Second United Nations International UN-SPIDER
Bonn Workshop: “Disaster Management and
Space Technology - Bridging the Gap”
Bonn, October 13 – 15, 2008

LIPI

Rapid- and slow-onset disaster management strategies and space based information: *special reference to end-to-end tsunami warning and mitigaton system*

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Deputy Chairman for Scientific Services
Indonesian Institute of Sciences (LIPI)
Chairman ICG/IOTWS – IOC-UNESCO

Talk Outline

1. Introduction
   - Nature of natural disasters
2. Rapid- and slow-onset and human induced ecological (response) disasters
3. Development of tsunami warning and mitigation system in Indonesia
4. The way forward
   - Needs and gaps
   - Strategies: towards a sustainable disaster resilient community
5. Closing

Simplisistic typology and character of natural disasters

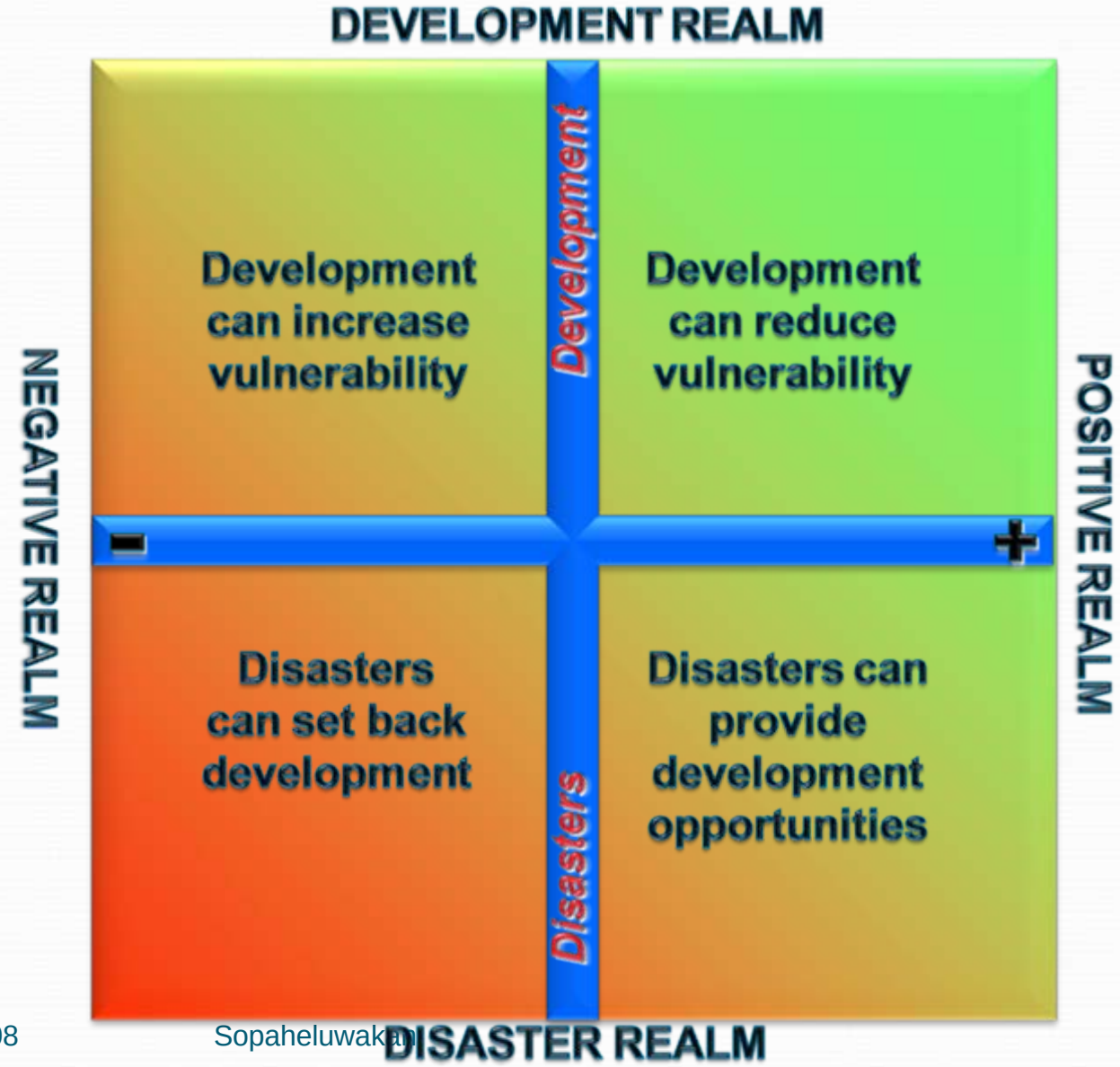
- **Natural processes:**
  - **Instantaneous:** earthquake, tsunami
  - **Gradual:** global warming, abrasion, landslide, drought
  - **Periodic:** earthquake, volcanic eruption, flood, drought, forest fire
  - **Irregular:** earthquake, tsunami
- **Man – nature interaction:**
  - Global warming, landslide, coastal and river abrasion, flood, drought

Origin

Periodicity

	Single	Multiple
Periodic	Volcanic eruption, earthquake, landslide	Landslide, flood, drought, forest fire
Irregular (time, place)	Earthquake	Landslide, tsunami, drought, forest fire, global warming, abrasion

