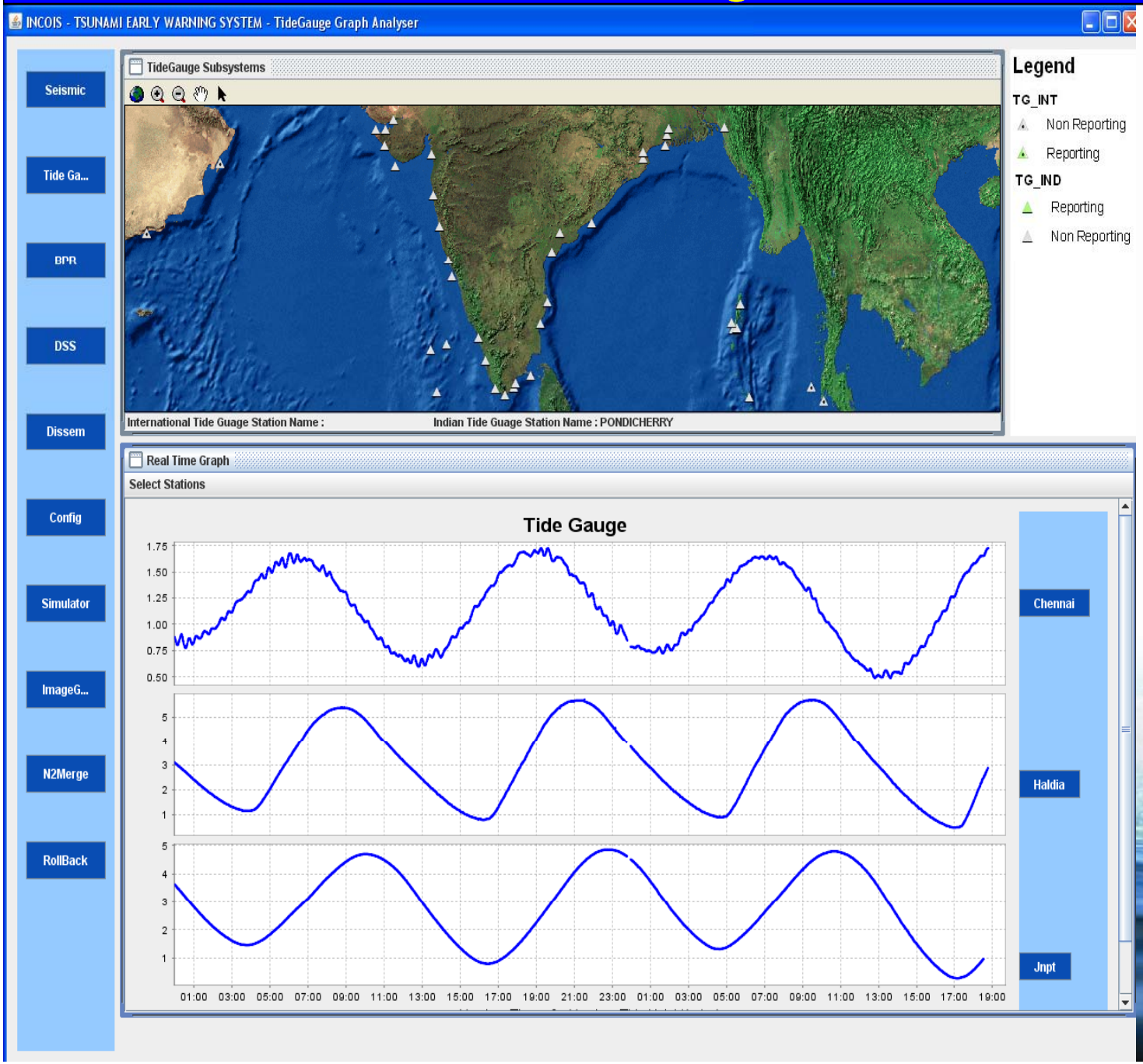
Deep Ocean Assessment and Reporting System for Detection of Tsunamis



- Network of 12 Tsunami Buoys are used to detect any significant water level changes due to tsunami
- Has a Bottom Pressure Recorder and a Surface Buoy System with Acoustic communication
- Capable of Measuring 1 cm water level change in 6000 m water column
- 4 values of 15 minutes average for every one hour in Normal Mode
- 4 values of 15 seconds average for every one minute in Tsunami Mode
- Automatic Tsunami Detection Algorithm in the BPR

