Satellite as a tool in Tsunami Early Warning system

EUMETSAT SATELLITE APPLICATION COURSE
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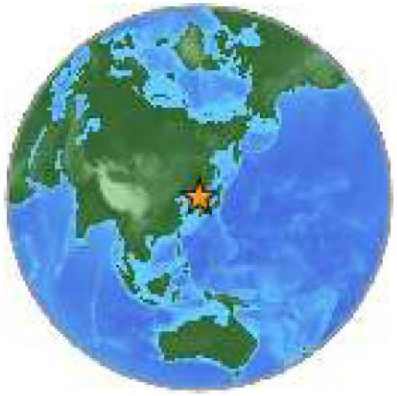
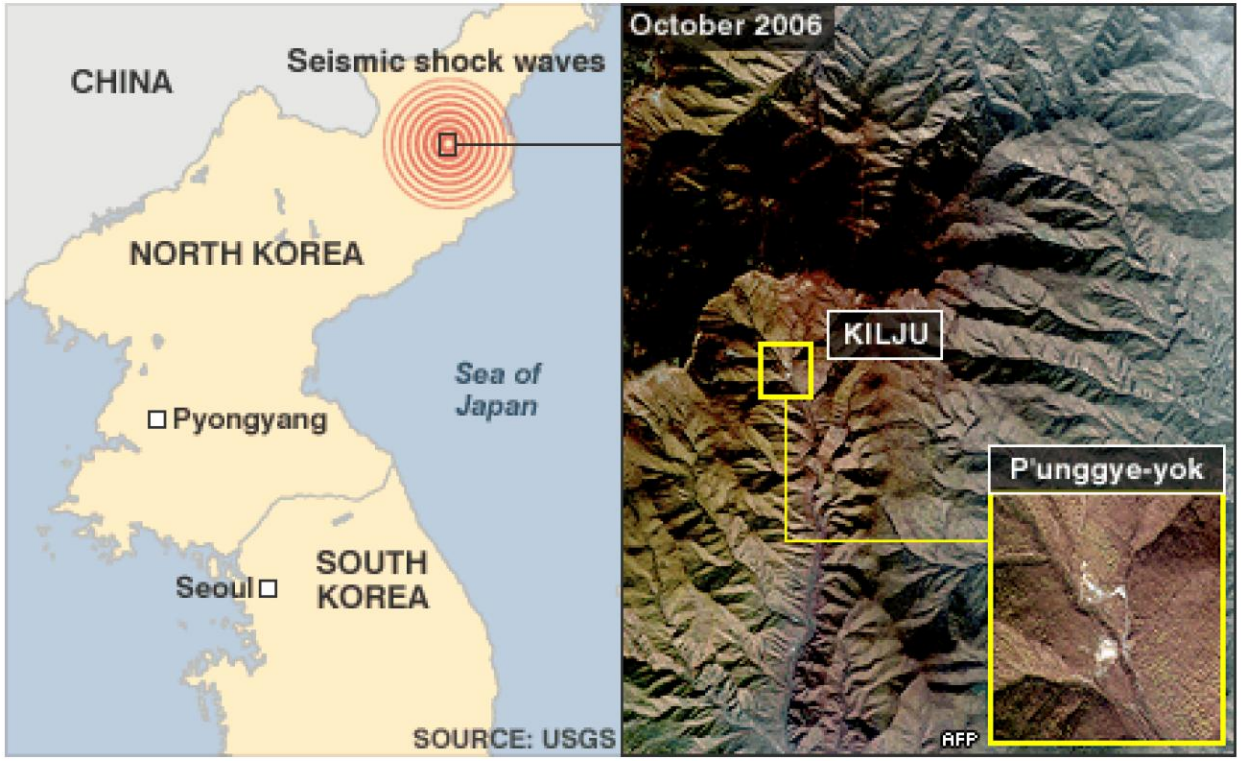
M5.1 NUCLEAR EXPLOSION - NORTH KOREA

Tuesday, February 12, 2013 at 02:57:51 UTC



At 02:57:51 UTC on February 12, 2013, monitoring stations of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and many other stations around the world detected a shallow seismic event with explosion-like characteristics in the Democratic People's Republic of Korea (DPRK).



Highlighted is the location of this event which corresponds to a suspected nuclear test site.

Images and location information courtesy USGS and CTBTO

Question

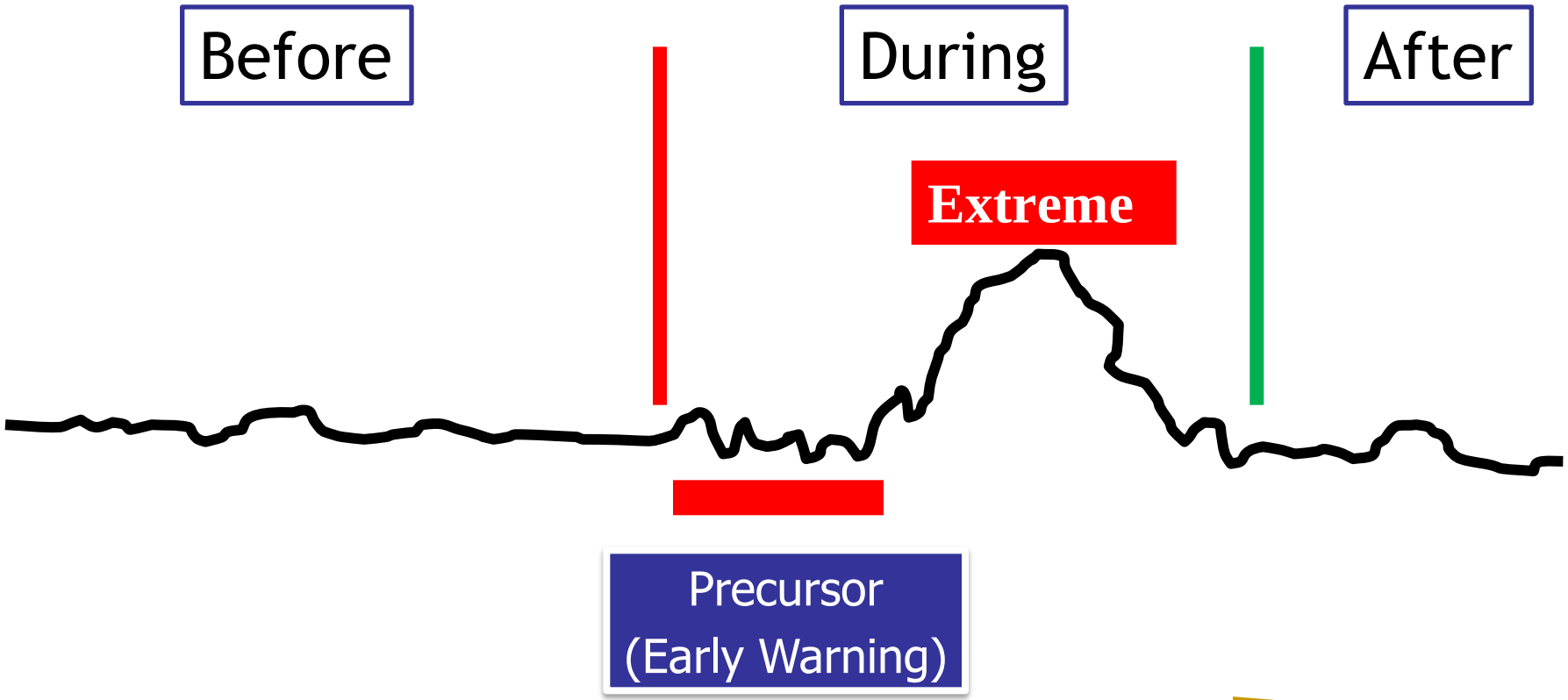
1. Satellite: tool of communication or as a sensor
2. Can we use satellite as a sensor to detect tsunami ?
3. If it can, how long it takes to get the latest image ?
4. Otherwise, satellite is only a tool of communication in tsunami early warning system.