Disaster and Development

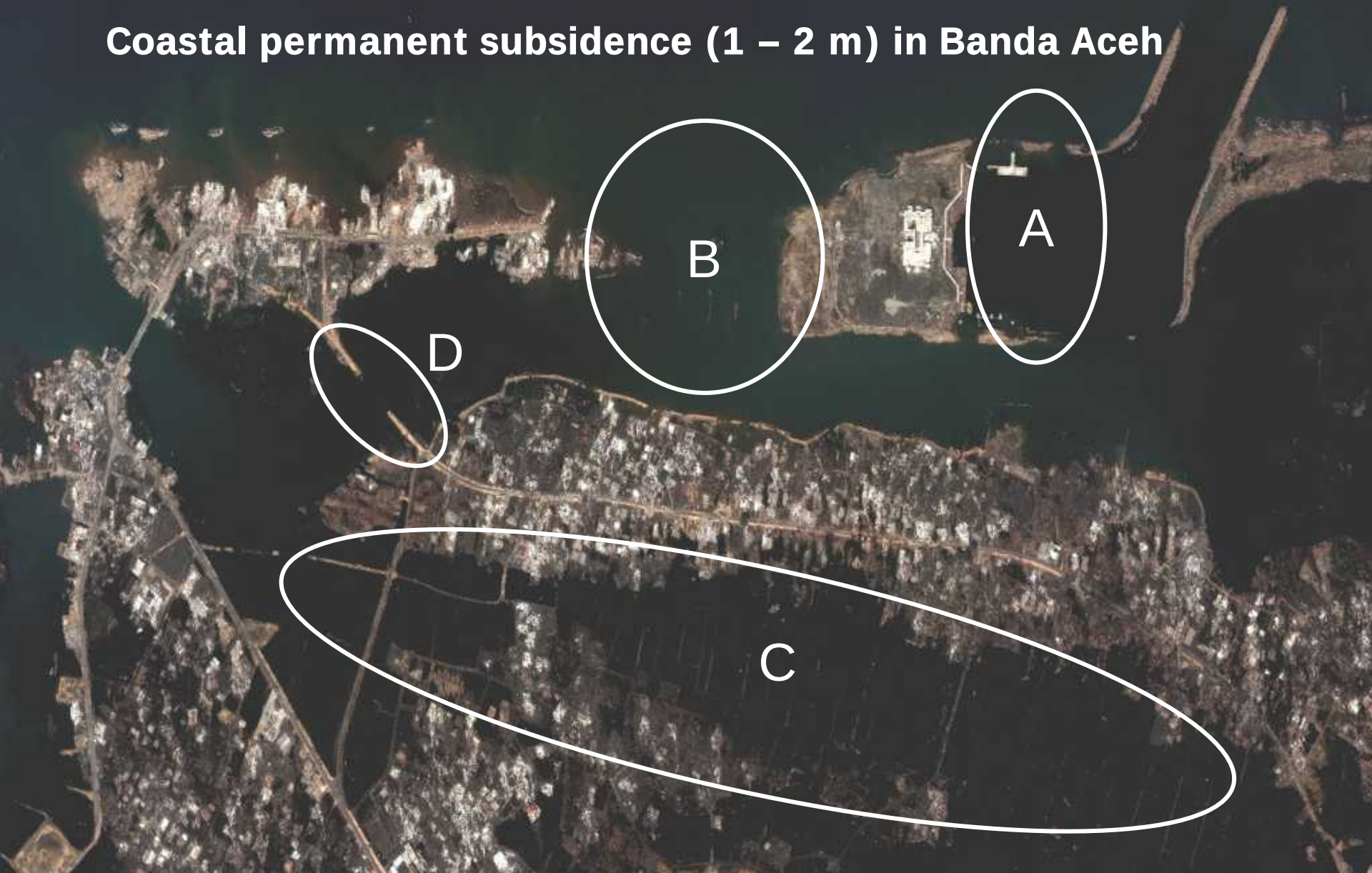


TSUNAMI EFFECT IN BANDA ACEH
250 KM NORTH EAST OF EPICENTER

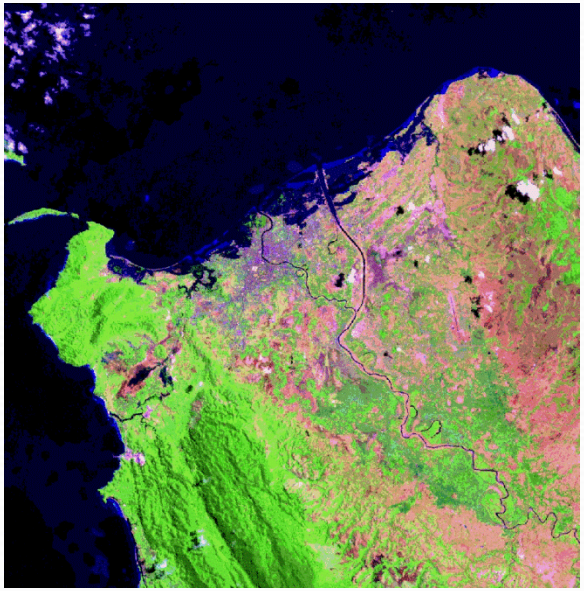
Satellite Image of BANDA ACEH
(courtesy Digital Globe)

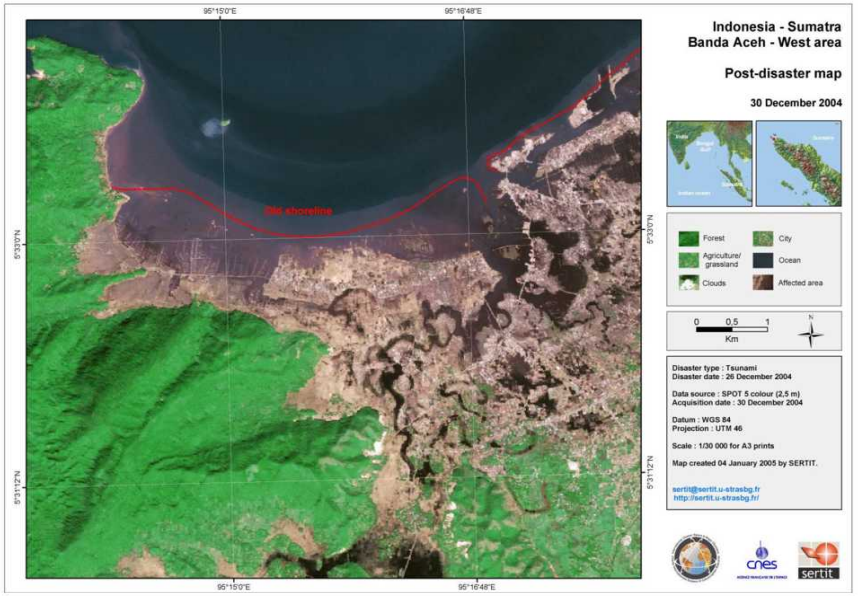
SHORELINE AFTER TSUNAMI

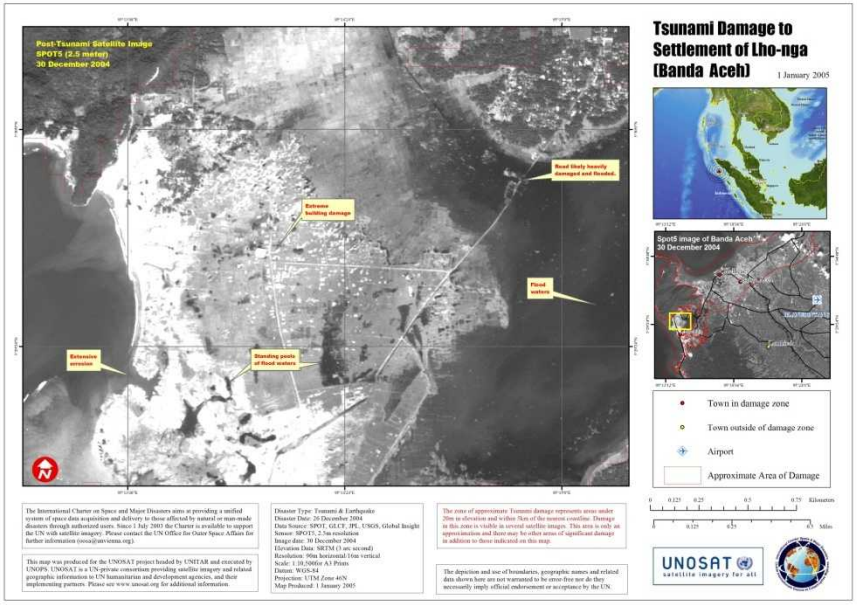
Coastal permanent subsidence (1 – 2 m) in Banda Aceh



Tsunami in Aceh (24 Dec 2004)



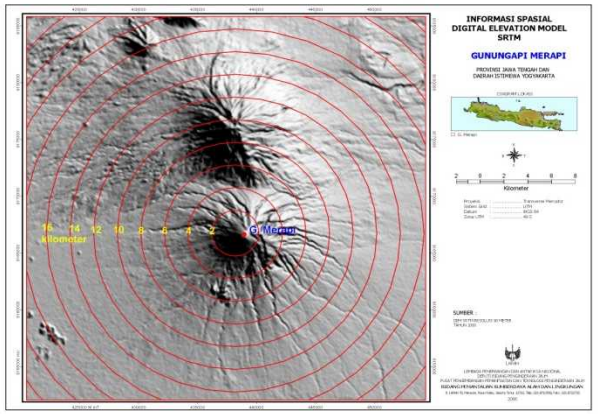




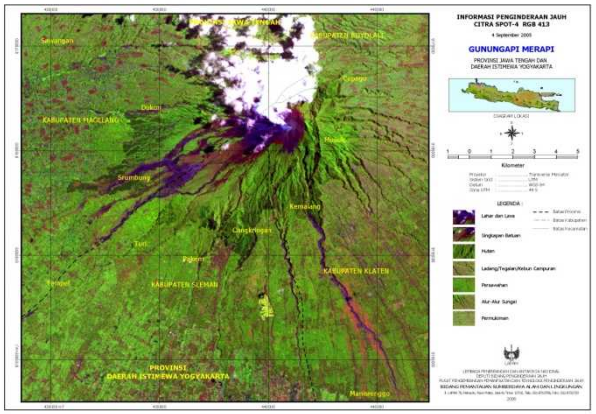
Merapi Volcano Activity

(April – August 2006)

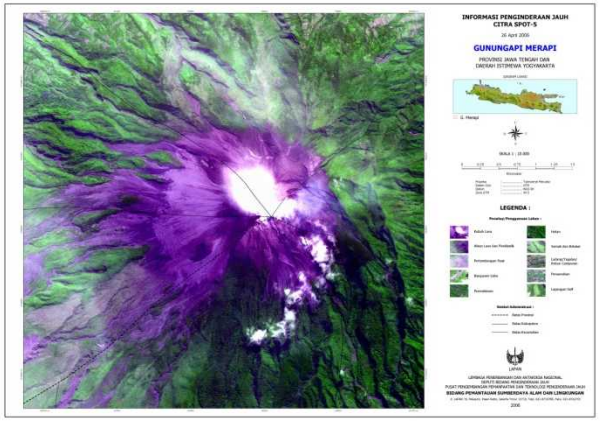
SRTM – 90m



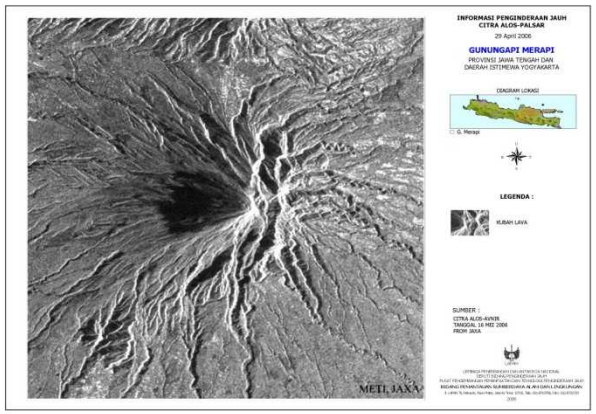
SPOT 4 – 10m



SPOT 5 – 2.5m

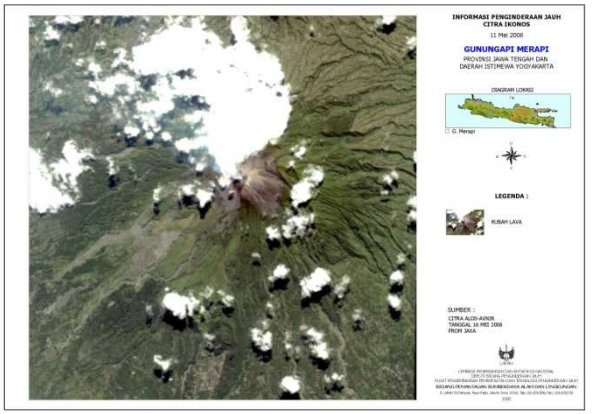


PALSAR/ALOS – 50m



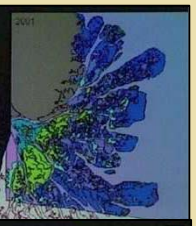
PALSAR/AVNIR – 10m

IKONOS – 1m



Coastal (multi) Disasters

(Rapid) coastal environmental changes




Coastal disasters

Balancing processes

(eutrophication, red tide)

