EARTHQUAKES: WHAT NEEDS TO BE DONE IN ASIA

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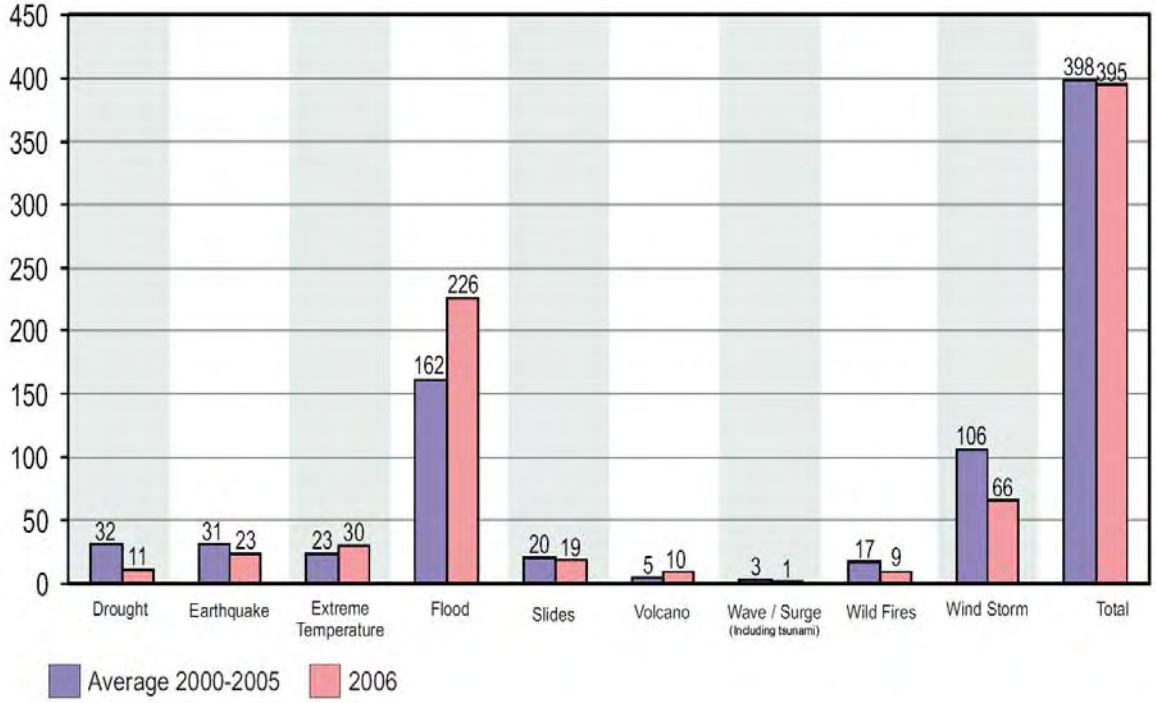
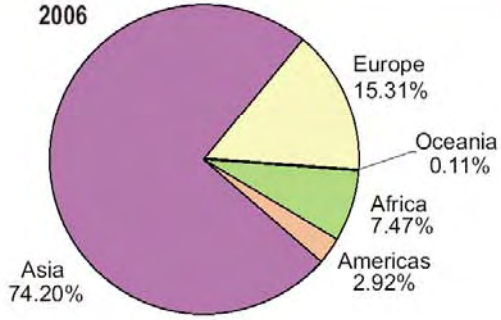
The frequency of natural disasters is rising rapidly:

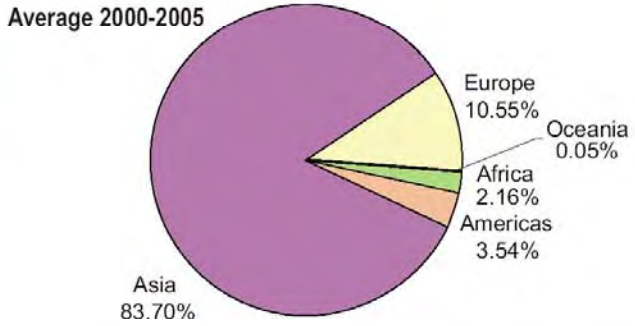
1900–1940	100	per decade
1960's	650	per decade
1980's	2000	per decade
1990's	2800	per decade

Natural disaster occurrence by disaster type



Percentage of people killed by natural disasters by continent





International Strategy for Disaster Reduction (UN/ISDR)
Tel: +41 22 9178908/8907
isdr@un.org
www.unisdr.org

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Source of data: EM-DAT: The OFDA/CRED International Disaster Database
www.em-dat.net
Université catholique de Louvain
Brussels - Belgium

Asia is seismically one of the most Earthquake prone regions in the world. The recent earthquake of 12th May 2008 in China, which claimed more than 50,000 human lives, is the reminder of the same.

COUNTRIES EFFECTED: TOP DAMAGE*

Country	Date	Killed
SE ASIA (Indonesia & other SE Asian countries)	26 –Dec-2004	280,000
China P Rep	27 –Jul-96	242,000
China P Rep	22- May – 1927	200,000
China P Rep	16-Dec – 1920	180,000
Japan	1-Sep – 1923	143,000
Soviet Union	5 – Oct – 1948	110,000
Italy	28 – Dec – 1908	75,000
Pakistan	8 – Oct – 2005	73,338
China P Rep	26-Dec – 1932	70,000
Peru	31-May – 1970	66,794
Pakistan	31- May – 1935	60,000
China P Rep	12- May -2008	~50,000
INDIA	26 - Jan - 2001	20,000

* sorted by number of people killed, total affected and by economic damage

Source: CRED EM-DAT

1995 Economic Losses US $ 179 billion

(Kobe earthquake)

2004 Economic Losses US $ 140 billion

(Sumatra earthquake)