Outline

1. Satellite : for communication or for sensor
2. Early Warning System (EWS)
3. Tsunami generation
4. Tsunami Early Warning System
5. Dissemination system and controling

EARLY WARNING

Detect and Monitors the Natural phenomena

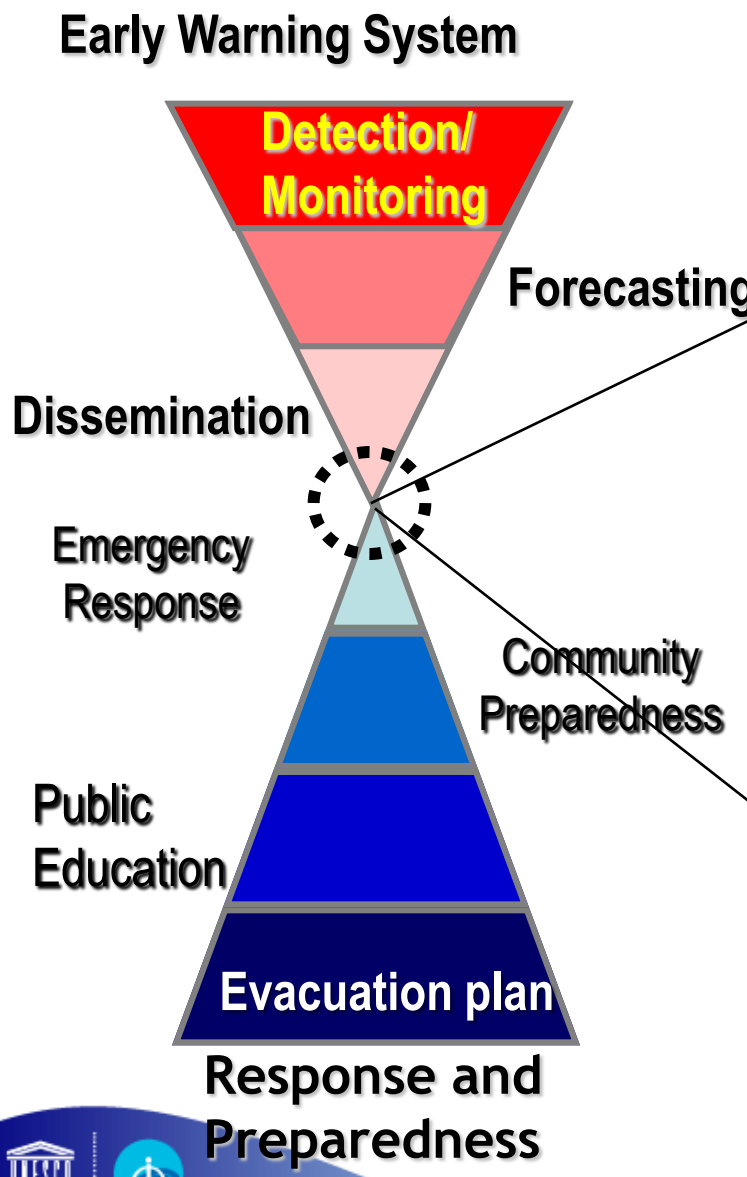


Early warning system (Ref: UN-ISDR)

The provision of timely and effective information, through **identified institutions**, that allows individuals **exposed to a hazard to take action to avoid or reduce their risk** and **prepare for effective response.**

Early warning systems include a **chain of concerns**, namely: understanding and mapping the hazard, monitoring and forecasting impending events, processing and disseminating understandable warnings to **political authorities** and the population, and undertaking appropriate and **timely actions in response to the warnings.**