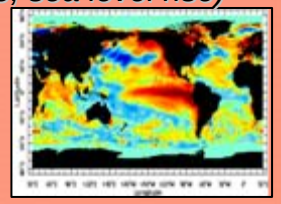

+ human-induced disasters

Rapid onset

(tsunami, storm surge)

Slow onset

(climate change, sea level rise)

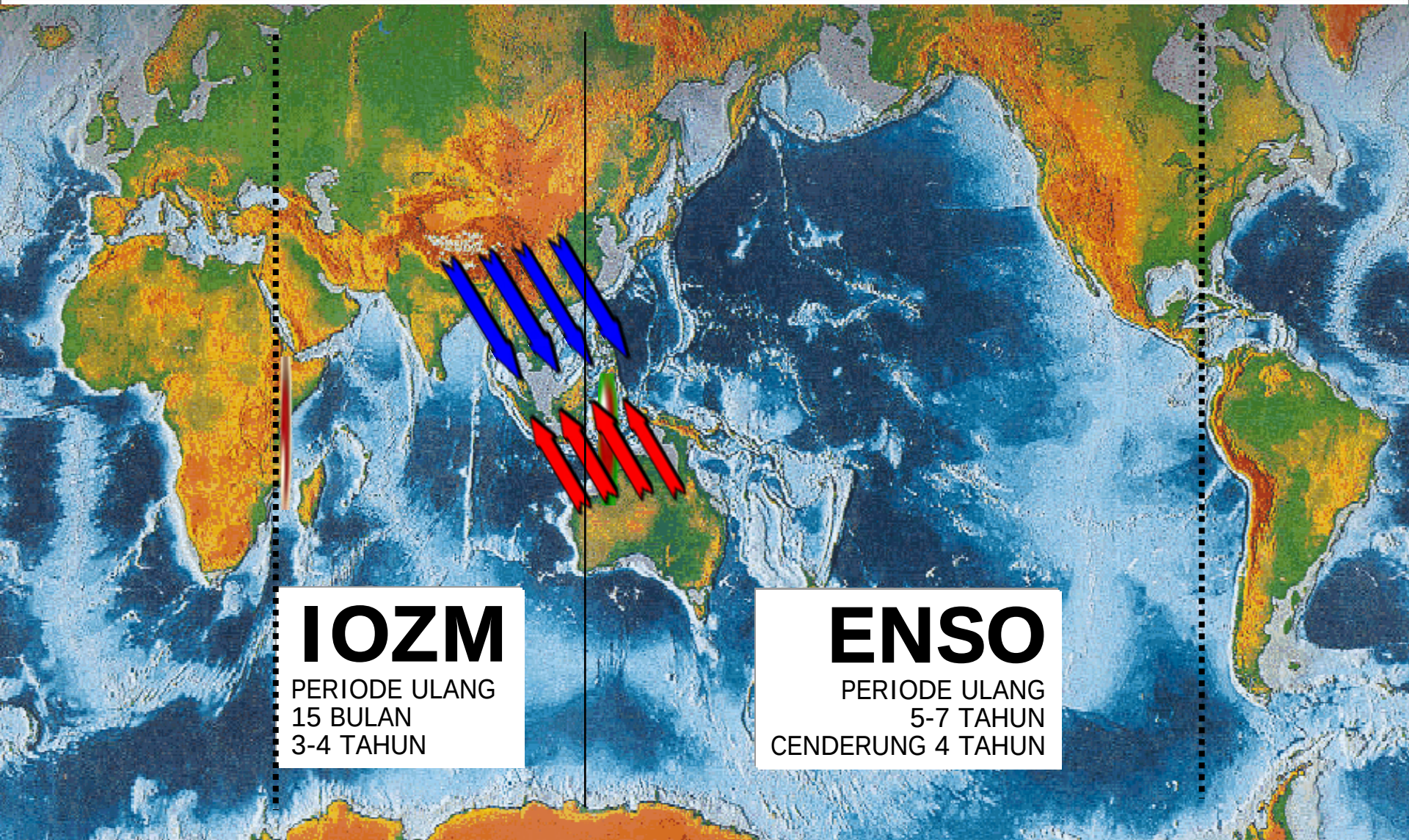


GLOBAL WARMING