JAPANESE SEISMOLOGISTS ESTIMATE

THAT A FUTURE M ~ 7.5 EQ IN VICINITY

OF TOKYO WILL COST 1.2 TRILLION US $

LATUR EARTHQUAKE, INDIA

29th SEPTEMBER 1993

M 6.2

HUMAN LIVES LOSS ~ 10000

NORTH RIDGE EARTHQUAKE, USA

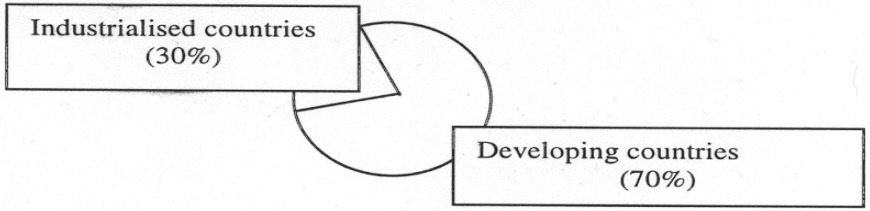
17th JANUARY 1994

M 6.7

HUMAN LIVES LOSS ~ 50

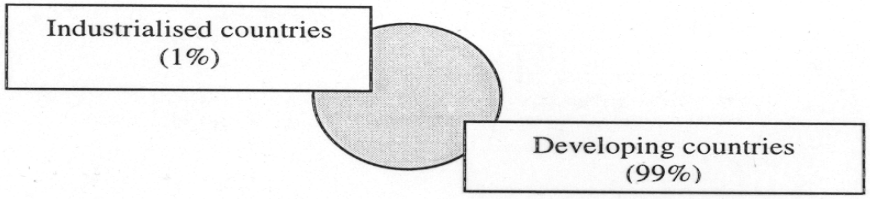
EARTHQUAKE-CAUSED FATALITIES

1900 - 1949



TOTAL –700 THOUSAND

1950 -1992

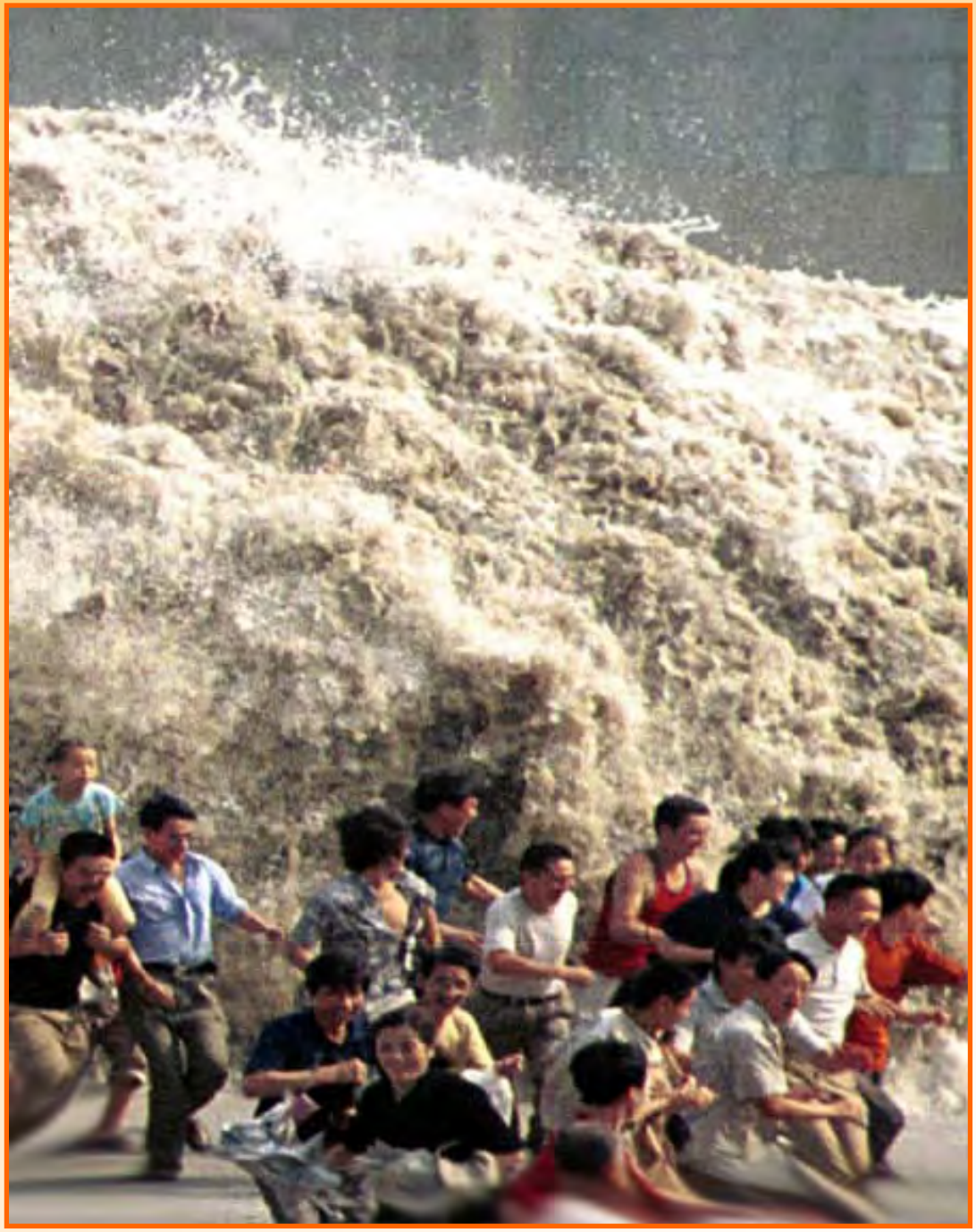


TOTAL~500 THOUSAND

Source: OFDA

26th December 2004:

Mega Tsunami




Banana
DANCE TIME NIGHT

The Indian Ocean

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

28th March 2005 Earthquake

- **India has a huge population living in the coastal regions. About 200 million.**
- **False alarms cause a lot of problem.**
- **After a couple of false alarms, the public will not respond.**

FALSE ALARMS SHOULD BE AVOIDED AS FAR AS POSSIBLE

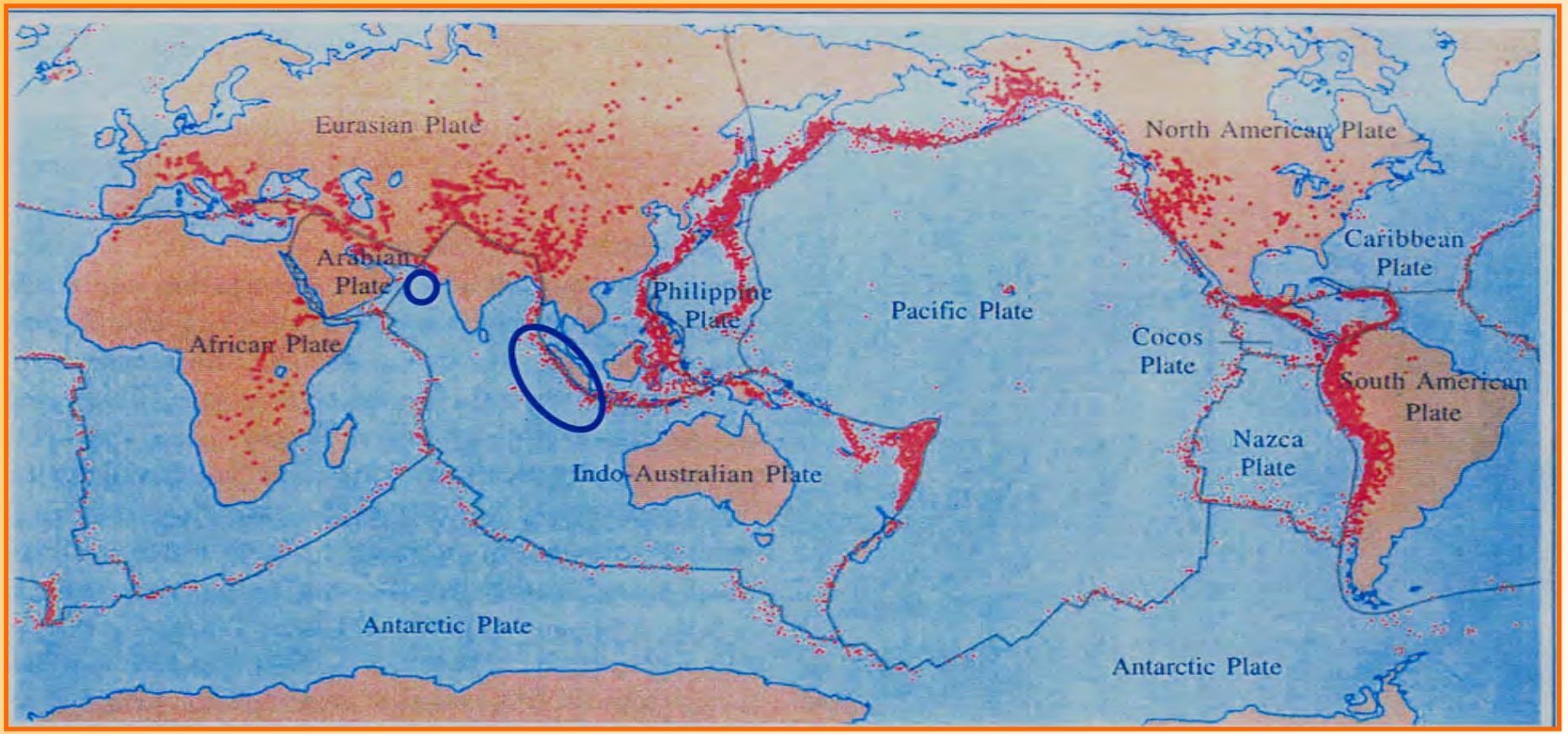


Diagram showing the distribution of earthquakes and major plate boundaries. It may be noted that globally, more than 75% of earthquake energy is released in the circum-Pacific belt, about 20% in the Alpine-Himalayan belt, and remaining 5% through the mid-oceanic ridges and other Stable Continental Region 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, and the possible locations of such events are enclosed in blue circle and ellipse.