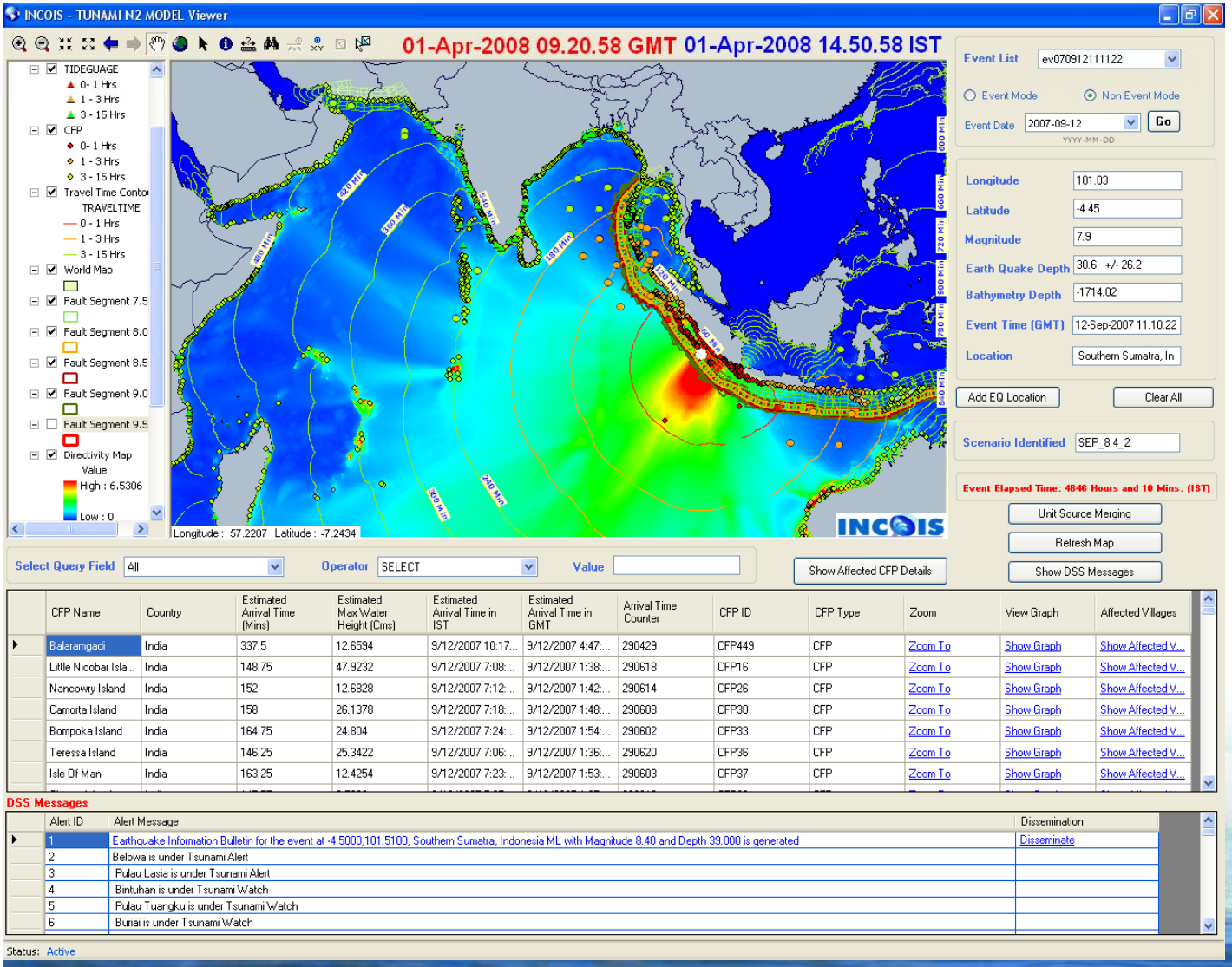


Tide Gauge Network



- Currently Tide Gauges installed and operational at 26 strategic locations along the Indian Coast
- More being planned in 12 locations in the next 1 year

Modelling for Operational Forecasting



Each simulation covers the entire Indian Ocean domain with 15 hours simulation time and a time step of 5 seconds. Out put profiles are generated at 30 m bathymetry for about 1800 coastal fore cast points (CFPs) covering the entire Indian ocean rim countries