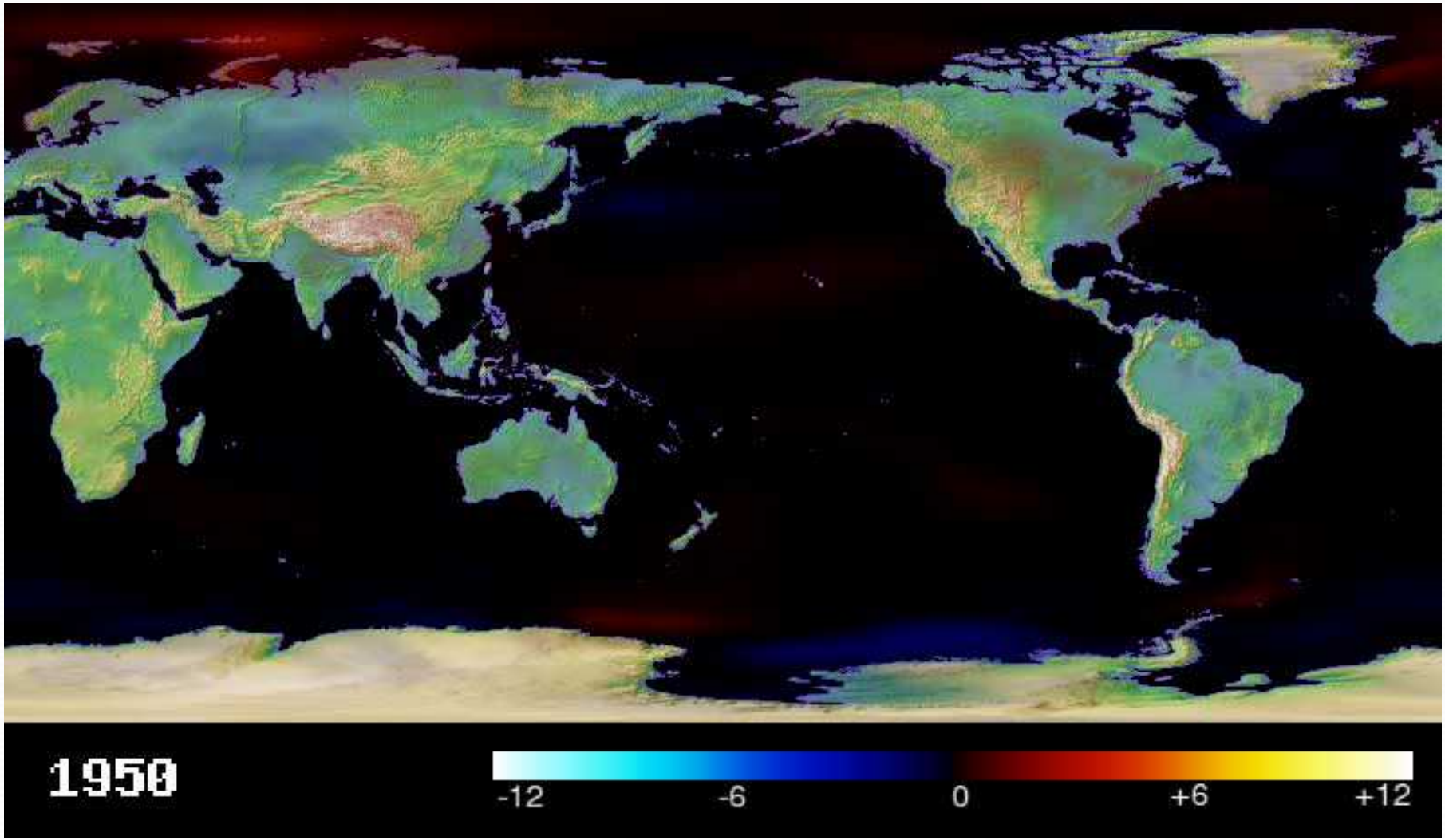
and the climate change

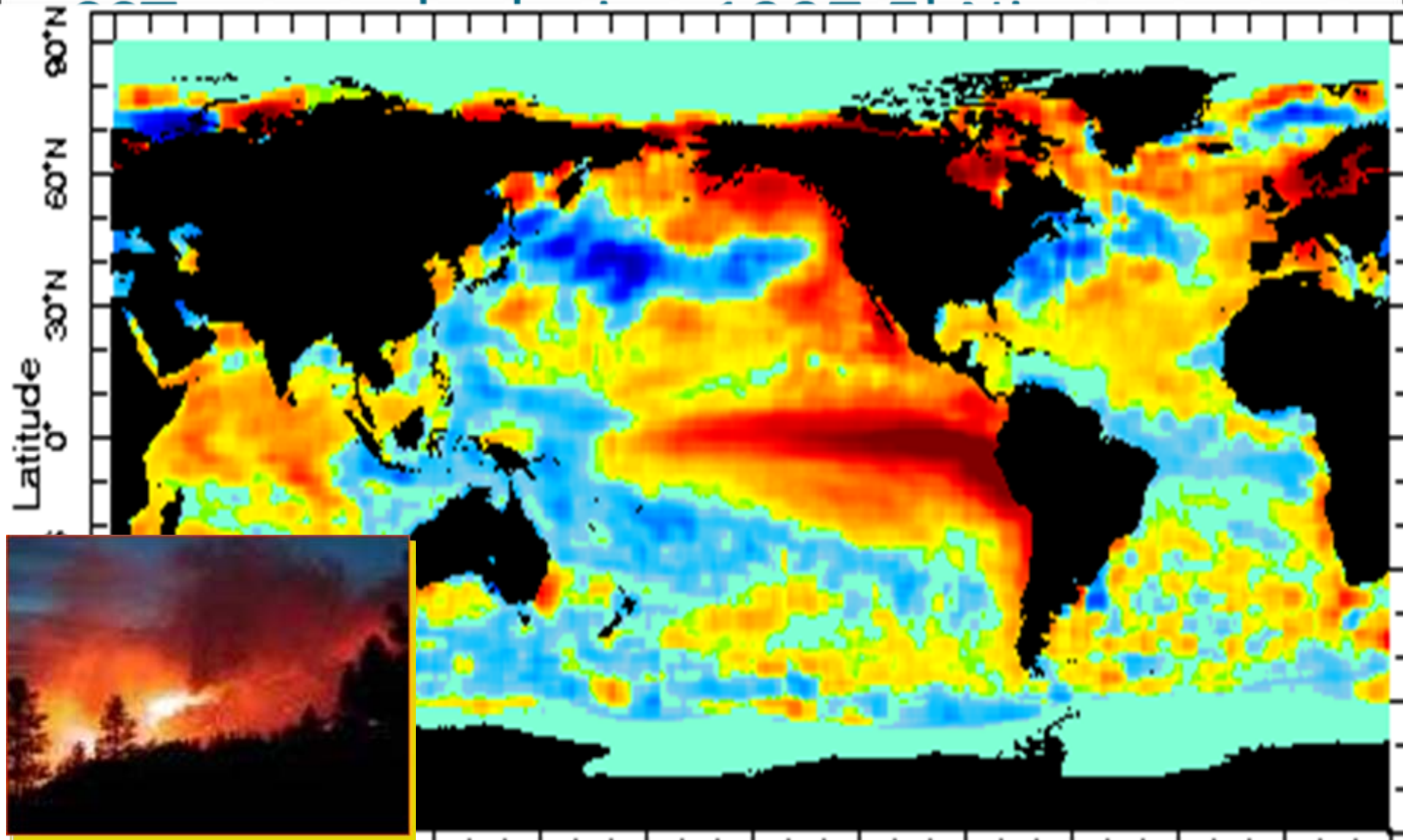
CAN CIVILIZATION SURVIVE?

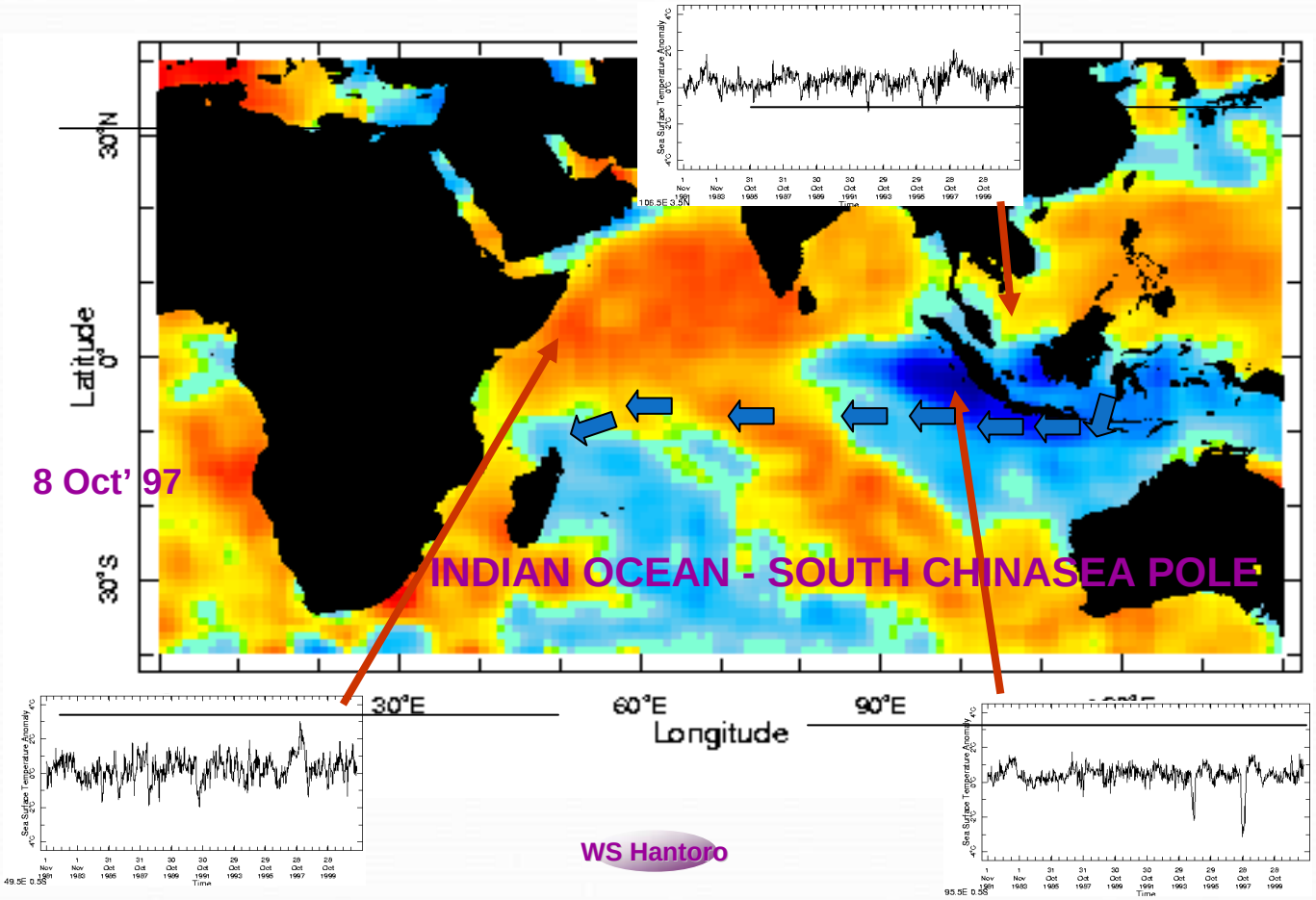
World's climate engines in the Indonesian Region