Indian Ocean Rim Countries

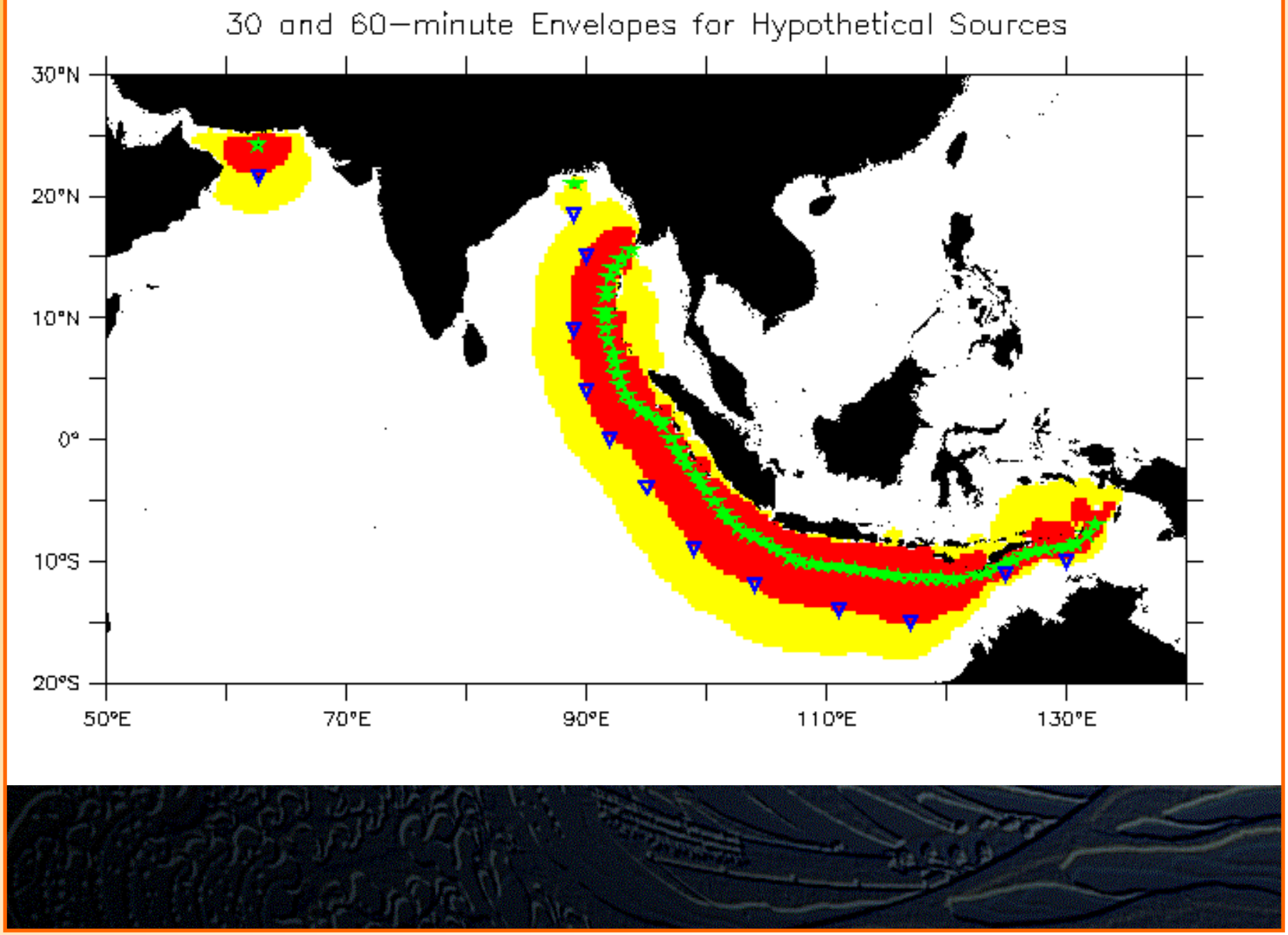
- Basically fall in two categories.
- Located close to the tsunamigenic earthquake sources.
- Far away from the tsunamigenic sources.

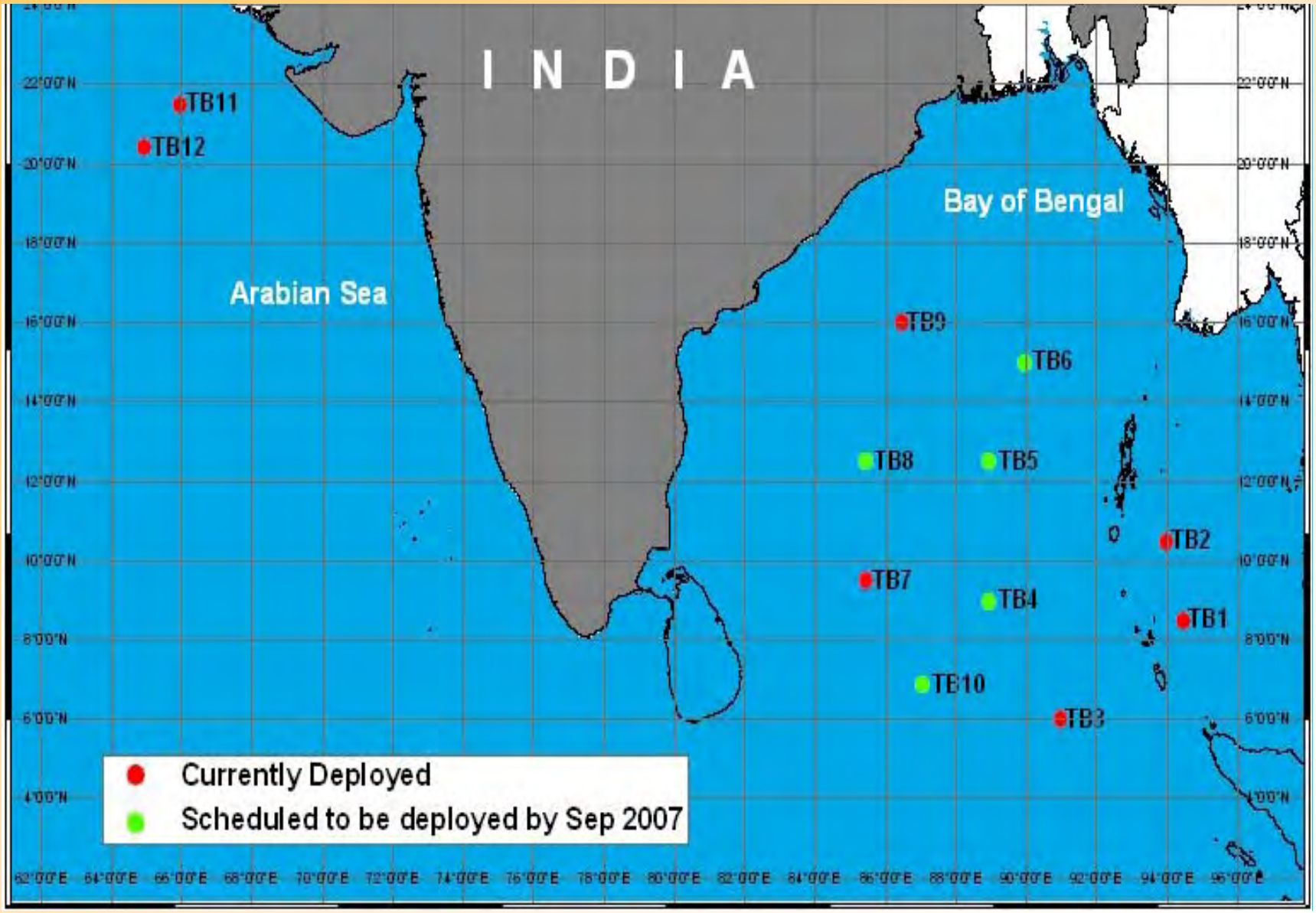
PROGRESS :

TSUNAMI The Indian Scenario

STATUS AS OF NOW

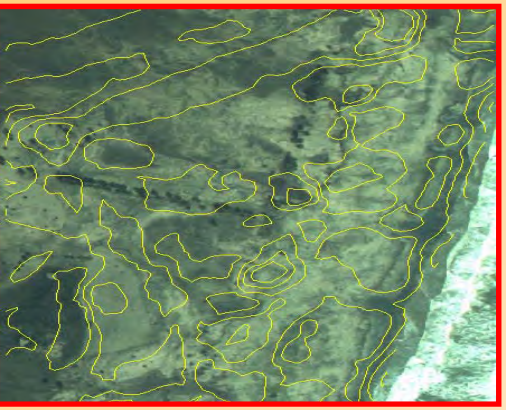
1. PROGRAM CONCEIVED IN JANUARY 2005
2. TECHNICAL DETAILS WORKED OUT DURING FEBRUARY & MARCH 2005.
3. NECESSARY APPROVALS & FUNDING IN MARCH/APRIL 2005
4. COMPLETED WITHIN 30 MONTHS, AS ESTIMATED IN MARCH 2005 & IS TOTALLY OPERATIONAL
5. DIRECT COST US $ 30 MILLION
6. TOTALLY OPERATIONAL & TESTED IN SEPTEMBER 2007


30 and 60–minute Envelopes for Hypothetical Sources
30°N
20°N
10°N
0°
10°S
20°S
50°E
70°E
90°E
110°E
130°E

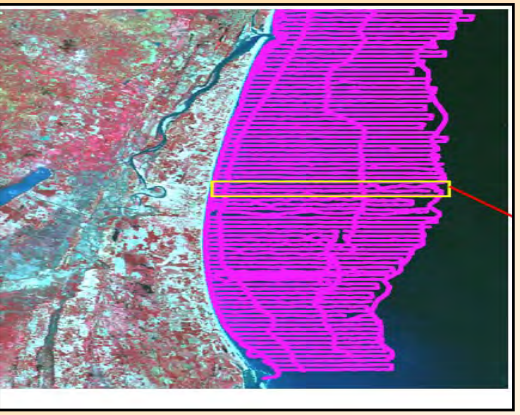

INDIA
Bay of Bengal
Arabian Sea
TB11
TB12
TB9
TB6
TB8
TB5
TB2
TB7
TB4
TB1
TB10
TB3
Currently Deployed
Scheduled to be deployed by Sep 2007