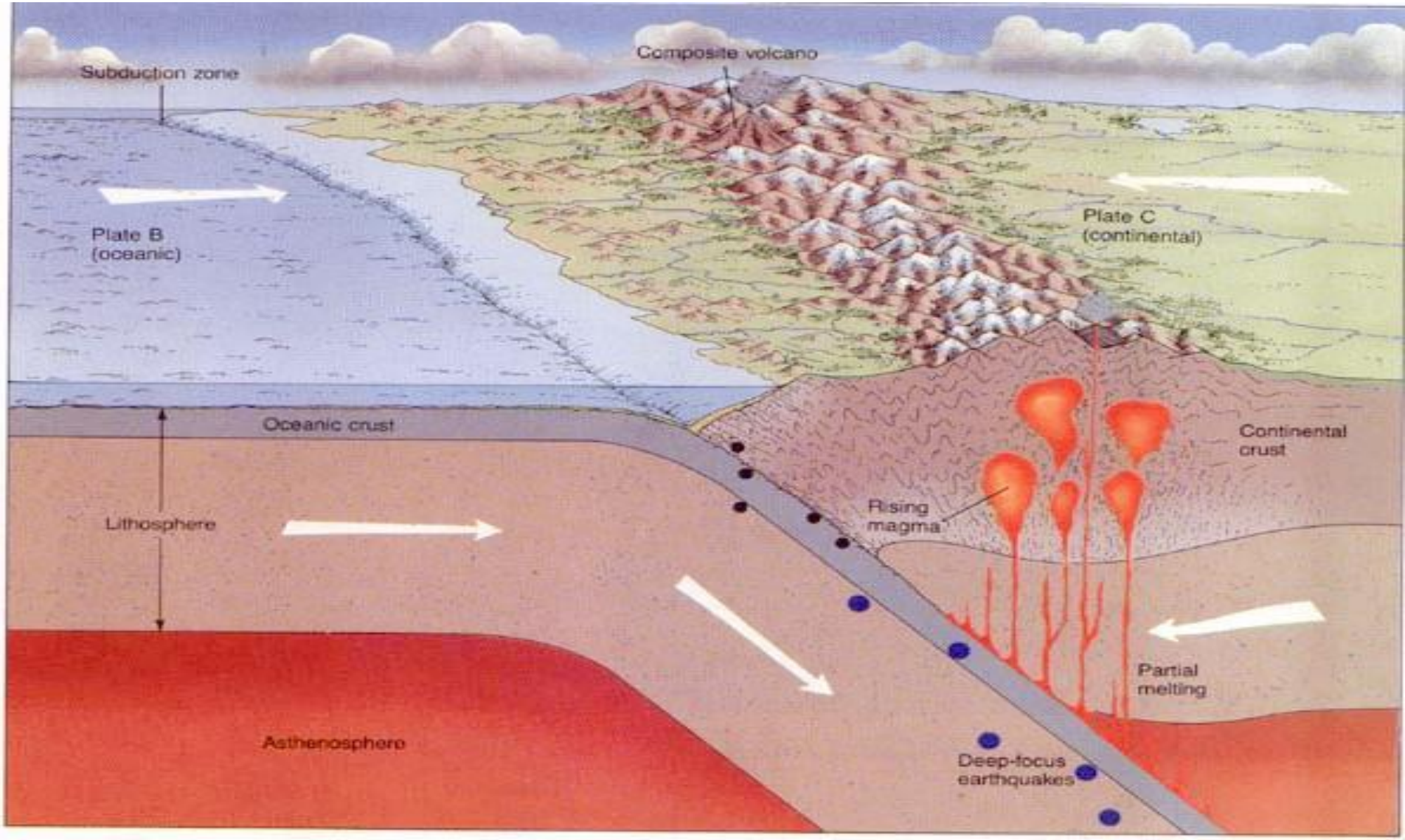
Capacity in critical condition



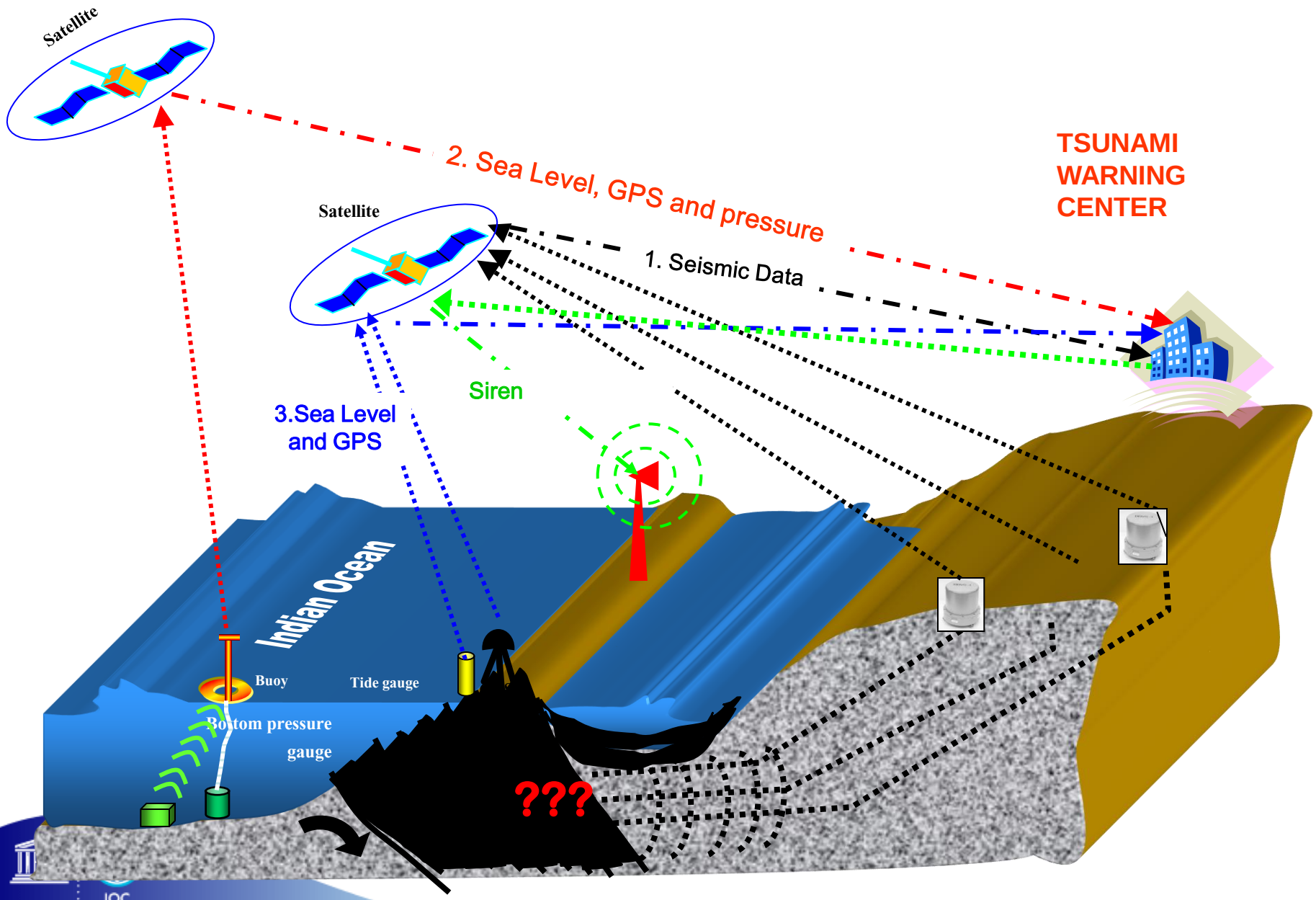
Synchronisation
upstream - downstream

- Receive early warning
- Understand warning
- Interpret the warning
- Rapid decision making and reaction
- Mobilization:
  - People
  - Local officers
  - Logistics
- Temporary shelters
  - 1st aid
  - Life support
  - Water and sanitation
  - Communication

Field stress along the plate collision

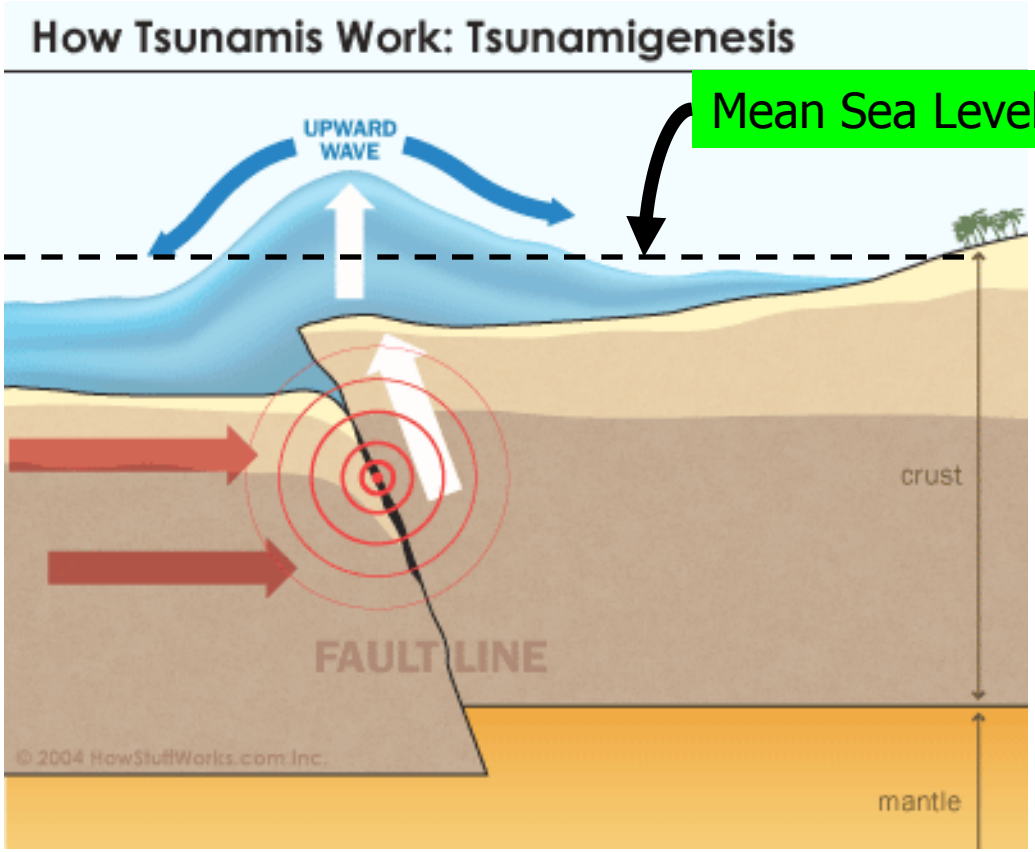


Tsunami Warning System



Which earthquake generates tsunami

- Earthquake with Magnitude >6.5
- Below the sea
- Depth < 70km.
- Mostly with vertical dislocation