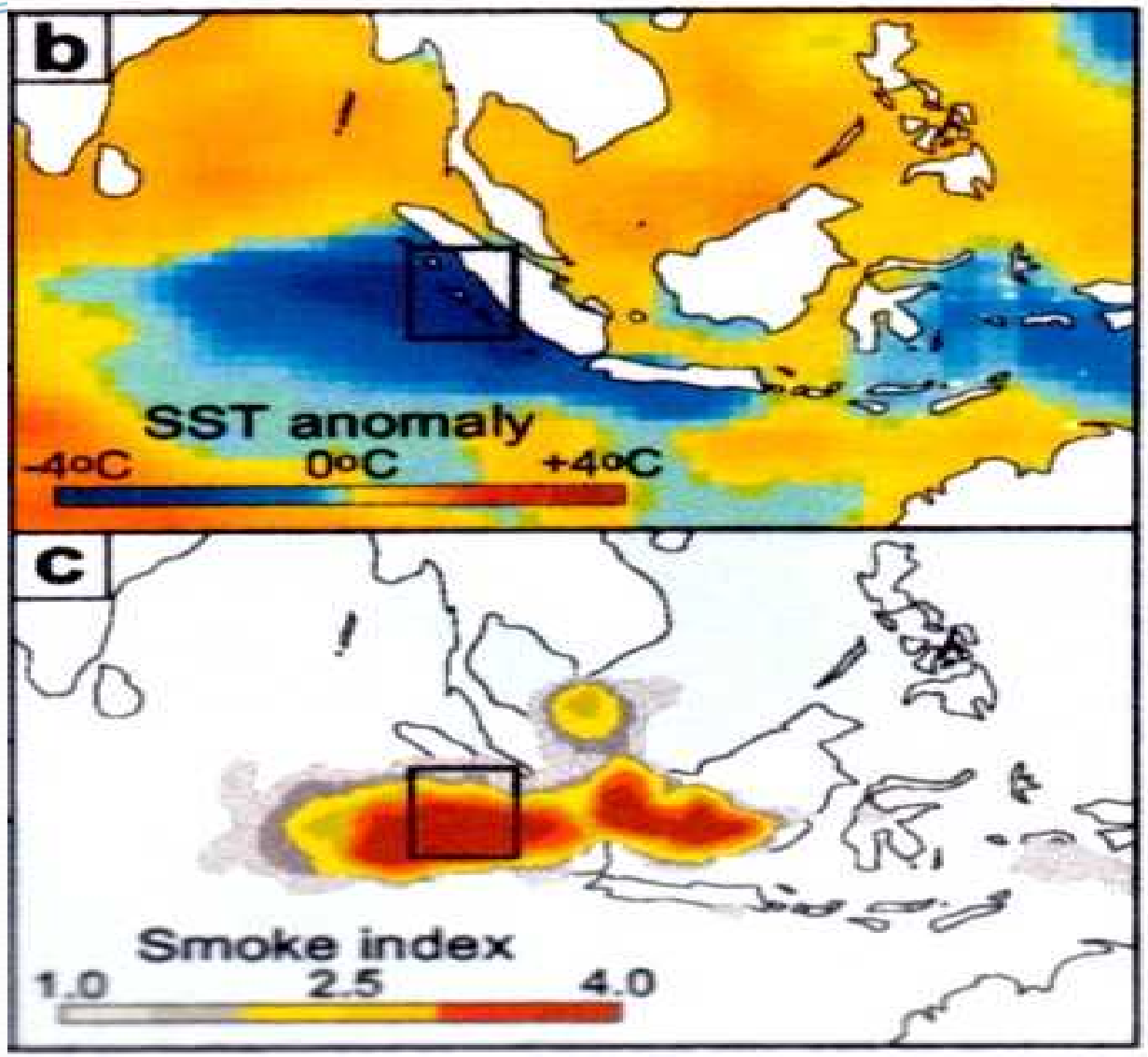
Animated Global Climate Change 1950 -




90°N
60°N
30°N
0°
Latitude



Gambar 4 Kondisi perairan Samudra Hindia saat terjadi coupling antara Indian Ocean Dipole dengan El Nino 19

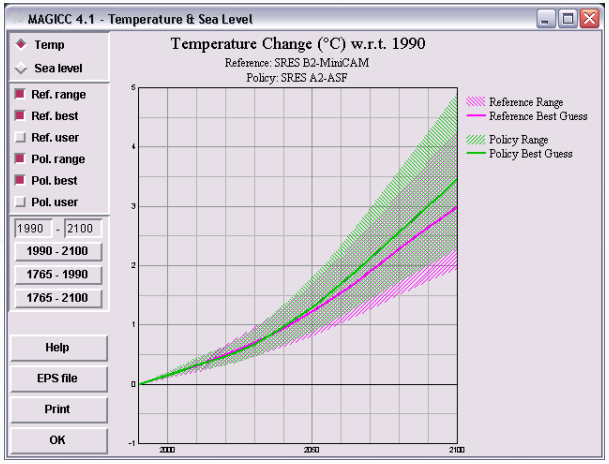


Gambar 8. Peta anomali suhu muka laut dan sebaran asap dan jelaga kebakaran pada tahun 1997

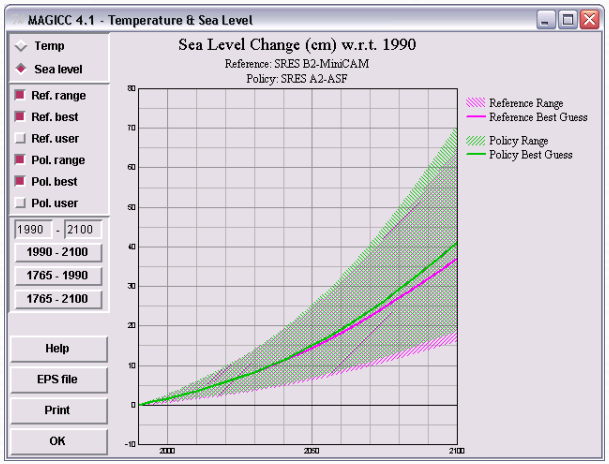
Impact of global warming on sea level

Possible average sea level rise (low – high emission GHG scenarios, 2080)