Risk Assessment – Coastal Vulnerability Mapping

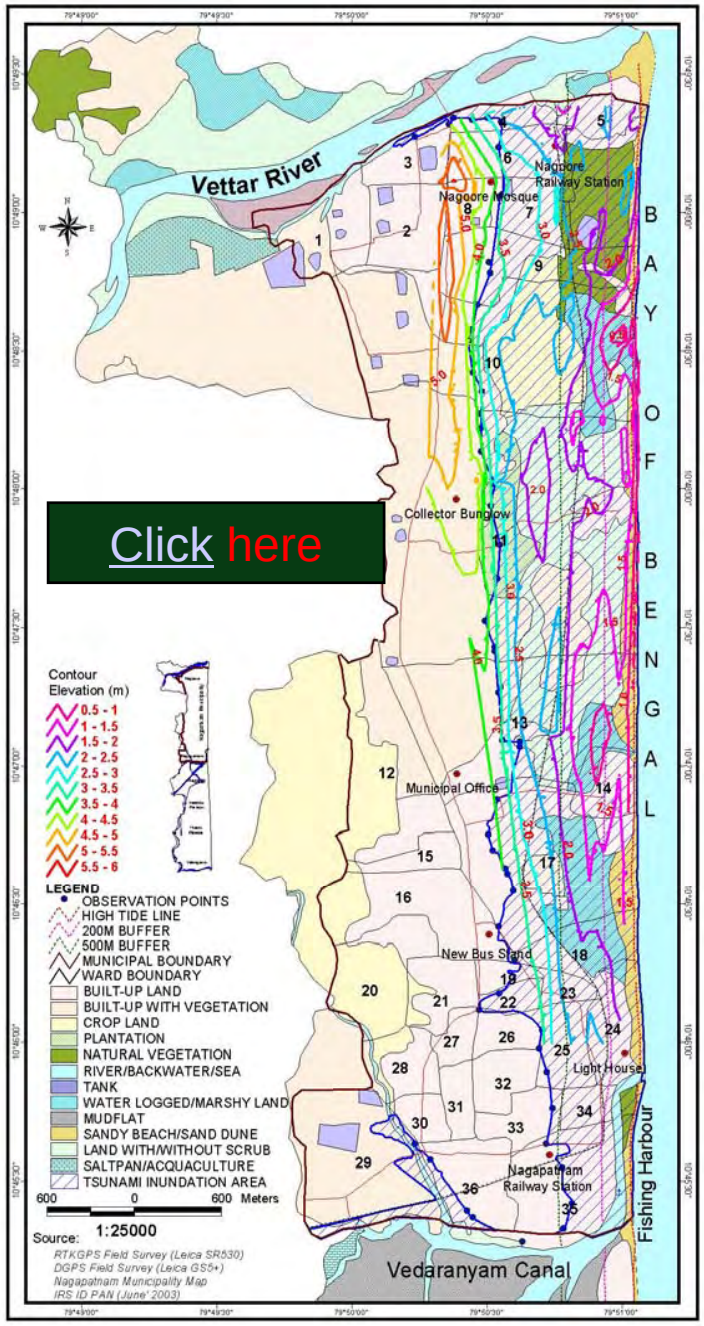
Base map overlaid on ortho image



1m contours overlaid on ortho image



Bathymetric Survey for Cuddalore



- Tsunamis cause coastal flooding resulting in loss of human life and damage to property.
- Tsunami Models predict surges for different scenarios and indicate the extent of inundation of seawater into the land.
- The predicted inundation areas are being overlaid on cadastral level maps of 1:5000 scale.
- The maps indicating the areas likely to be affected due to flooding will be provided to the central and state level departments that are involved in Disaster Management.

- Coastal Inundation scenarios simulated for 5 historical Earthquakes
- 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 by NRSA using Cartosat and ALTM Surveys
- Bathymetric Survey conducted for a few vulnerable areas. Detailed survey being planned for other areas

SEPTEMBER 12, 2007

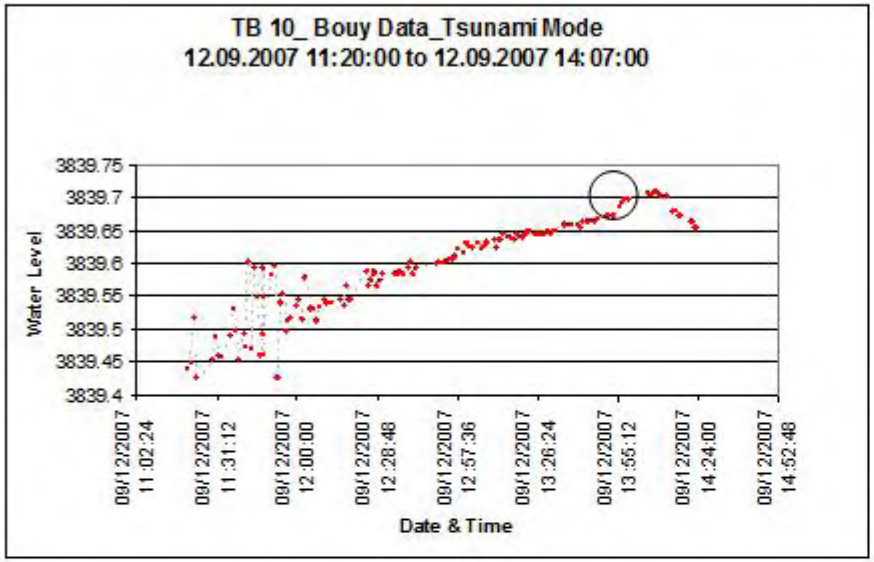
M 8.4, 4.521° S, 101.370° E

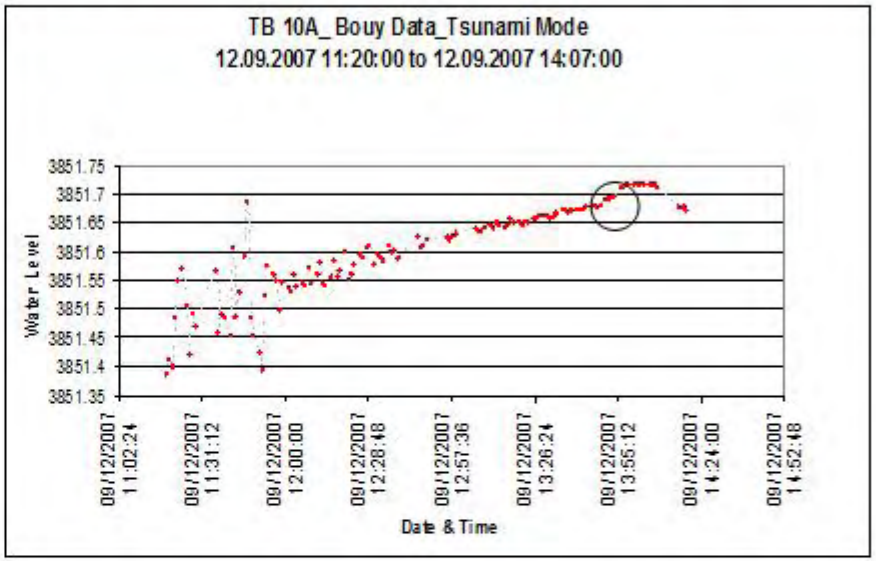
INCOIS generated a database of Model Scenarios considering various earthquake parameters. For the September 12, 2007 event scenario Ids 28.2 & 29.2 were picked from the scenario database. They were used to calculate the estimated travel time and run up heights at various coastal locations and water level sensors (Tide guages & BPRs and tidal stations) as evident from the table below:

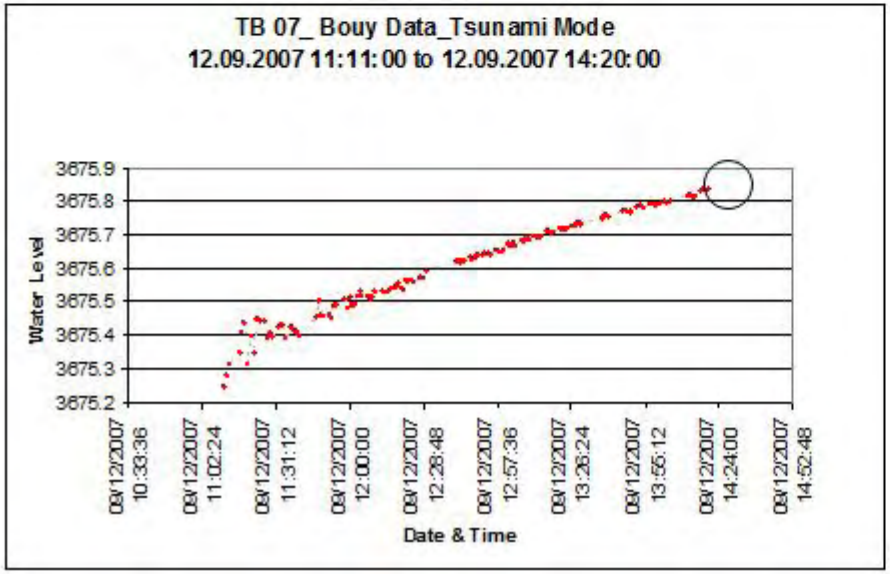
Location	Estimated Arrival Time (h)	Estimated water level (cm)	Observed Arrival Time (h)	Observed water level (cm)
Padang	1751	80	1754	60
Coco's Island	1748	40	1748	50
Sabang	1903	20	1903	30
TB 3	1903	2	1913	1
TB10A	1931	1	1941	2
TB10	1930	2	1945	1
Port Blair	2010	10	2013	8
Chennai	2105	20	2110	18

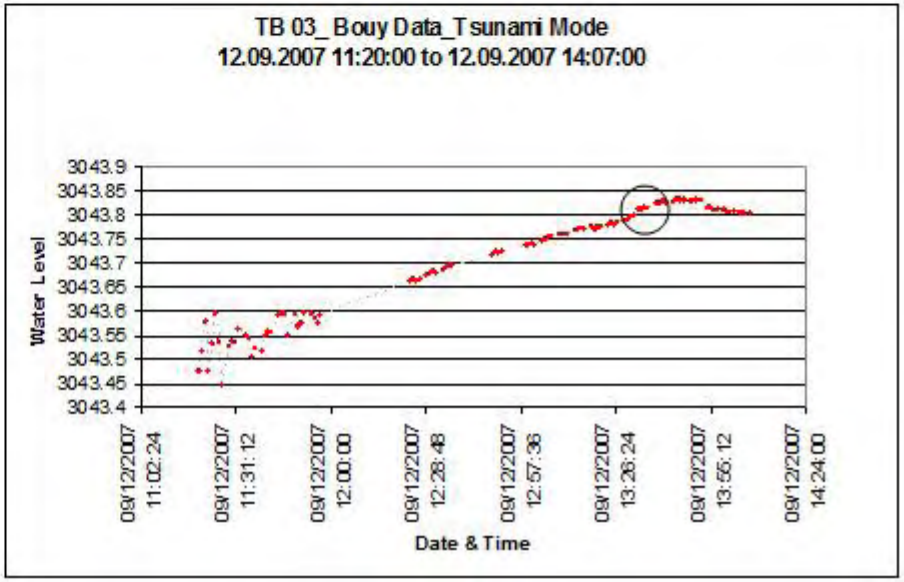
BPR Water level observations of Sep 12, M8.4 Earthquake

- ~ 20 to 30 mm change in water level at ETA observed in TB03, TB10, TB10 A



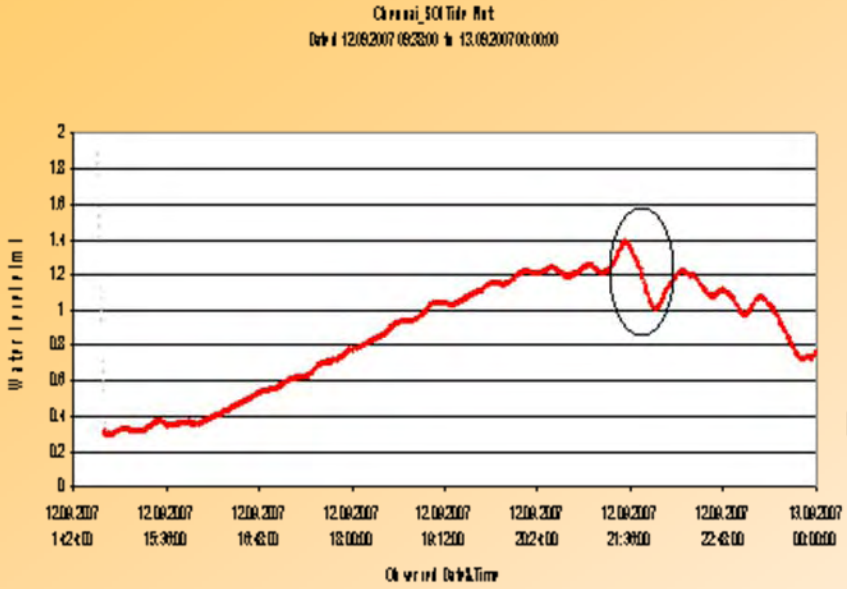


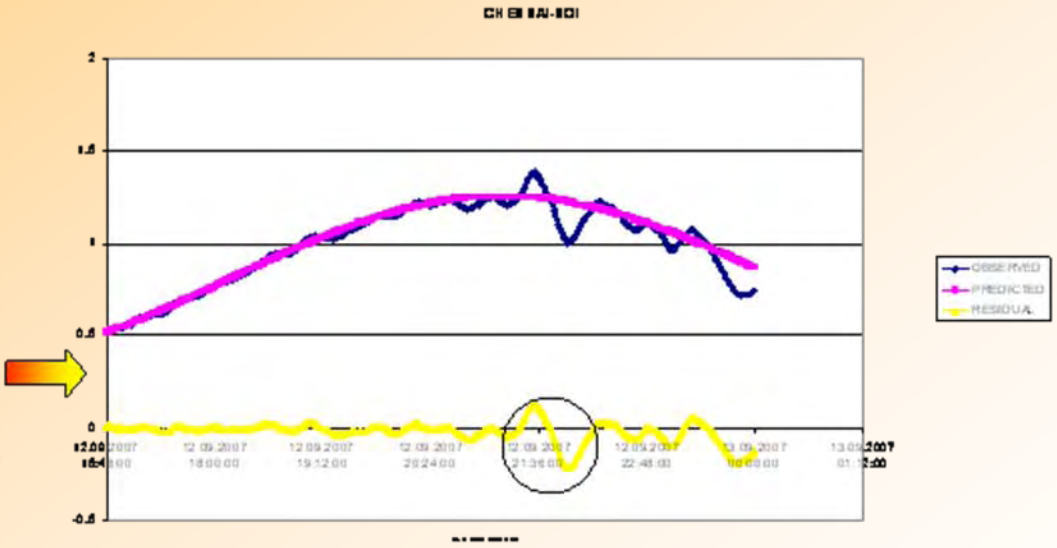


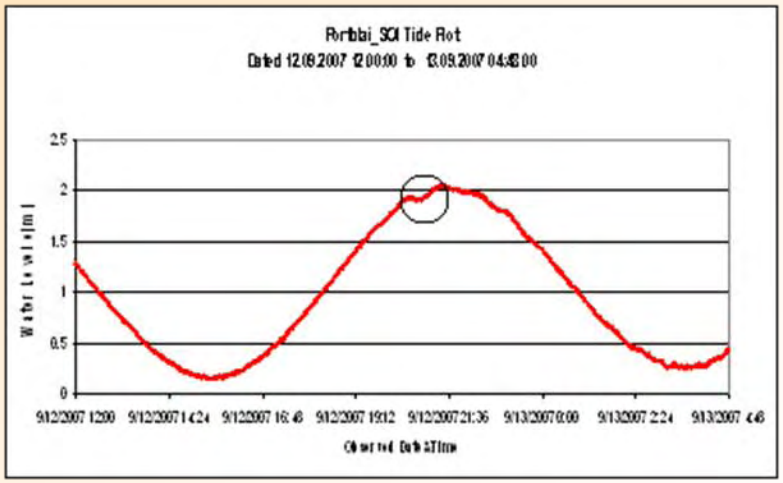


Tide Gauge Water level observations of Sep 12, M8.4 Earthquake

- Port Blair showed ~ 10 CM Change in Water Level at ETA (20 10)
- Chennai showed ~ 18 CM Change in Water Level at ETA (21 05)