The TUNAMI N2 model is customized for Indian Ocean region

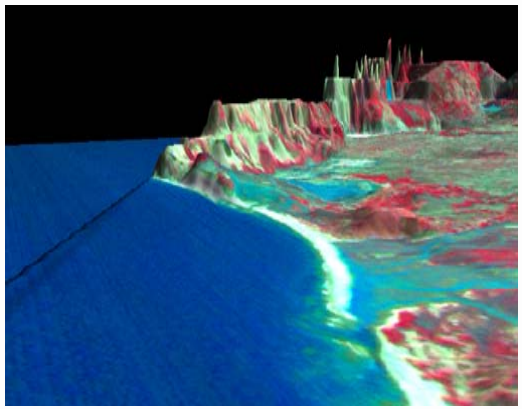
- **This model had been extensively validated using the December 26 2004 Tsunami observations**

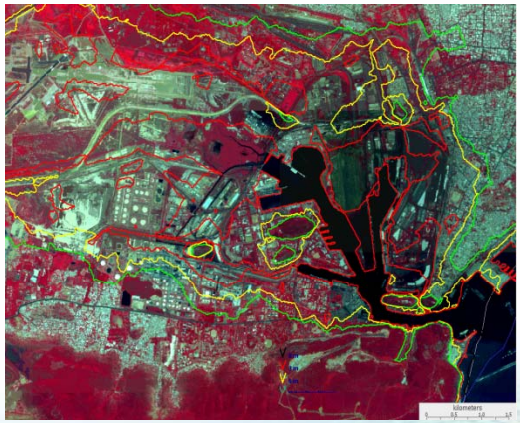
For operational forecast

- **A large database of open ocean propagations scenarios**
- **For epicenters separated by 100 km all along two Tsunamigenic zones**
- **Scenarios for different magnitudes (6.5, 7.0, 7.5, 8.0, 8.5, 9.0 & 9.5) and depths (10, 20, 40, 60, 80 & 100 km)**

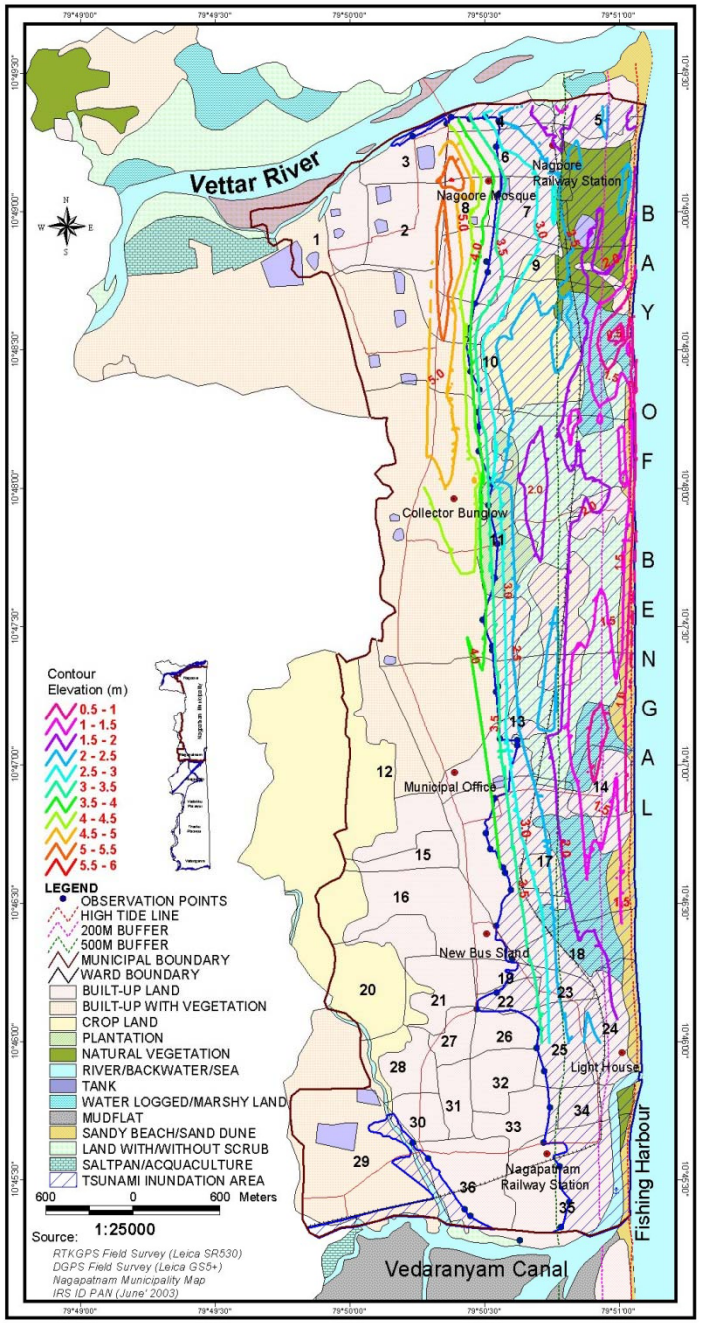
Travel times
Surge heights
Directivity maps