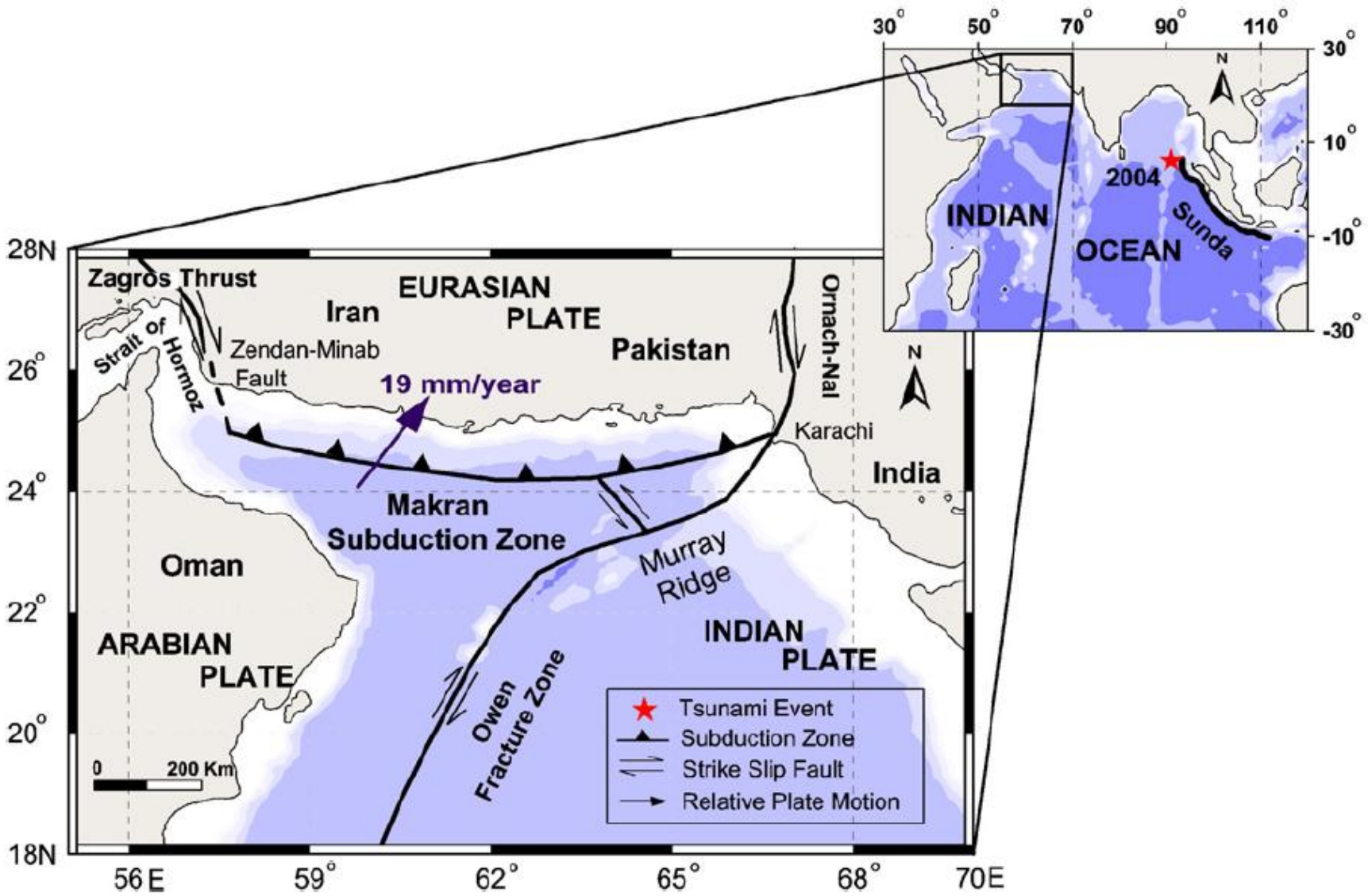


Chi-Chi, Taiwan
Earthquake, 1999

Satellite image before and after
Tsunami Aceh (Sumatra) 26 December 2004

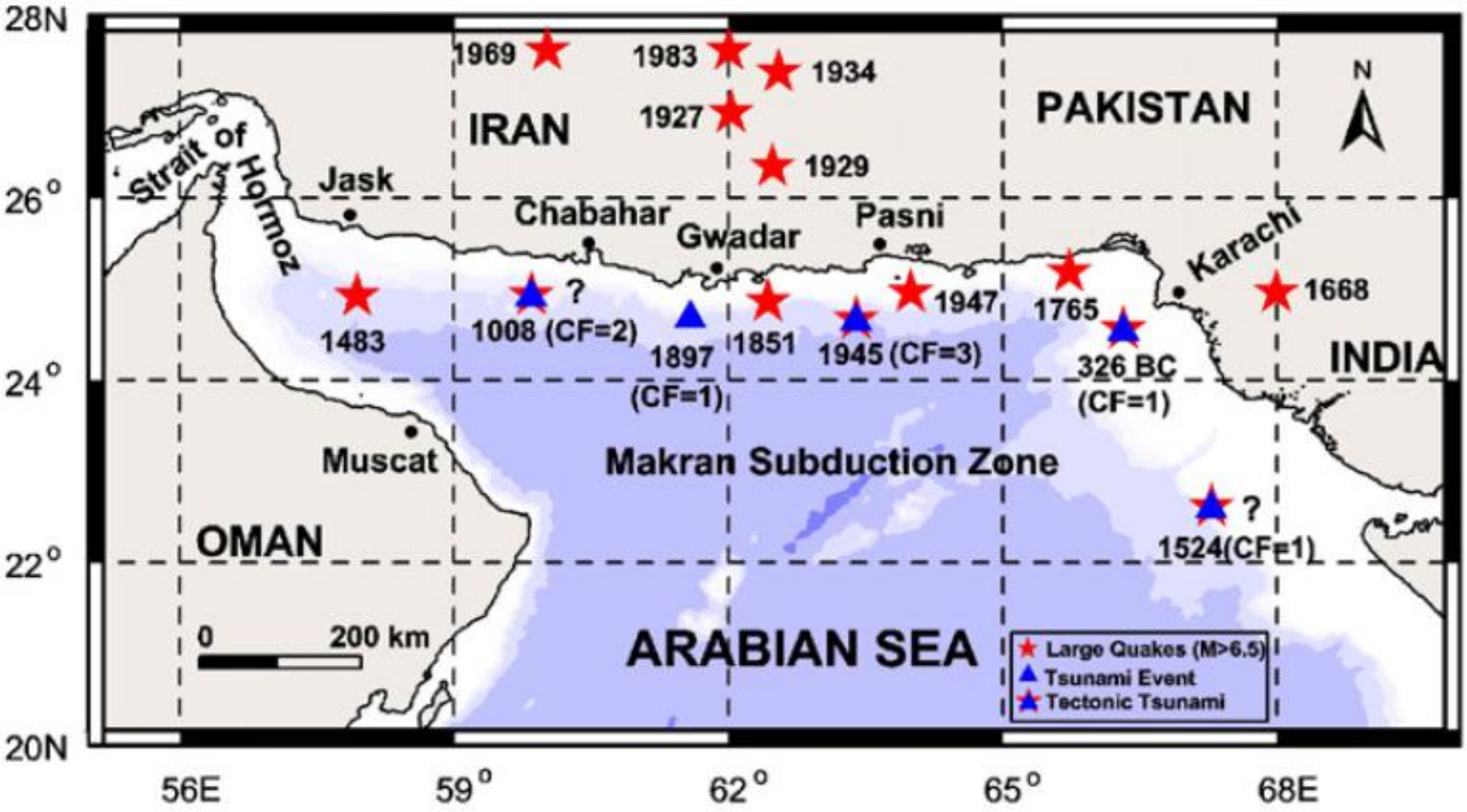
Tectonic of Makran subduction zone

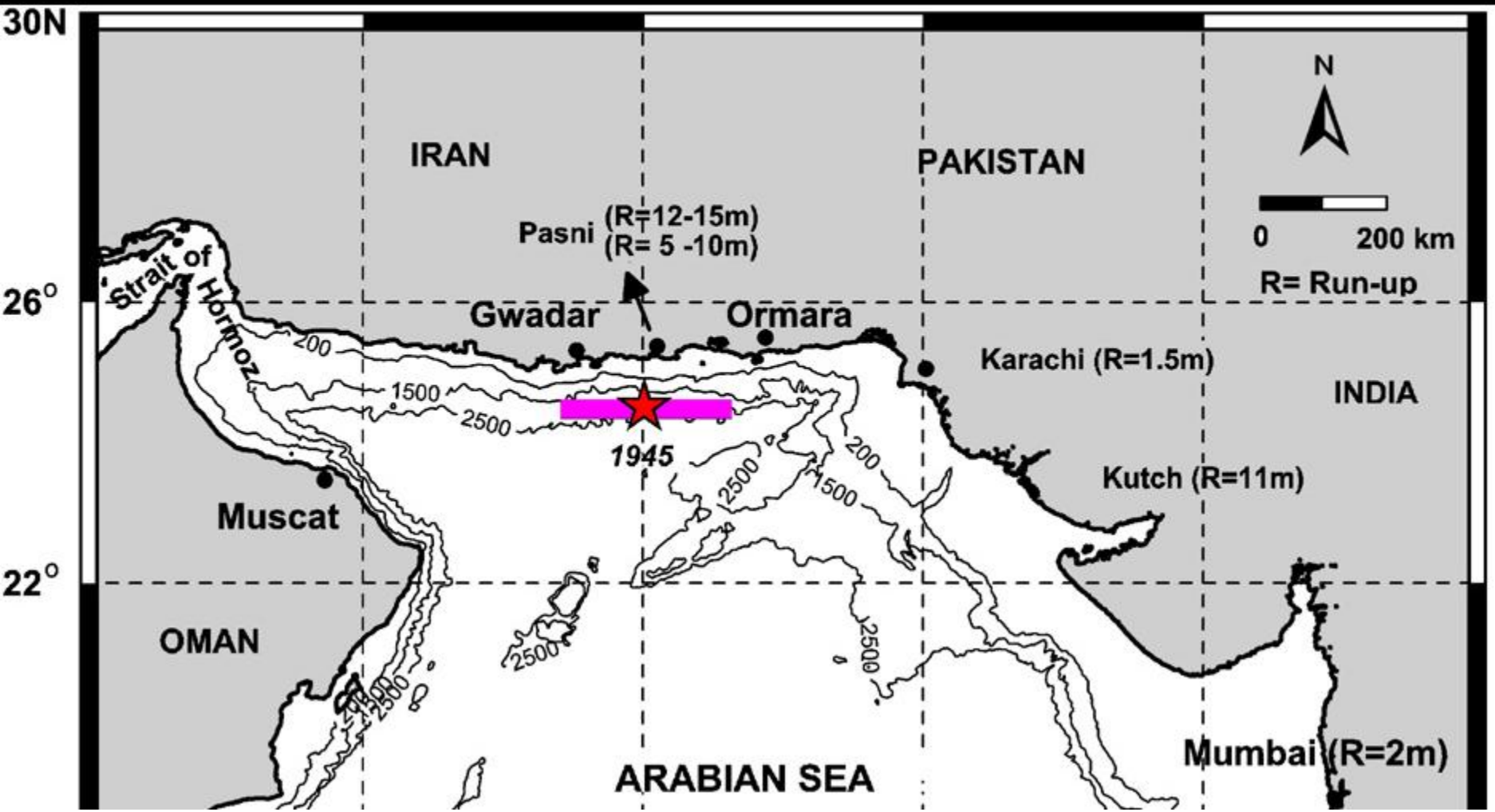
Ref: Mohammad Heidarzadeh et al 2008

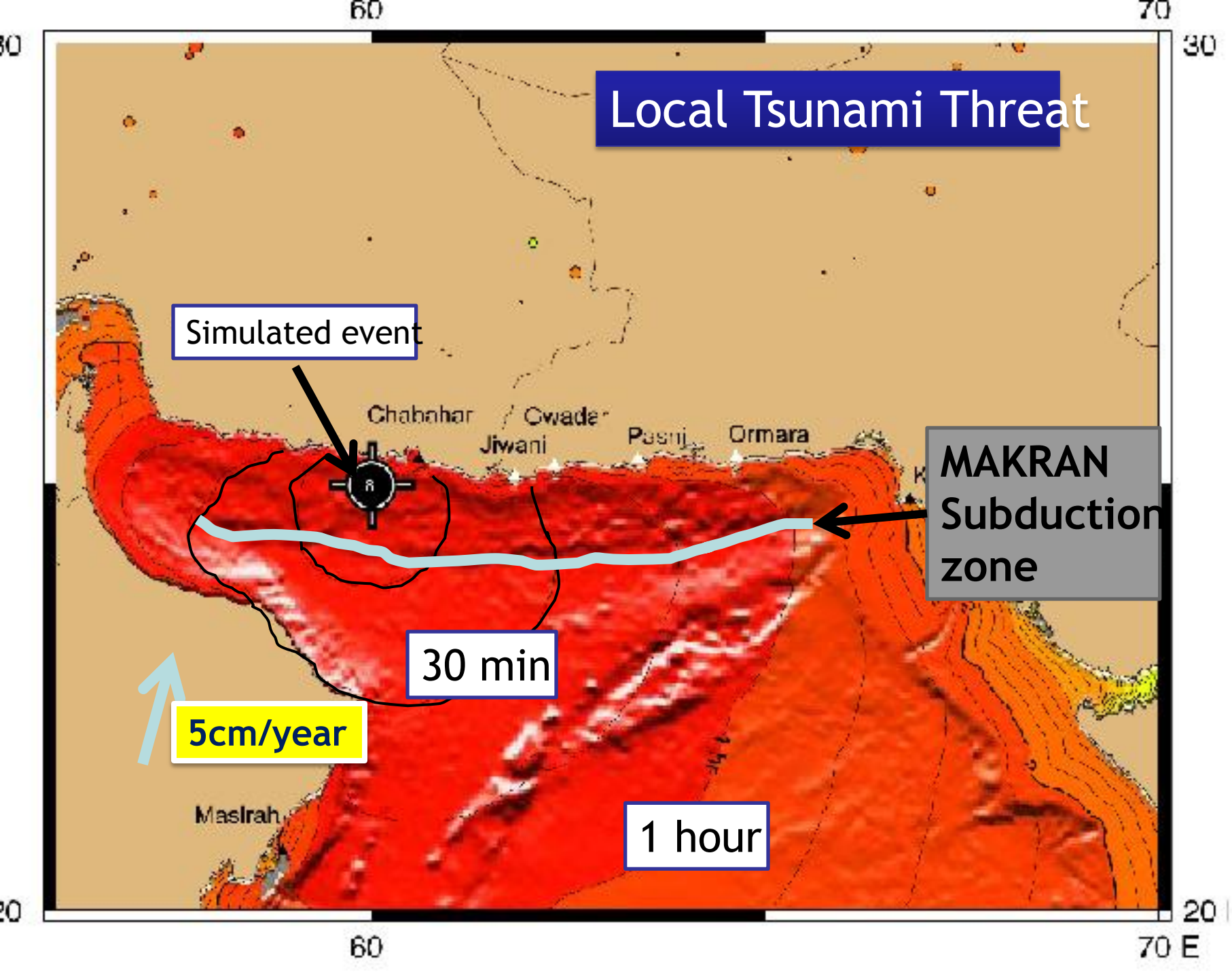


Historical earthquake

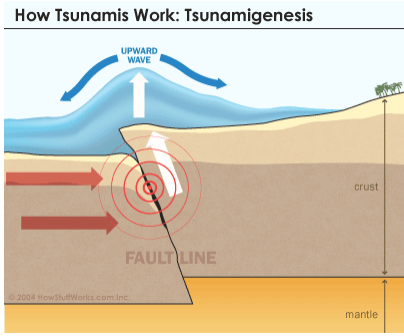
Ref: Mohammad Heidarzadeh et al 2008




30N
26°
22°
IRAN
PAKISTAN
INDIA
OMAN
ARABIAN SEA
N
0
200 km
R= Run-up
Pasni (R=12-15m)
(R= 5 -10m)
Gwadar
Ormara
Karachi (R=1.5m)
Kutch (R=11m)
Mumbai (R=2m)
Muscat
Strait of Hormoz
1945
200
1500
2500


Local Tsunami Threat
Simulated event
Chabahar
Gwadar
Jiwani
Pasni
Ormara
MAKRAN
Subduction
zone
30 min
5cm/year
Masirah