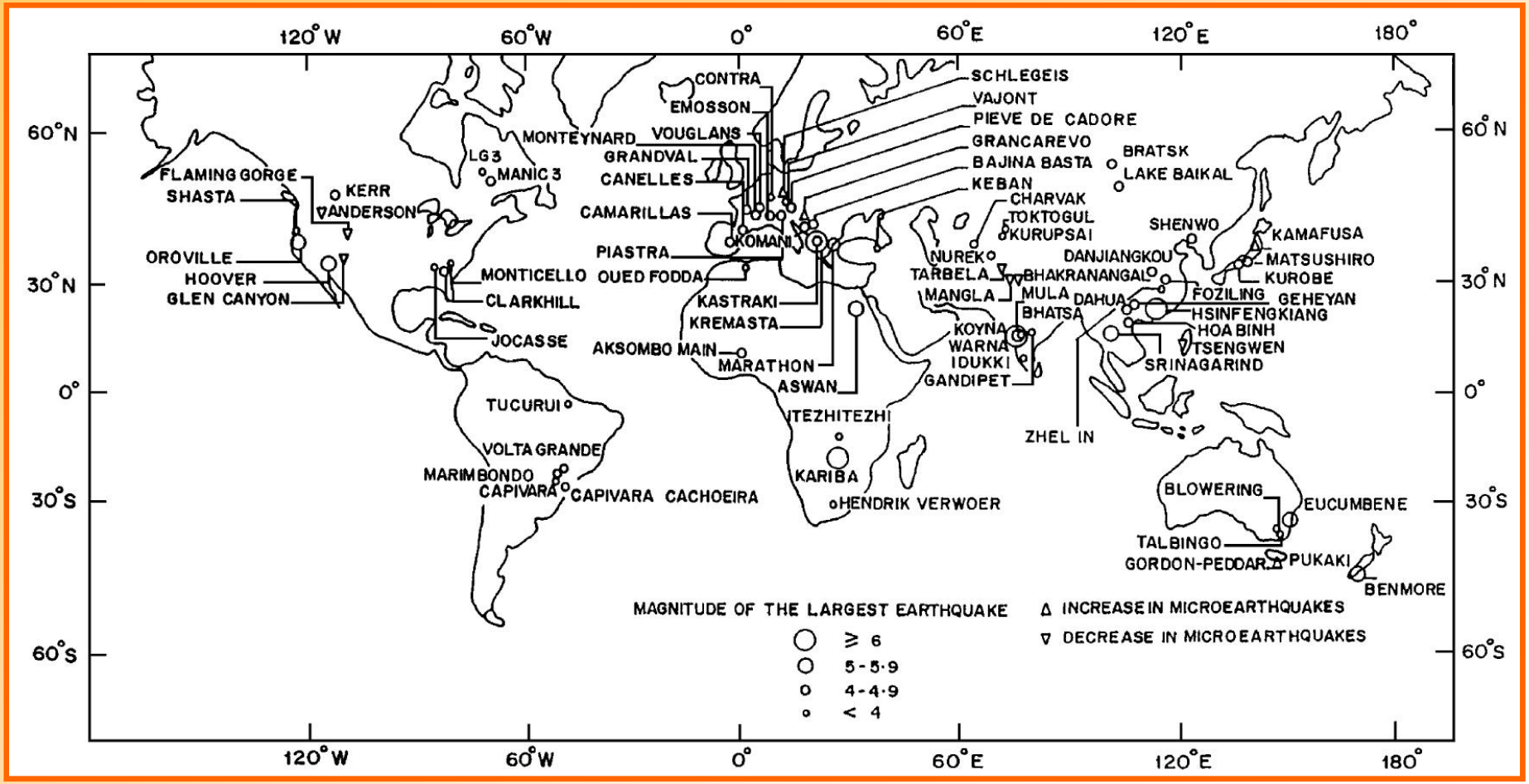




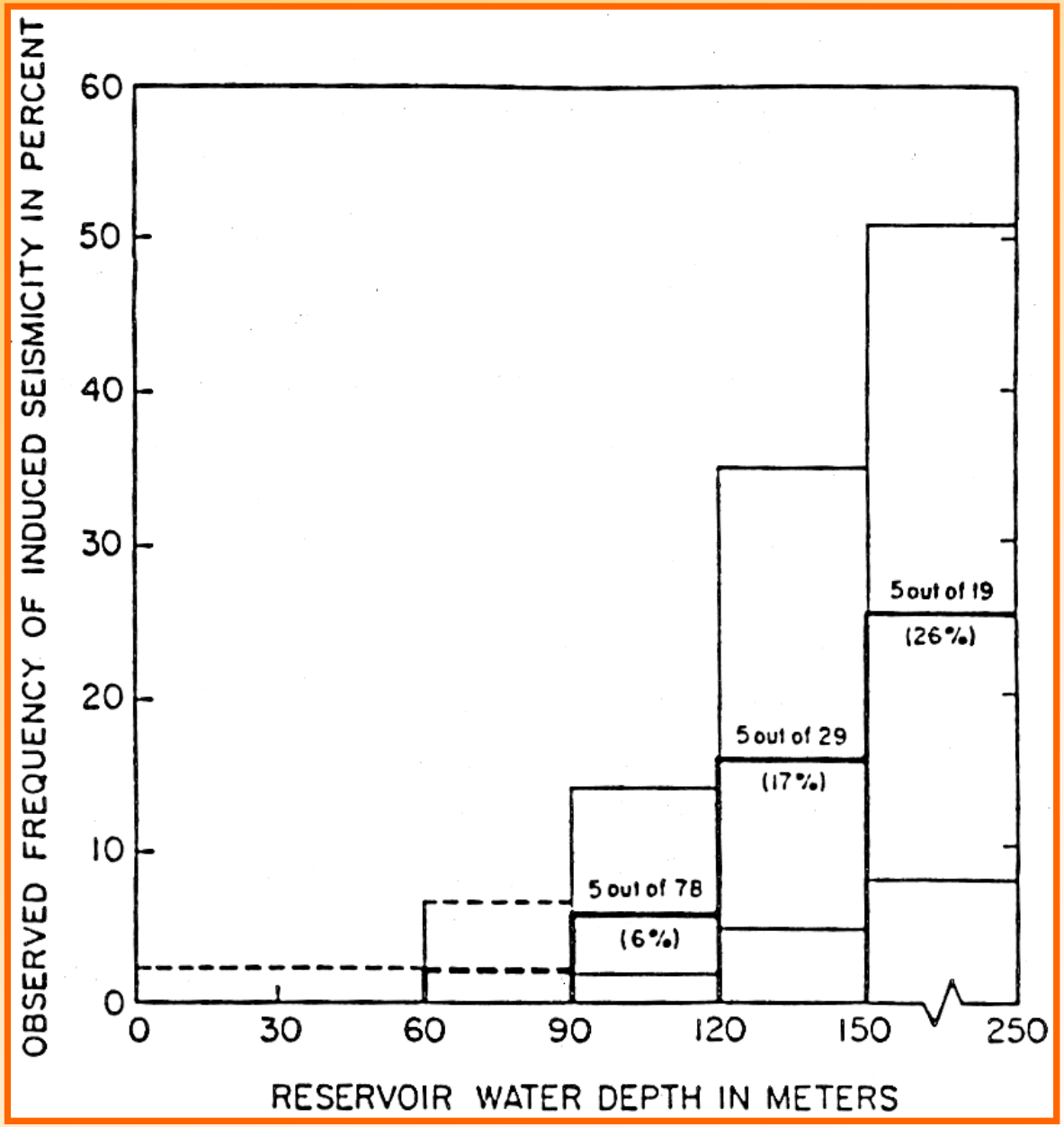
TRIGGERED EARTHQUAKES

LARGEST TRIGGERED EARTHQUAKES

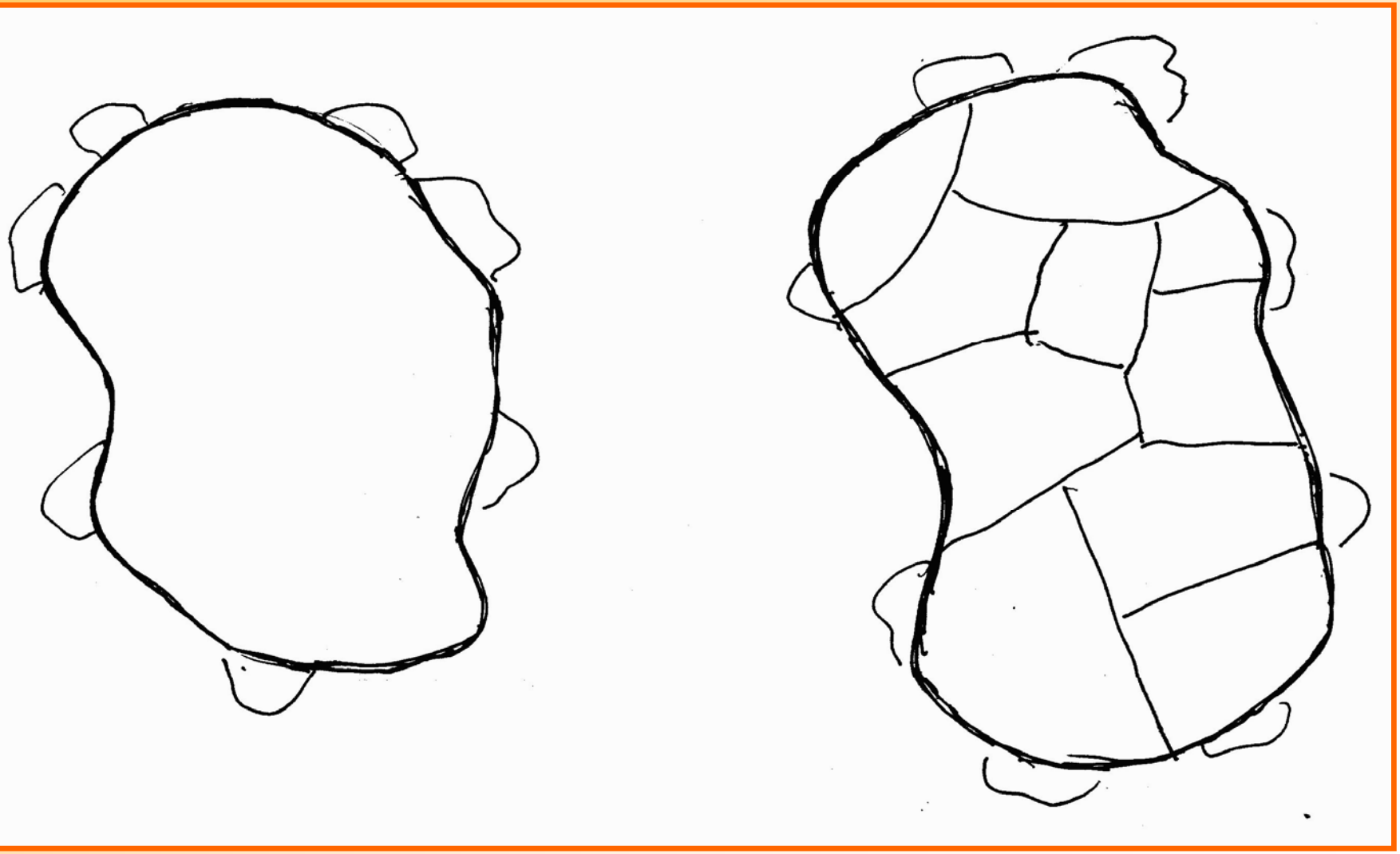
- **HSINGFENGKIANG, CHINA 1962, 6.1**
- **KARIBA (ZAMBIA-ZIMBABWE 1963,6.2**
- **KREMASTA, GREECE, 1966, 6.2**
- **KOYNA, INDIA, 1967, 6.3**



Global distribution of known sites of artificial water reservoirs triggered earthquake. Earthquakes exceeding magnitude 6 occurred at Hsingfengkiang, China and at Koyna, India in the ROAP region. (Gupta 2002)