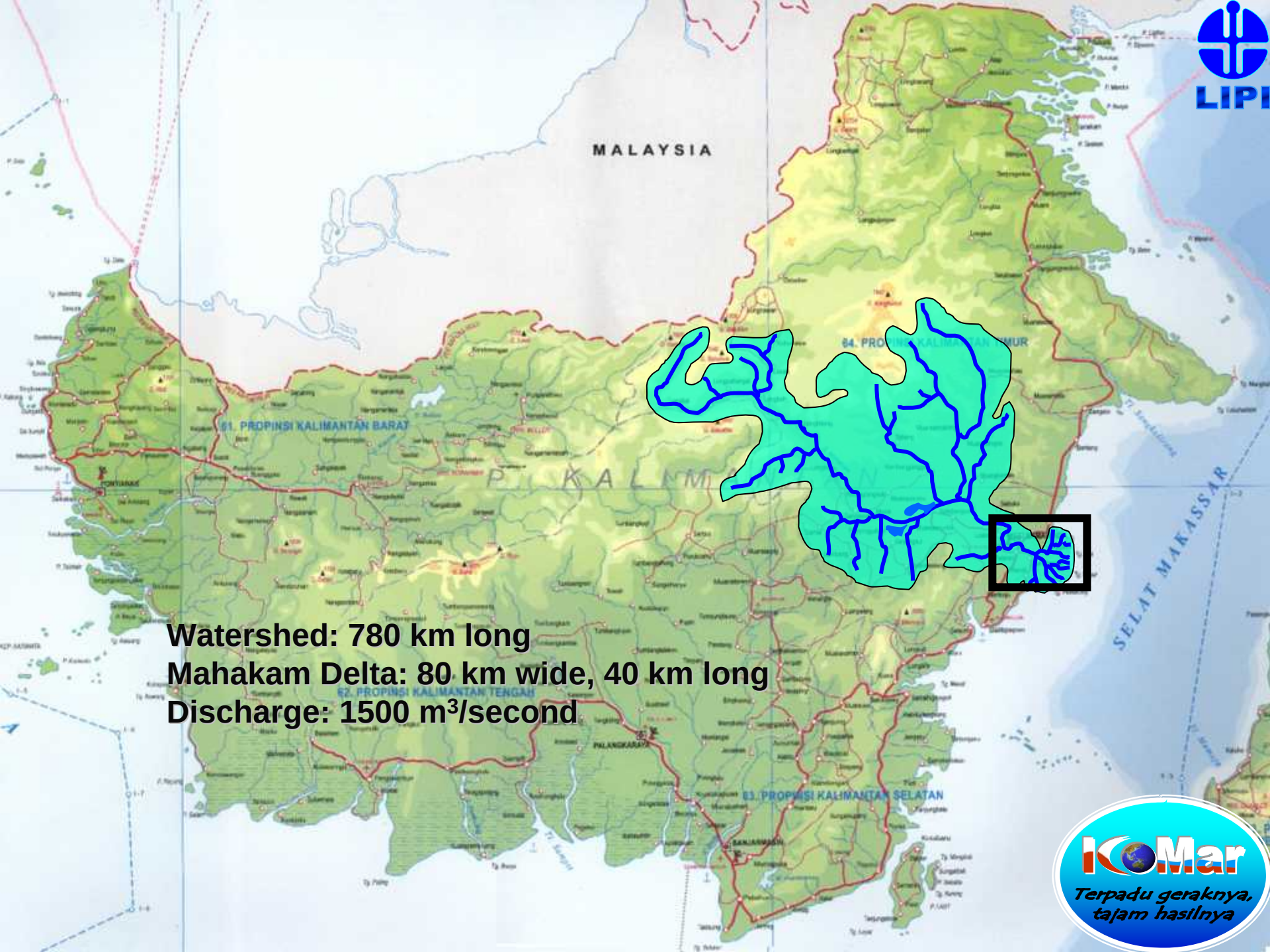
Global temperature

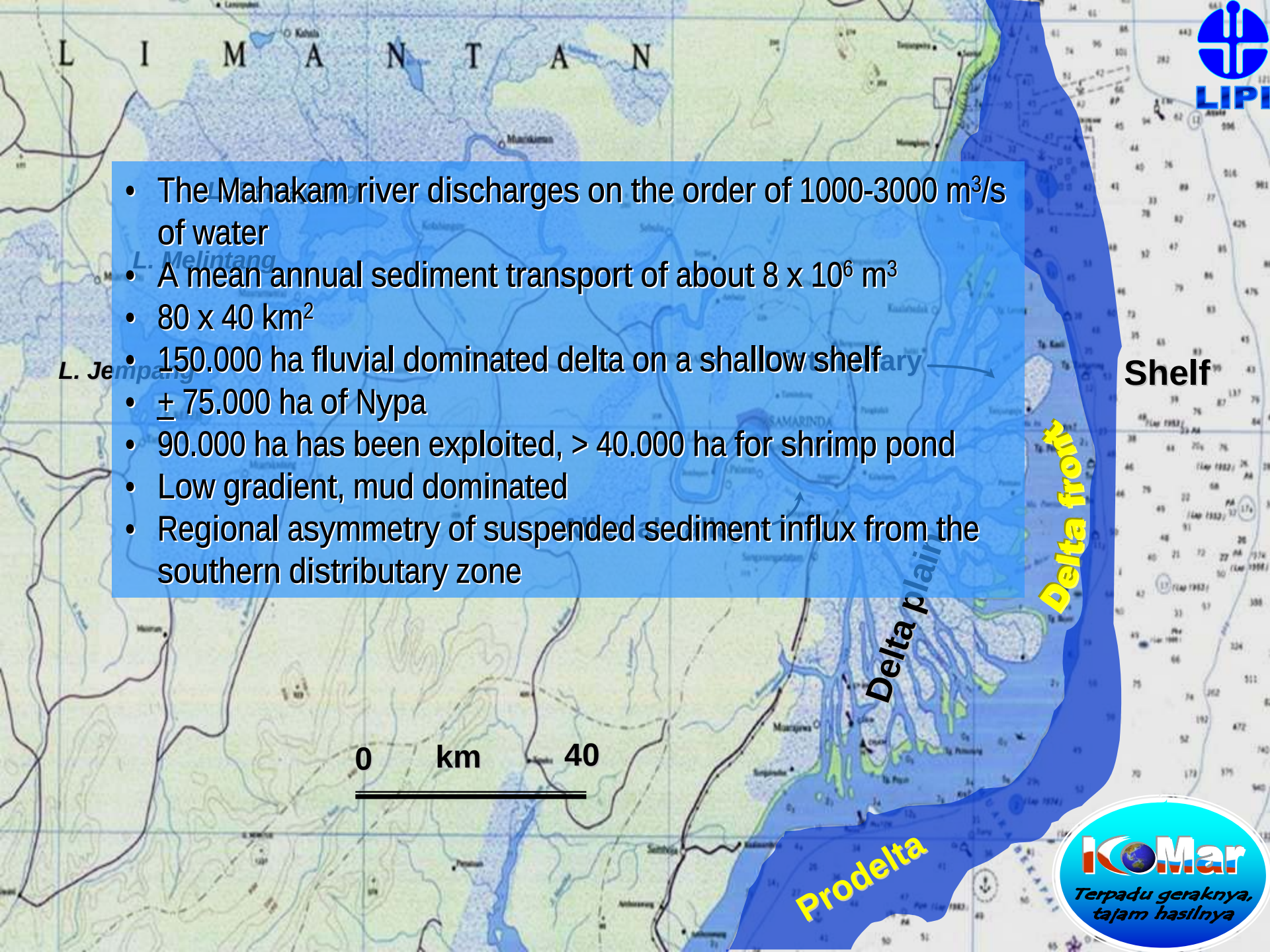


Average Sea level rise



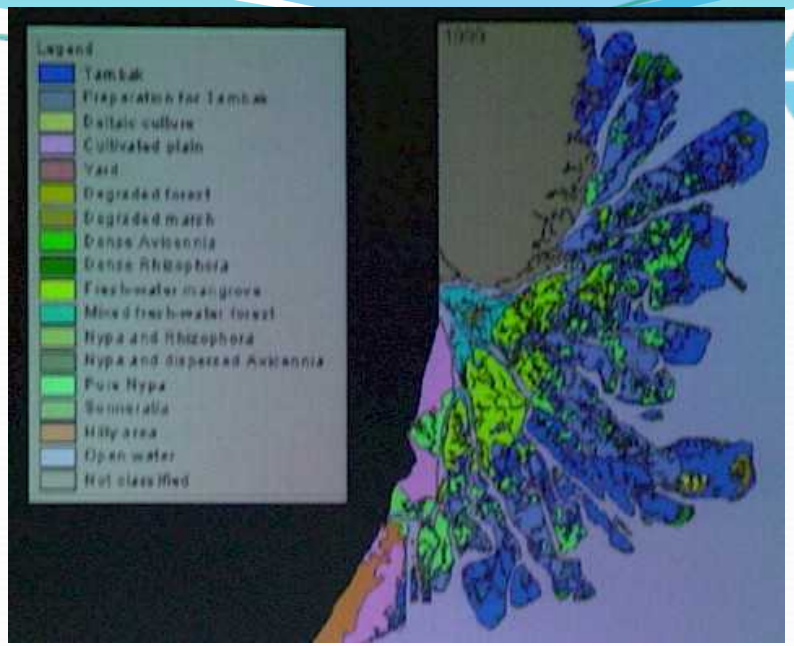
Estimated Lost of land	of total land area of the above map
Maximum	**5.71 %**
Best guess	**0.75 %**


MALAYSIA
61. PROPINSI KALIMANTAN BARAT
62. PROPINSI KALIMANTAN TENGAH
63. PROPINSI KALIMANTAN SELATAN
64. PROPINSI KALIMANTAN TIMUR
P. KALIMANTAN
SELAT MAKASSAR
PONTIANAK
PALANGKARAYA
BANJARMASIN
Watershed: 780 km long
Mahakam Delta: 80 km wide, 40 km long
Discharge: 1500 m³/second
LIPI
IOMar
Terpadu geraknya, tajam hasilnya

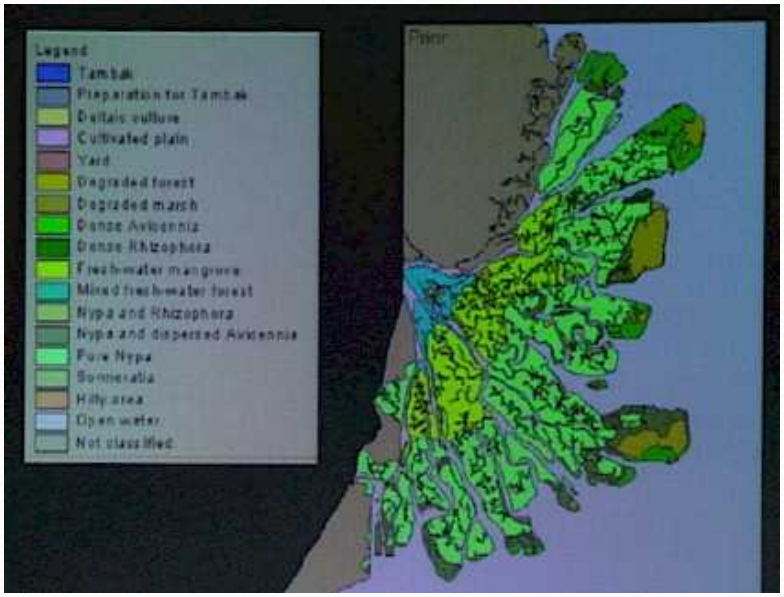


- The Mahakam river discharges on the order of 1000-3000 m^3/s of water
- A mean annual sediment transport of about 8×10^6 m^3
- 80 x 40 km^2
- 150.000 ha fluvial dominated delta on a shallow shelf
- ± 75.000 ha of Nypa
- 90.000 ha has been exploited, > 40.000 ha for shrimp pond
- Low gradient, mud dominated
- Regional asymmetry of suspended sediment influx from the southern distributary zone

Blast (1999)