1 hour
60
70
30
20
60
70 E

Abrupt change, physics of the earth (<30mnt) after the large earthquake generated tsunami



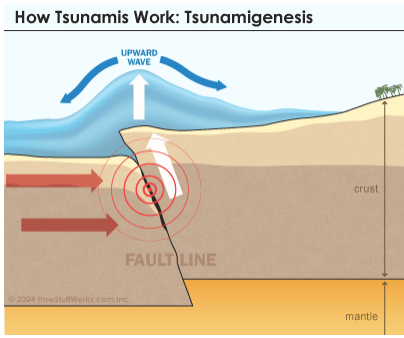
Near field

- Deformation of the ground
- Strong shaking (>1mnt)
- Change of water pressure at the bottom and surface
- Could be sea water receding at the beach
- Low sound of explosion or rumble from the sea
- Tsunami

Far field

- Seismic wave
- Could be sea water receding at the beach
- Tsunami propagation, change of water pressure at the bottom and surface
- Tsunami

Measurement or detection



Phenomena

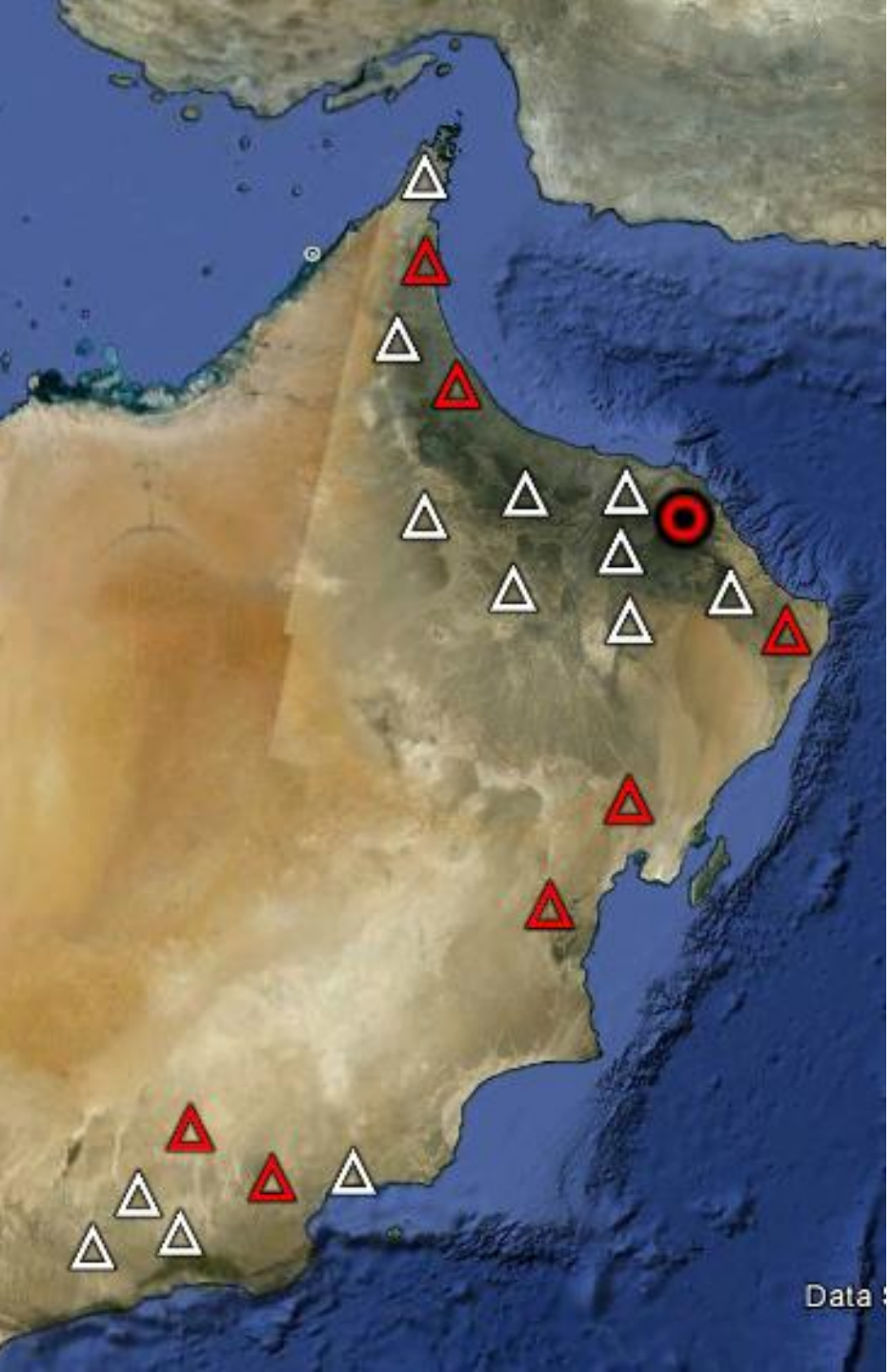
- **Deformation**
- **Strong shaking or seismic wave**
- Change of water pressure at the bottom and the surface
- Change of sea level at the beach
- Rumble sound

Sensors

- GPS (Global Positioning System)
- **Strongmotion seismograph**
- **Seismograph**
- DART-buoy, wave radar
- Tide Gauge
- Infrasound

Satellite as a tool in Tsunami Early Warning

Early stage (before tsunami arrives in the coast)	Post event (After tsunami arrives in the coast)
Observation →Information for decision • Sea level surface height • Earth deformation **Dissemination system** • Dissemination of early warning messages	**Observation → Emergency response** • Earth deformation **Dissemination system** • Dissemination of information



Network of seismic sensors

- Implementation starts in December 2012 for 10 months

21 Broadband stations

- 7 BB in Operational
- 10 Short period in operational, upgrade into BB and 3 data loggers
- 1 CTBTO stations