Reservoir water depths are the most important correlate



SUGGESTIONS

Several countries in Asia do not have adequate earthquake recording and GPS monitoring of crustal deformation. Such countries need to be identified and a suitable mechanism to instrument them needs to be developed.

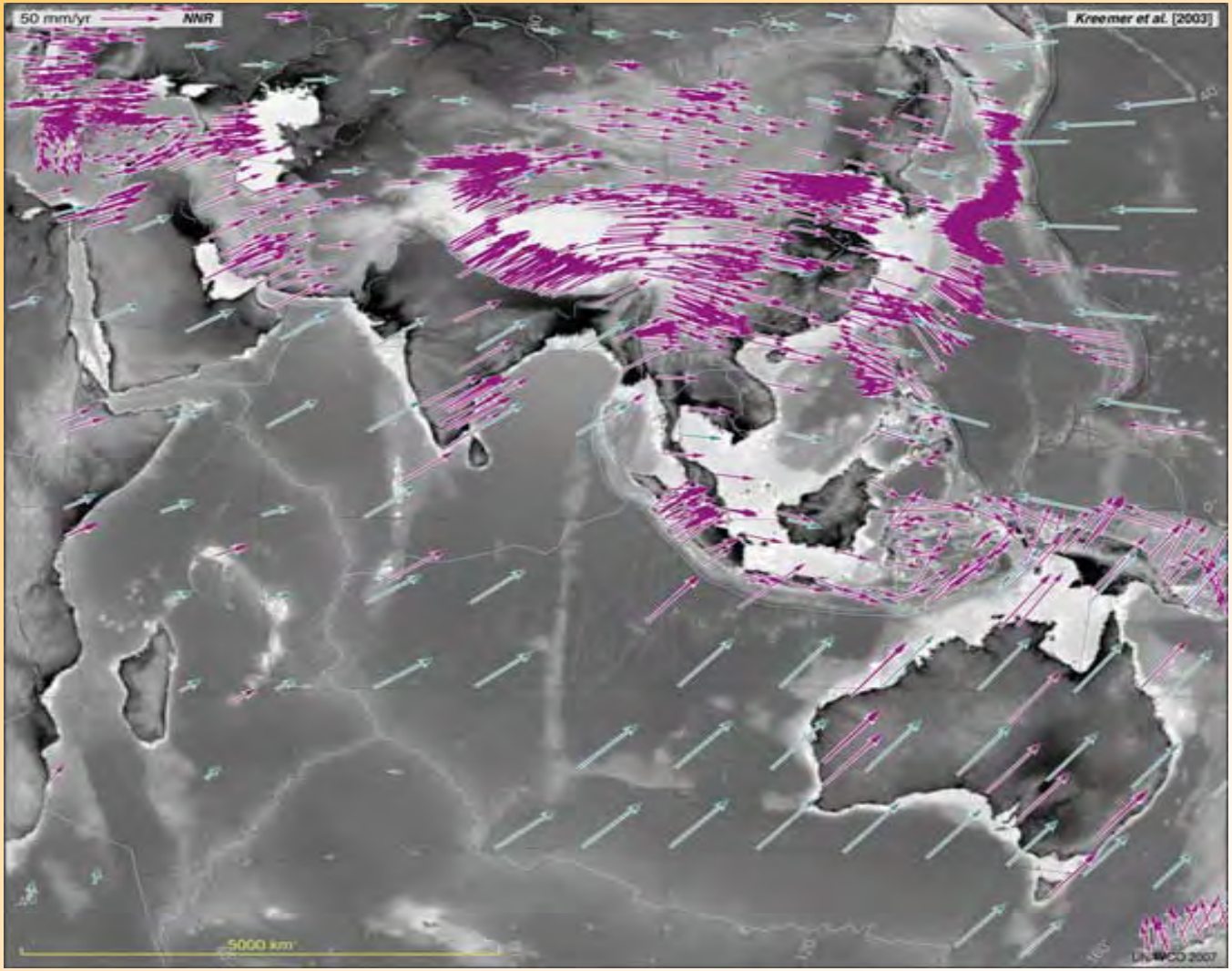


Plate motion (in ITRF 2000) in Asia and Pacific region (Kreemer et al, 2003) (*Geophys.J. Int., 154,8-34)*