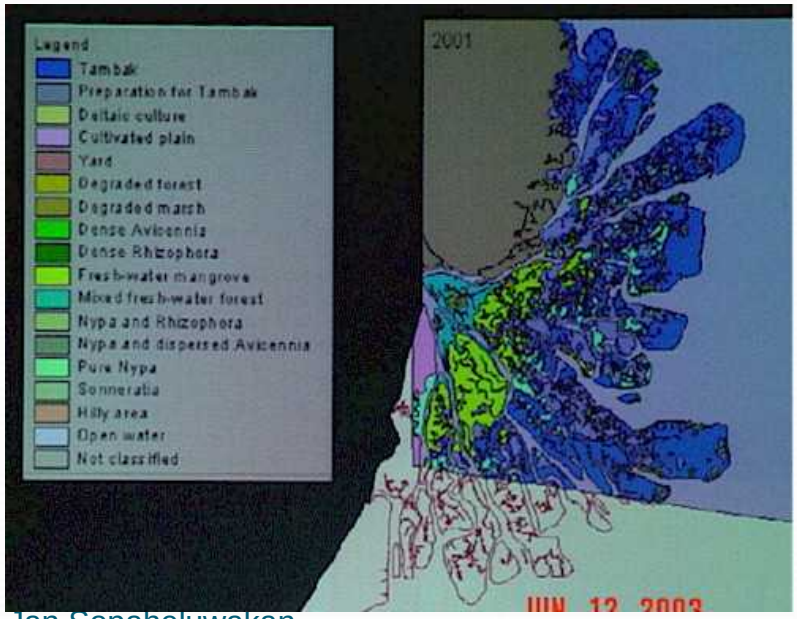


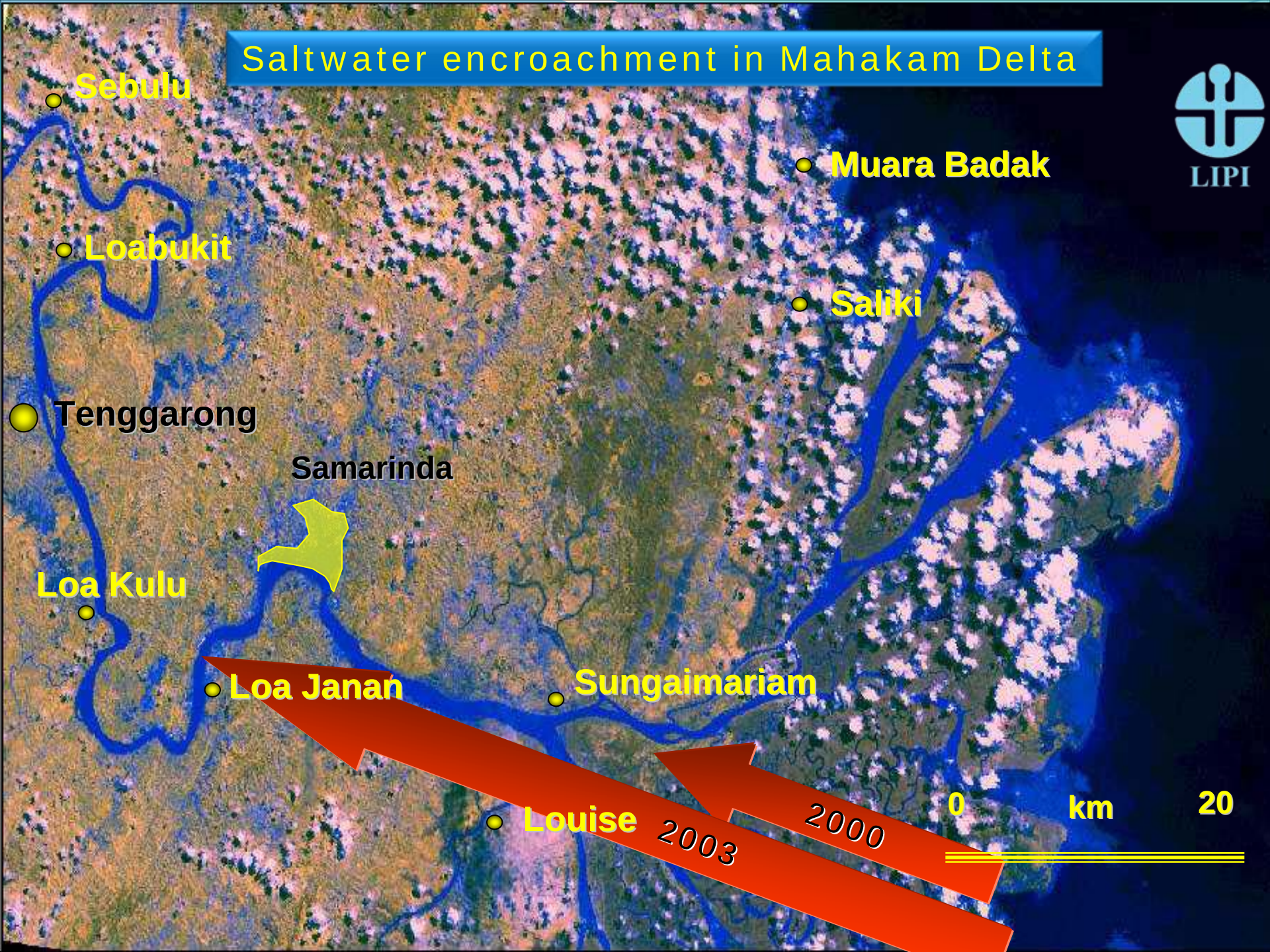
Prior (1986)



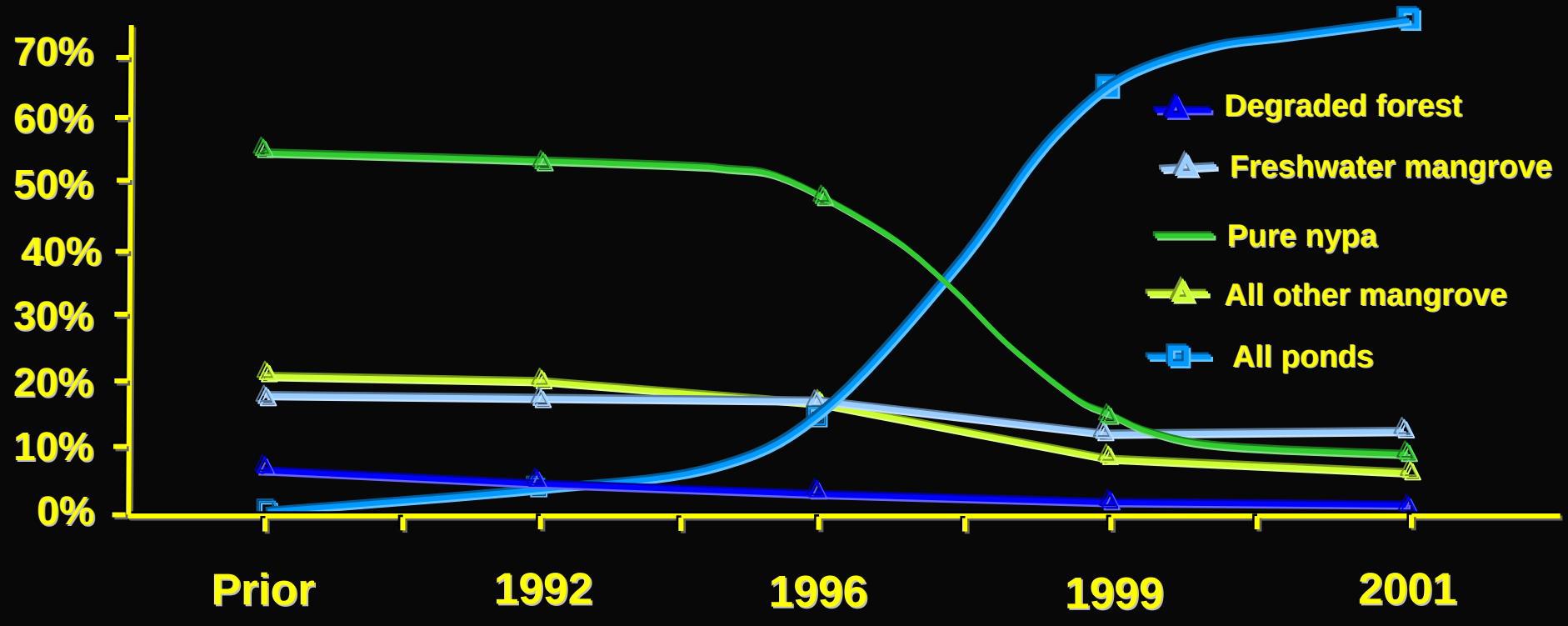
CIRAD, 2003

Peak (2001)