Start operation
in December 2012

Near real time data
are available in GTS
-1 minute sampling rate
- 5 minutes transmission

- 7 new stations
- 3 current stations

GPS network

- Implementation starts in December 2012 for 10 months

New stations

4 at Tide Gauge
6 at Meteo stations

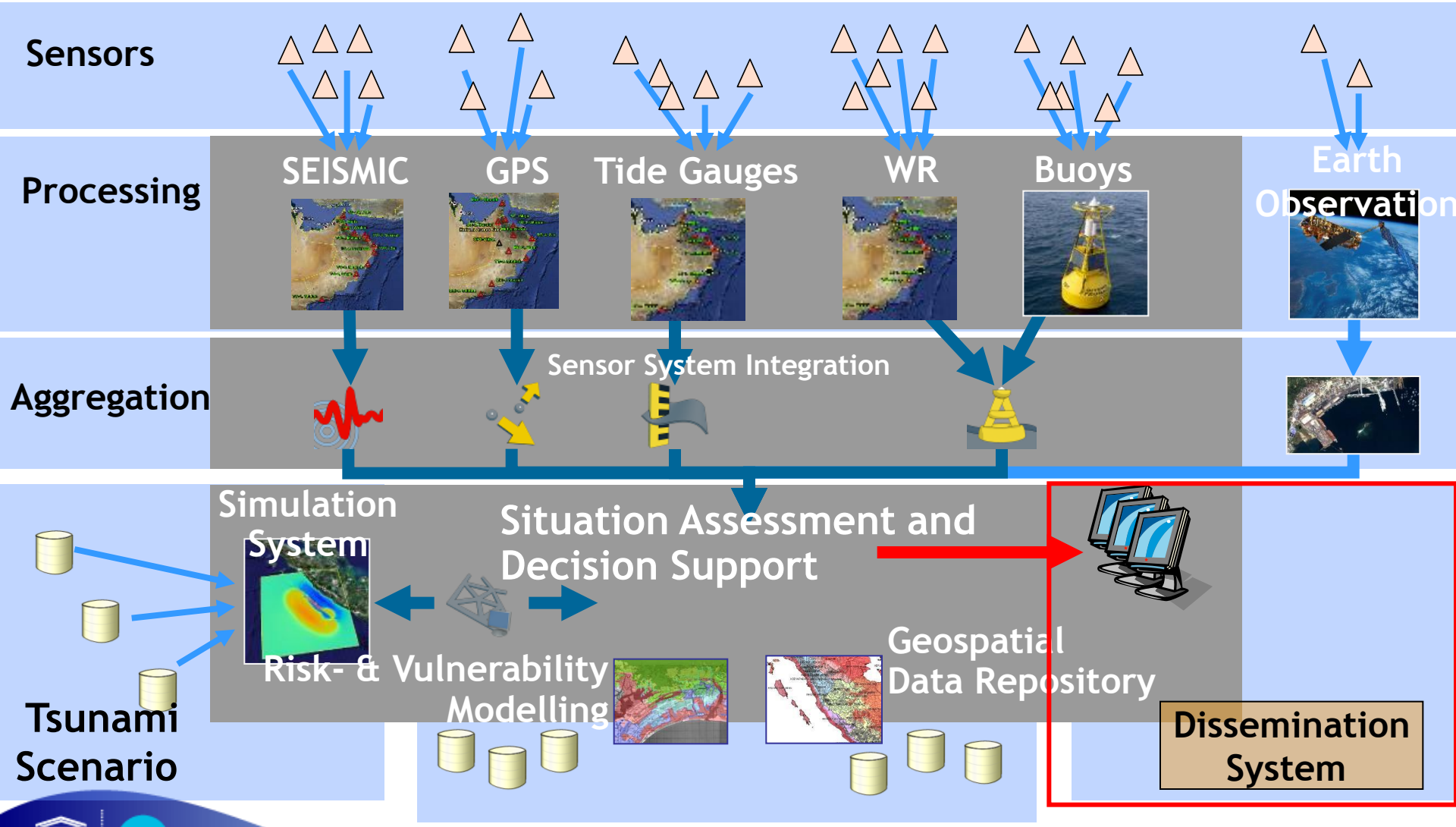
Current station

Wave Radar

5 Wave Radar stations

Co-located with sea level Stations.
the exact locations will be assessed to obtain
the best capability