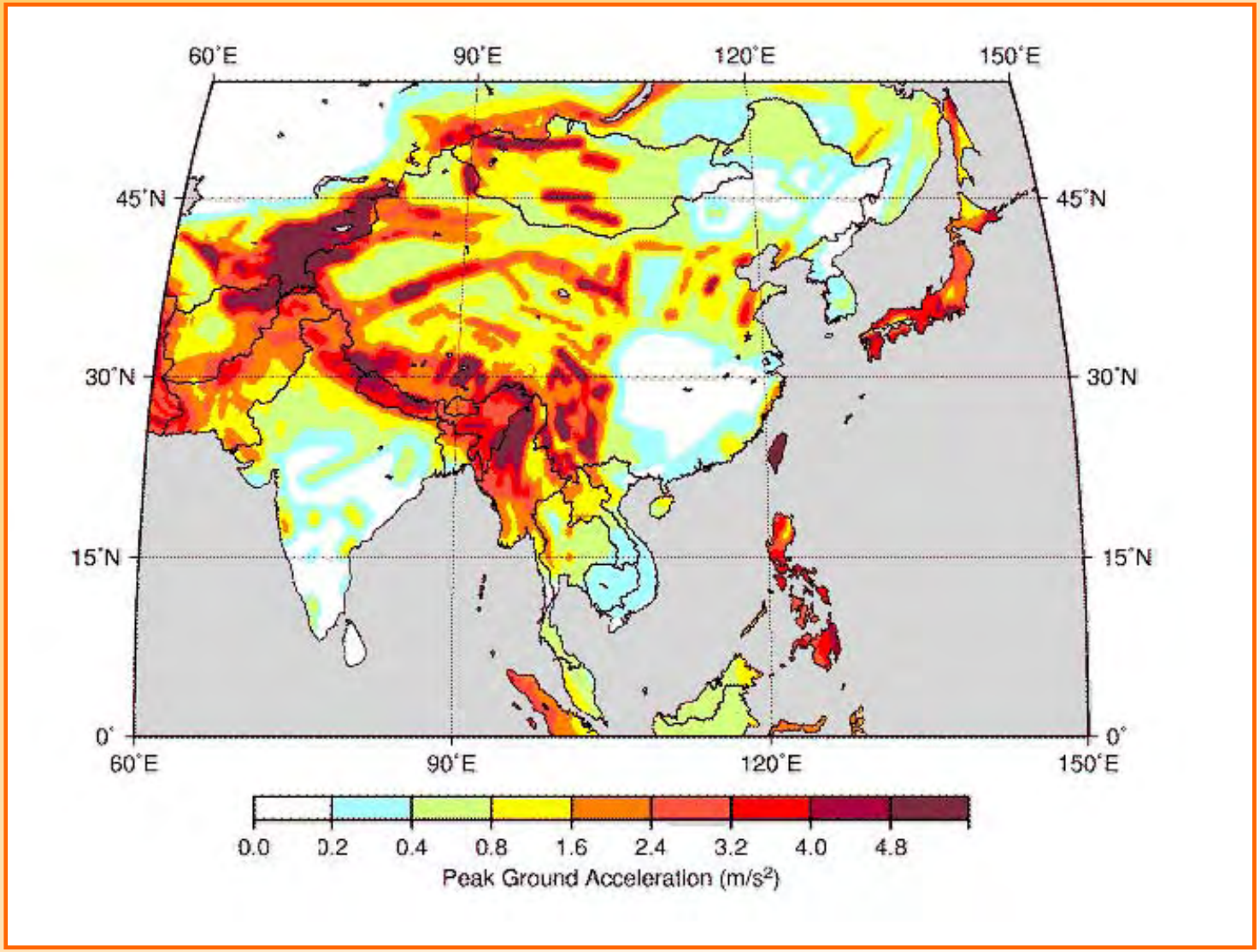
Develop scenarios of present day losses (social and economic) if earlier disastrous earthquakes re-occur. Also develop building codes for earthquake prone countries where necessary, and ensure their implementation.

Time occurrence	Deaths in collapsed house	Deaths in Part-collapsed house	Total potential Deaths
Midnight (sleeping)	40%	20%	344,000
Morning (awake and sleeping)	20%	10%	177,000
Noon Time (out working)	10%	5%	88,000

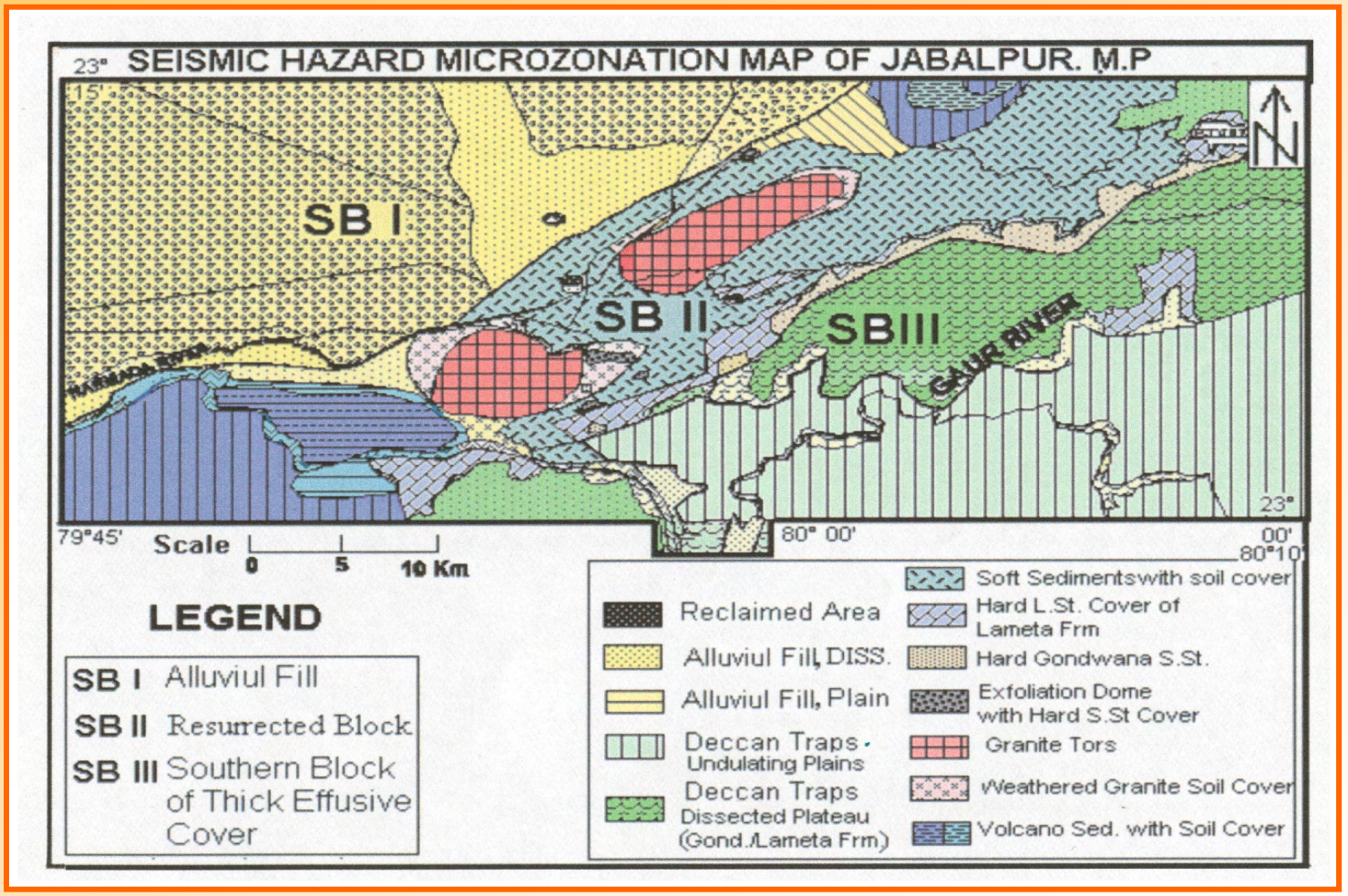
Estimates of Human lives likely to be lost if the Kangra Earthquake of 1995, which claimed 20,000 lives, was to occur today. (Arya, 1992)

The Muzzafarabad earthquake occurred about 300 km away, west of Kangra, late in the morning and claimed an estimated 80,000 lives

Global Seismic Hazard Assessment Program (GSHAP) was a flagship program of IDNDR. Anticipated accelerations due to earthquakes at the bedrock are available for all the major cities in earthquake prone areas. A major effort is required to estimate the accelerations at the surface taking into consideration the local ground conditions and use them for micro-zonation of major cities.



The seismic hazard map of Asia depicting peak ground acceleration (PGA), given in m/s2, with a 10% chance of excedence in 50 years. (www.seismo.eth.ch/GSHAP/)



First order Microzonation Map of Jabalpur, M.P. (DST, India, 2007)

A large percentage of population in the Asia lives in self designed non-engineered homes, which are very vulnerable to horizontal accelerations experienced during the earthquakes. This can be improved enormously by simple inexpensive retrofitting. This should be taken up as a major initiative

It is important to learn to live with earthquakes in earthquake prone areas. Several countries have developed earthquake drills. A lot of information is available as what to do before, during and after an earthquake. This needs to be appropriately spread to public.

Artificial water reservoirs can trigger earthquakes. Ways and means are now available to find safer sites. Whenever a large artificial water reservoir is being created, necessary surveys should be conducted to find a suitable site.

Tsunami forecasts are now available for most Asian countries. However, countries need to develop facilities to make use of these advisories

There is a great short fall in current research activities on how science is used to shape social and political decision–making in the context of hazards and disasters

Environmental hazards risk typically depends not only on physical condition and the events, but also on human actions, conditions (vulnerability factors, etc), decision and culture.

In spite of the growth in knowledge, losses from natural hazards are on an increase.

“Make appropriate use of available scientific and technology knowledge for the benefit of humanity”

THANK YOU