Coastal Topography, Bathymetry & Modelling



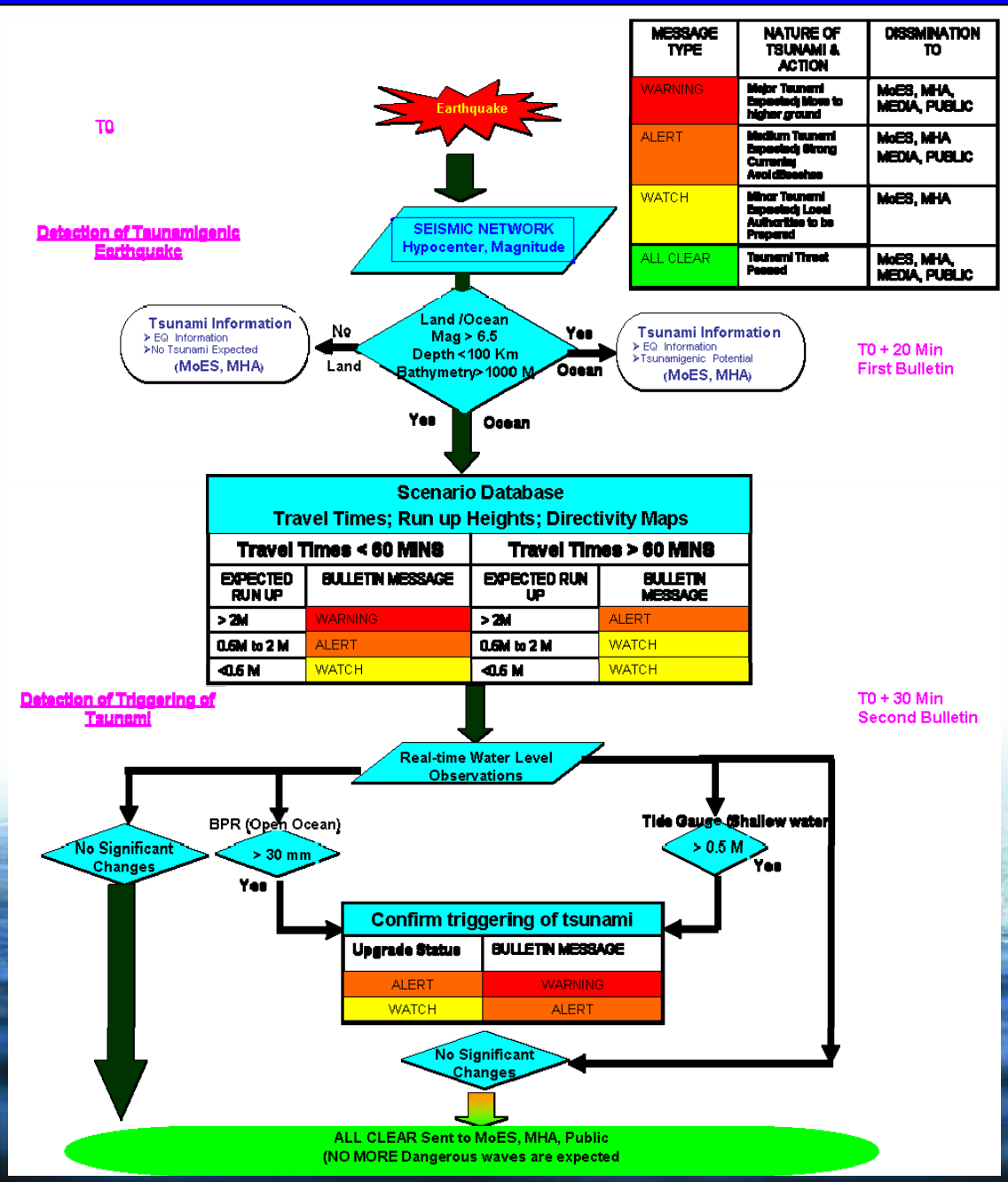


Bathymetric Survey for Cuddalore



- Coastal Inundation scenarios simulated for 5 historical Earthquakes using TUNAMI N2 model and the predicted inundation areas have been overlaid on cadastral level maps of 1:5000 scale.
- Coastal Bathymetry: Maps of Special Order are required (Accuracy 0.5 M)
- Coastal Topography: Contour Intervals of 0.5 M at 1:25, 000 Scale are required
- Topography Data being generated using Cartosat and ALTM Surveys
- Bathymetric Survey conducted for a few vulnerable areas. Detailed survey being planned for other areas.

DSS and SOP



Types of Bulletins

EQ Info: 20 Min: MHA

Warning (Evacuation): 30 Min: MHA, Public

Alert (Vigilant): 30 Min: MHA, Public

Watch: 30 Min: MHA

Tsu. Info – Upgrade/Downgrade/All Clear

- **Warning/Alert/Watch based on EQ Parameters, a regions' proximity to the Earthquake Zones (Travel Times) & Expected Run-up from Pre-run Model Scenarios**
- **Warnings to Far Source Regions only after confirmation of tsunami triggering based on real-time water-level observations & Correction of Scenarios**
- **This will reduce possibility of False Warnings**
- **Decision support system**

Dissemination Tools – Email, SMS, Web

From: tsunami **To:** tsunami; Director; seismo@imdmail.gov.in; tsunami.incois@gmail.com; seismicinfo.incois@gmail.com; shailesh@moes.gov.in; aeic@bmg.go.id; algeen@met.gov.mv; nmc@mete