Open Architecture of Tsunami Warning Center

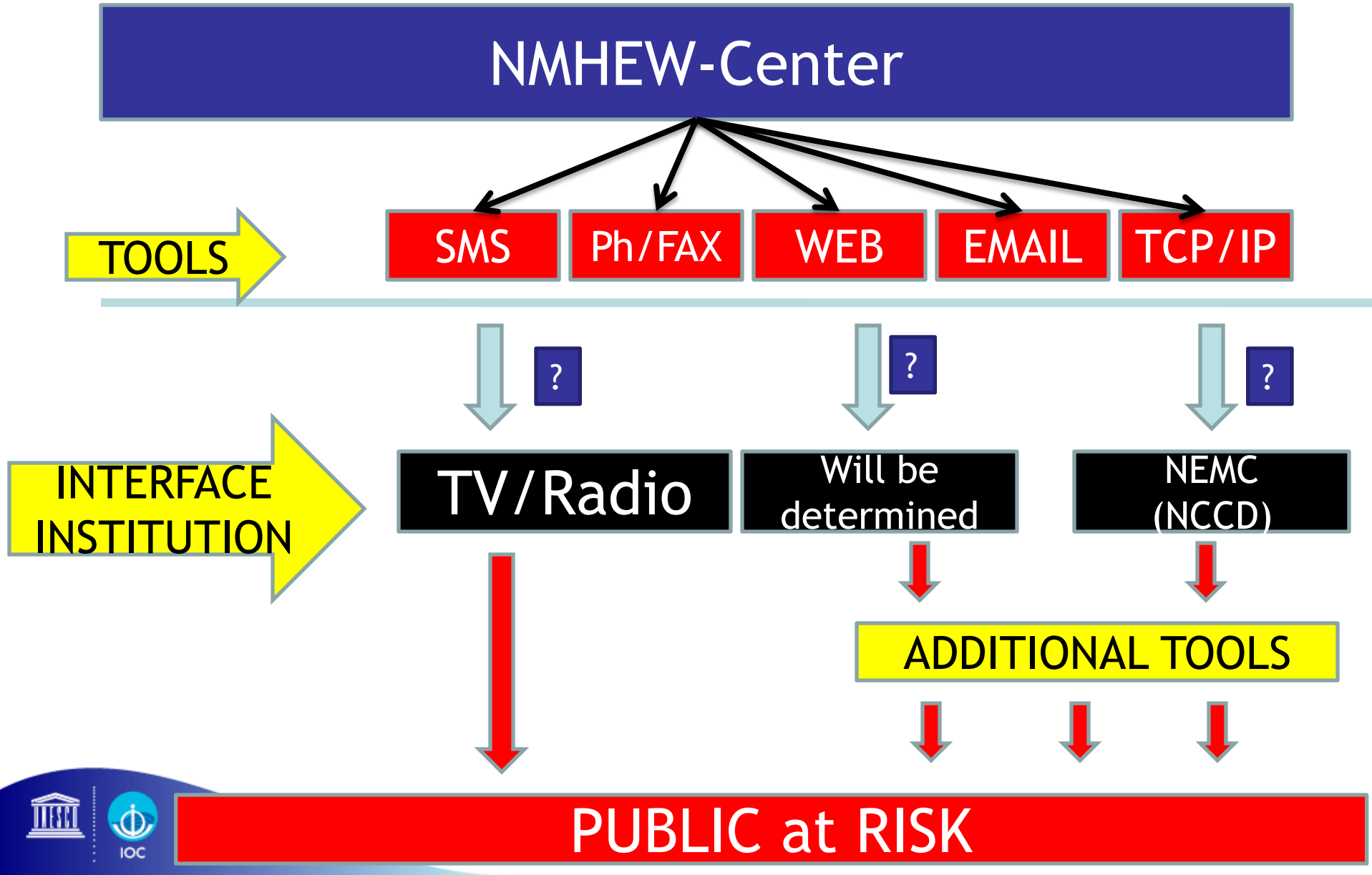


Time line of tsunami warning

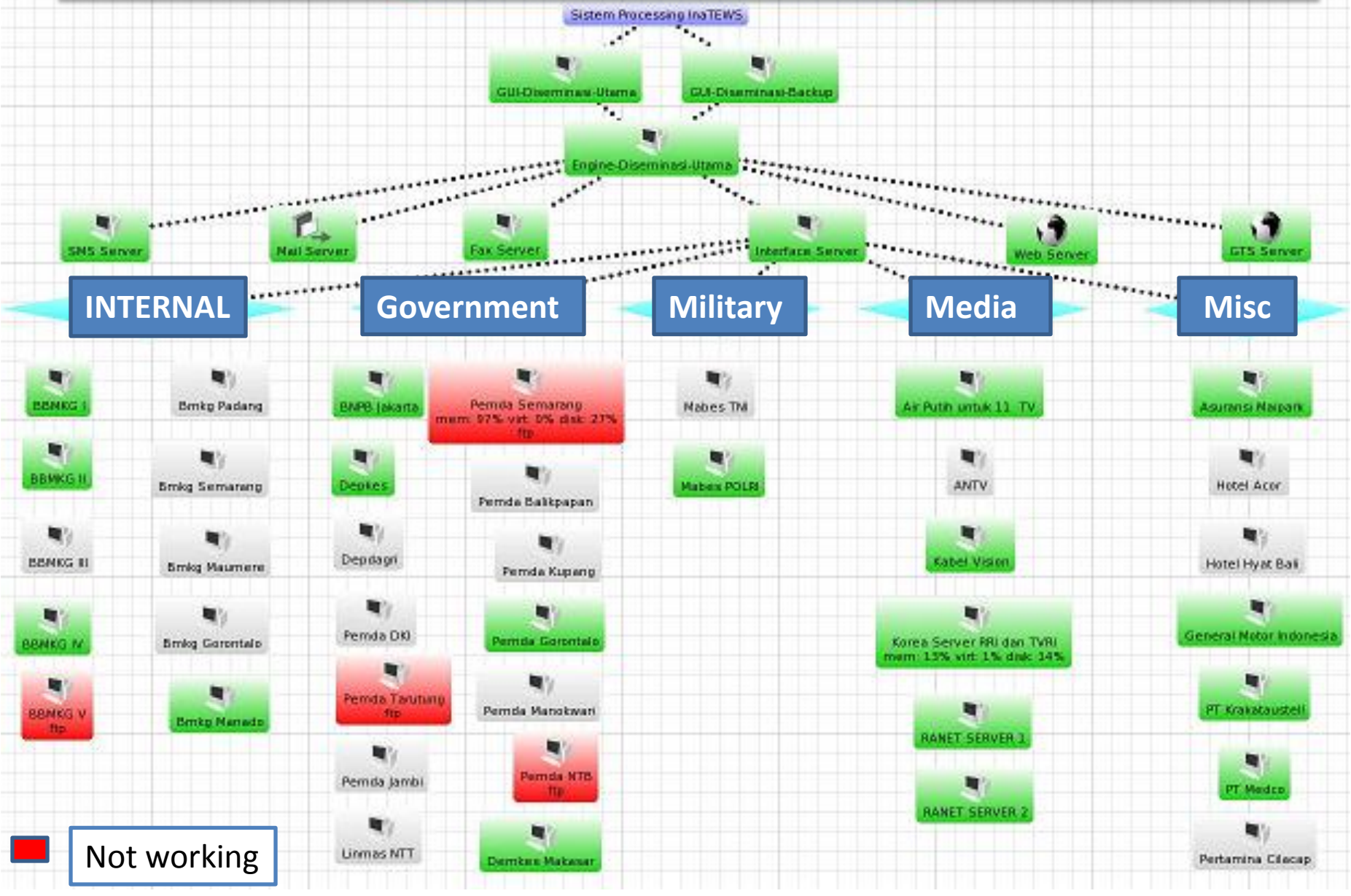
t0	Earthquake		
T1=5m	FIRST WARNING	Bulletin no 1	Seismic
T2=6m	ESTIMATION OF THE THREAT	Bulletin no 2	Tsunami scenario
T3=20m	FIRST OBSERVATION FIRST UPDATING	Bulletin no 3.1	Tide gauge Buoy GPS
t4	SECOND OBSERVATION SECOND UPDATING	Bulletin no 3.2	
t5	THIRD OBSERVATION	Bulletin no 3.3	
t6	END OF THREAT	Bulletin no 4	

WP4

WARNING CHAIN



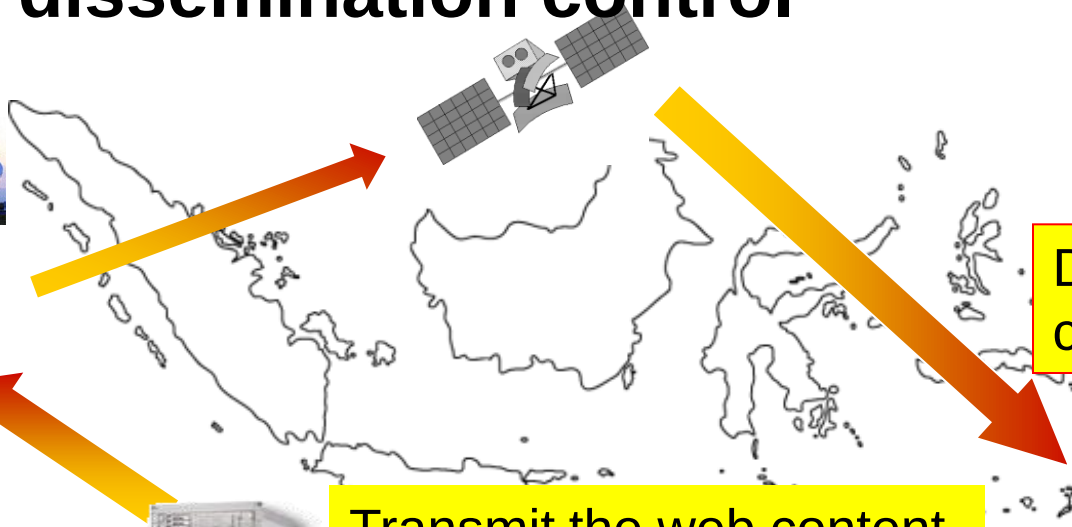
Network of dissemination monitoring (Indonesia TEWS)



Digital Video Broadcasting System (DVB) And dissemination control

EWS

Satellite provider



DVB components

Transmit the web content to remote area

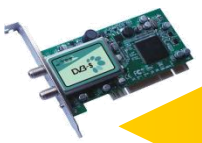
Automatic

Dissemination Server

Automatic

Web Server

DVB monitoring center



GSM modem

GSM modem

SMS

SMS Server

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Terima Kasih
Shukran
Thank you