Subject: Eq Info from ITEWC for 7.5 Earthquake at Talaud Islands, Indonesia (6 Mins ago)

==EARTHQUAKE INFORMATION BULLETIN 01==
Indian Tsunami Early Warning Center (ITEWC)
Indian National Centre for Ocean Information Services (INCOIS), Hyderabad

Version A: This report supersedes any earlier reports about this event.
This is a computer-generated message and has not yet been reviewed by a seismologist.

Preliminary Earthquake Parameters

Earthquake Magnitude: 7.5 Mw(mB)(preferred) (Great)
Network Magnitude(s): 7.2 (MLv), 7.4 (mB), 7.5 (Mw(mB)), 6.6 (mb)
Earthquake Date Time: 11-Feb-2009 23:04:55 (IST) 11-Feb-2009 17:34:55(UTC)
Location Lat: 3.86 N Long: 126.85 E
Focal Depth: 60 km
Region: Talaud Islands, Indonesia

Additional Earthquake Parameters

Event ID:ew090211173539
Event Solution: Type A (Automatic)
No of Stations Used: 20
No of Phases Used :20
RMS Error: 1.6
Azimuthal Gap: 63 degrees

Elapsed Time: This Earthquake happened 00 Hours, 06 Minutes, 12 Seconds ago

Tsunami Information

The water column height at epicenter location is: 272 m
Pacific Tsunami Warning Center (PTWC) or Japan Meteorological Agency (JMA) may issue the additional information for this earthqauke

Source of Information Contacts

Indian Tsunami Early Warning Center (ITEWC)
Indian National Centre for Ocean Information Services (INCOIS), Hyderabad

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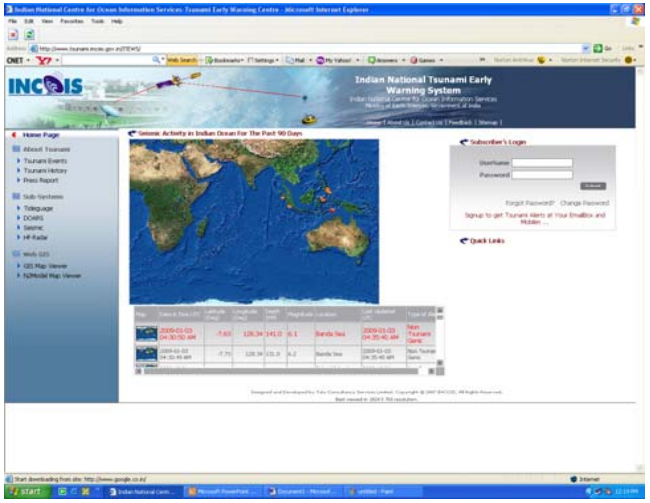
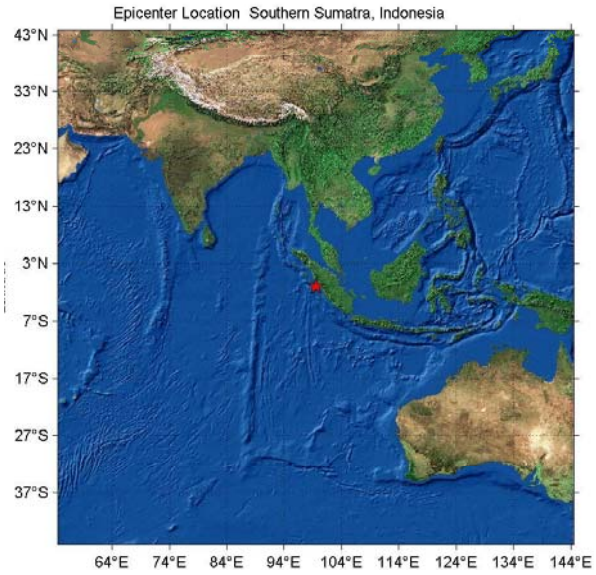
You are receiving this "EARTHQUAKE INFORMATION BULLETIN 01" message via Dissmination Module. Version 2.1. configured to send mail from



Handling of the Event by Warning Centers



Southern Sumatra Earthquake of M8.0 on 30th Sep 2009 at10:16:07 (UTC)

This earthquake generated a local tsunami near the epicenter especially at Padang, Indonesia (30 cm). The event did not generate any water level changes in Indian Coasts.

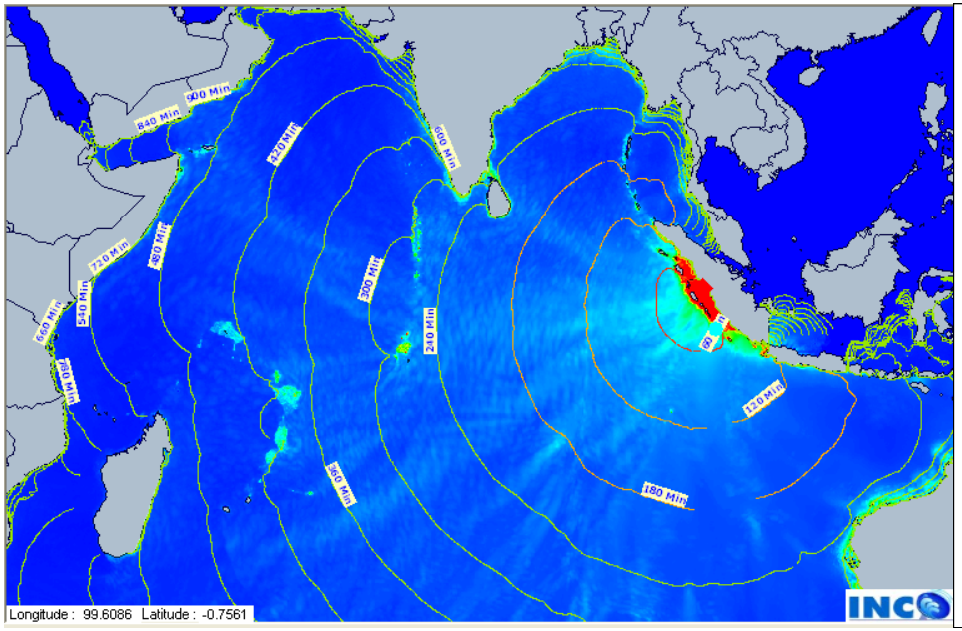
Different SOPs for the IO Region

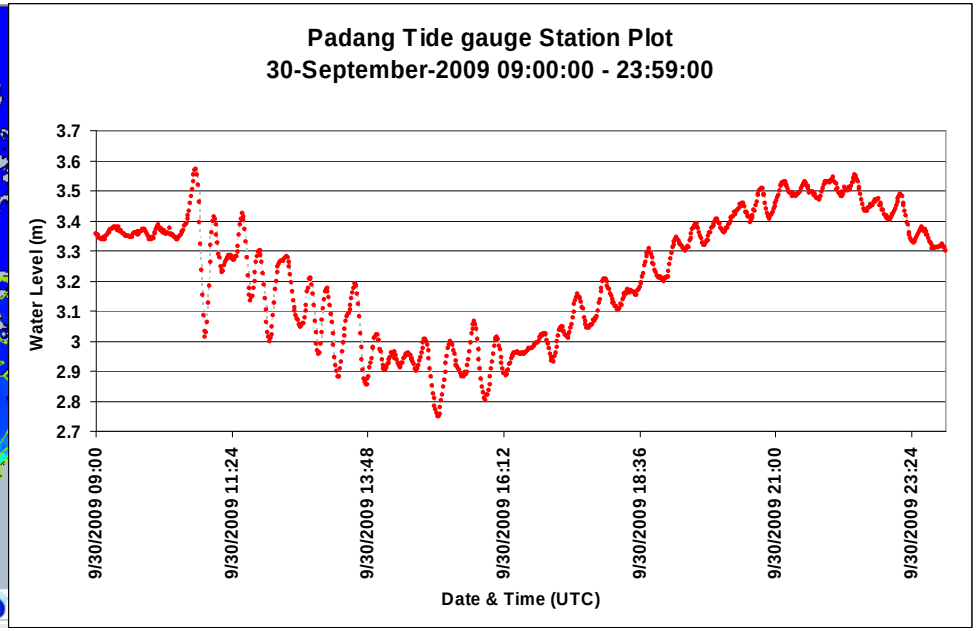
India: Eq info + Model Simulations + WL data

PTWC: Eq info + WL data

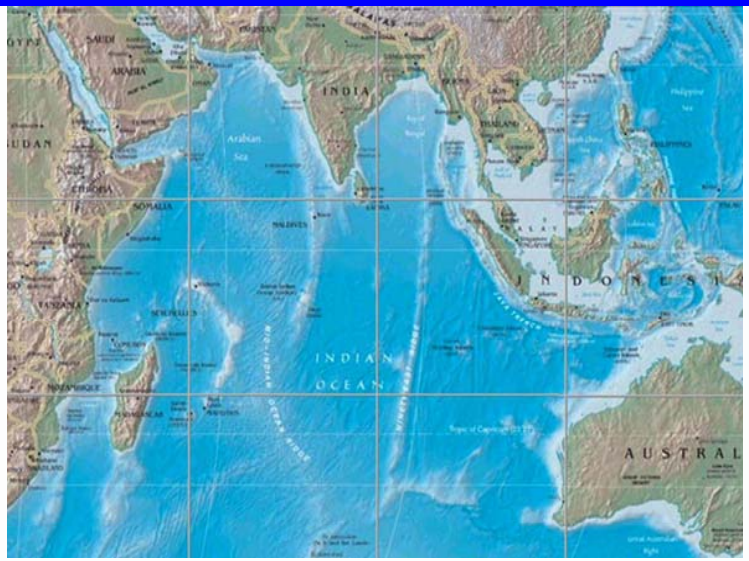
JMA: Eq info + WL data

Conflicting Bulletins





Significant role in the Indian Ocean



1. India-a key player major in the international coordination on arrangements for Indian Ocean region *[Kobe(Jan 05), Phuket (Jan 05), Paris (Mar 05), Mauritius (Apr 05) and Paris (Jun 05)]*
2. India is the only country that is developing capability to detect tsunami generated in the two tsunamigenic zones that would affect Indian Ocean
3. India served as Chairman of International Coordination Group set up by UNESCO/IOC for Indian Ocean Ocean Tsunami Warning and Mitigation System, a network of national systems
4. India is the First Country in the Indian Ocean to operationalise the TEWS that has been recognised as the most modern. ICG/IOTWS accepted Indias' offer to be Regional Tsunami Watch Provider for the Indian Ocean.

Achievements / Awards received in 2008

Geospatial Excellence Award 2008 for the Usage of Geospatial Technology for Disaster Management by GIS Development, a Global Geospatial Technology Magazine

Geospatial Solution of the year Award Under The Indian Geospatial Awards 2008 by Geospatial Today, a premier Geospatial Technology Magazine

Silver Award of National Awards for e-Governance 2008-09 under the Best Government Website Category

Special Achievement in GIS (SAG) 2009 Award from ESRI

Thank you for your kind attention