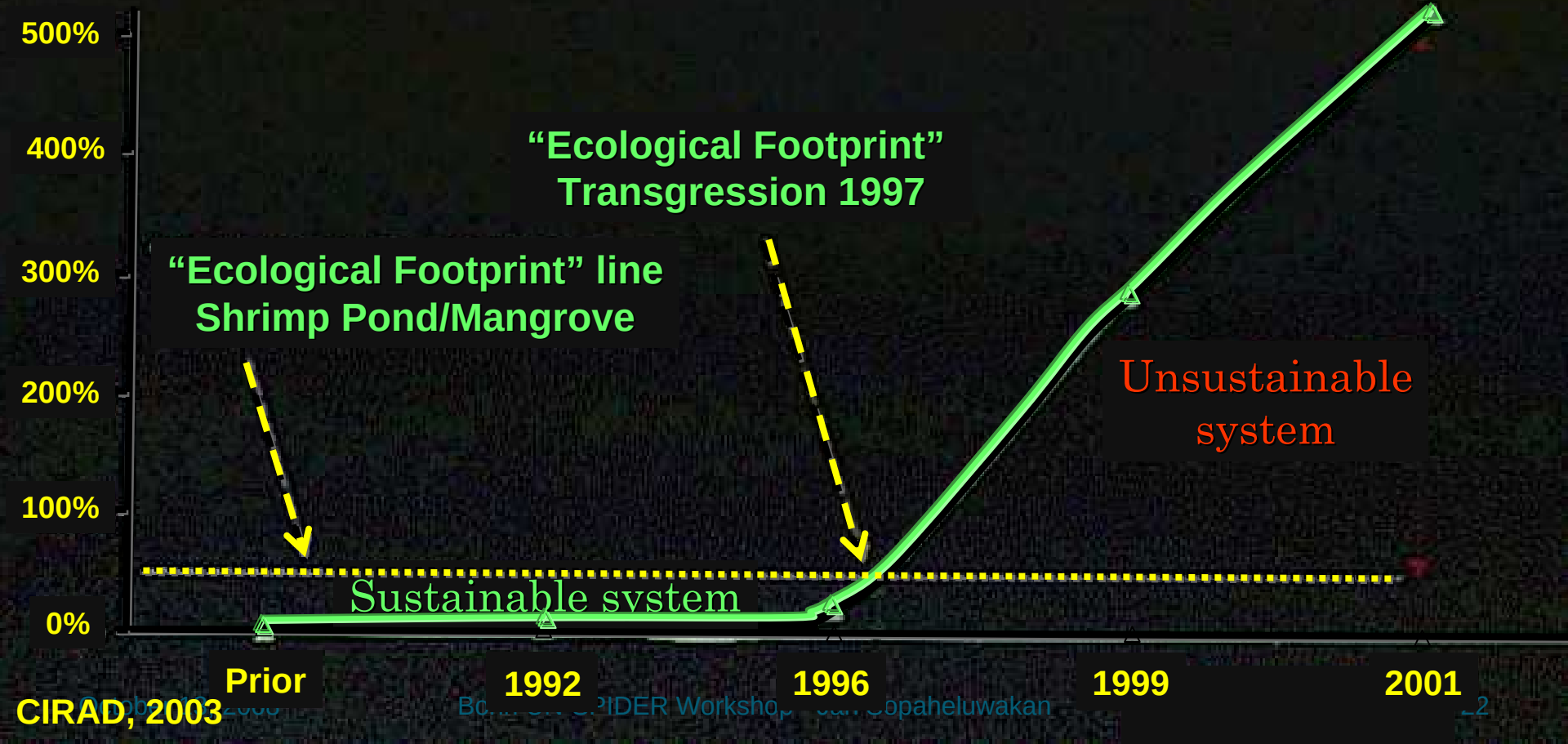

Saltwater encroachment in Mahakam Delta
Sebulu
Muara Badak
Loabukit
Saliki
Tenggarong
Samarinda
Loa Kulu
Loa Janan
Sungaimariam
Louise
2003
2000
0
km
20
LIPI

Land cover and land use change

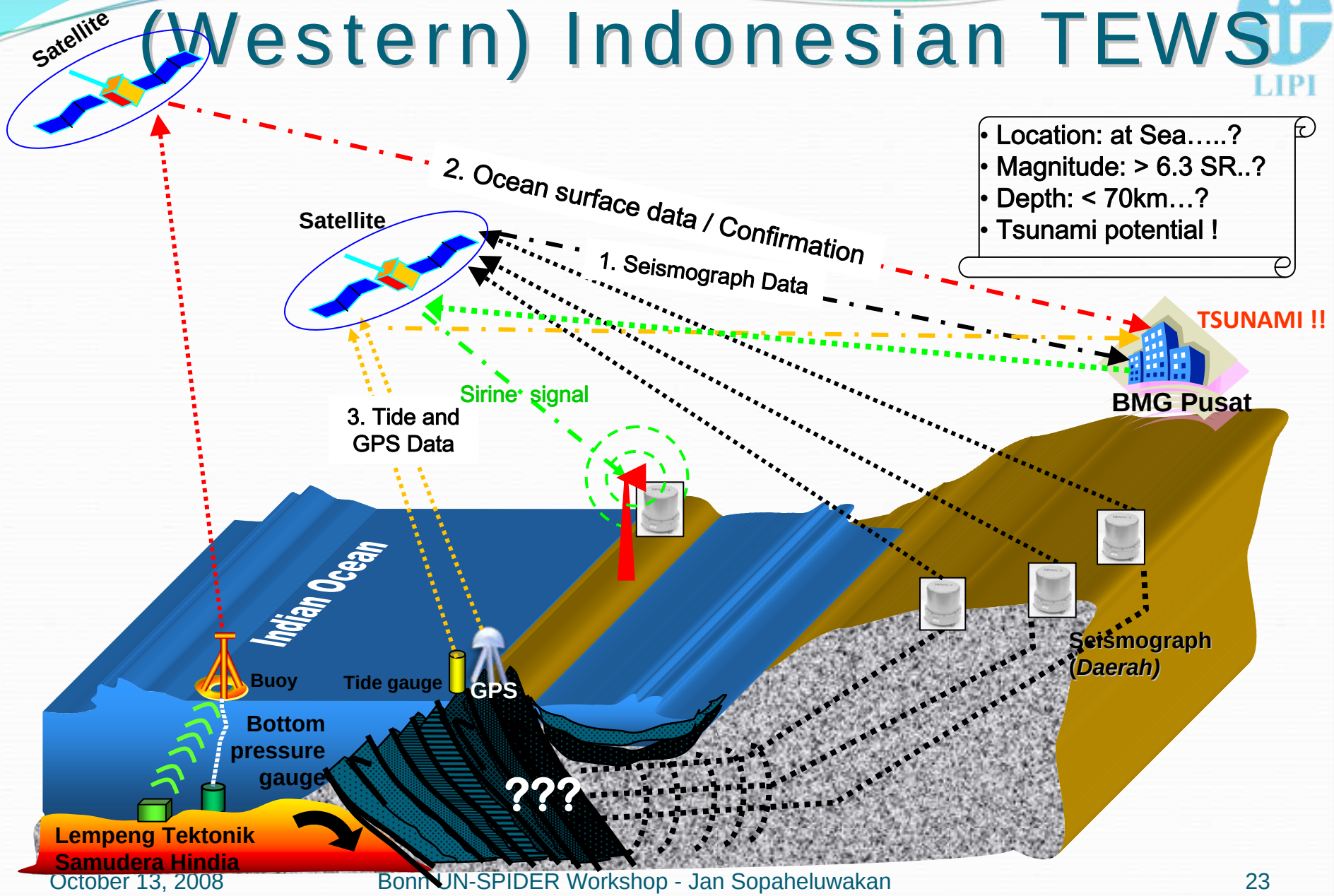


CIRAD, 2003

Ratio Shrimp Pond/Mangrove



(Western) Indonesian TEWS



The Concept:
DECISION SUPPORT SYSTEM

BMG

Monitoring Systems

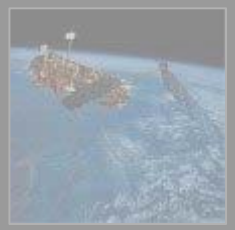
Seismic

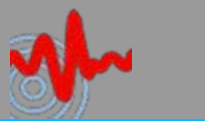
GPS

Tide Gauges

Buoys

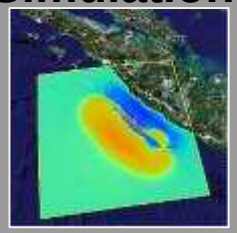
EO

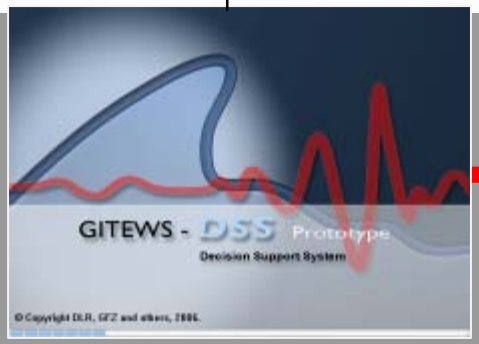


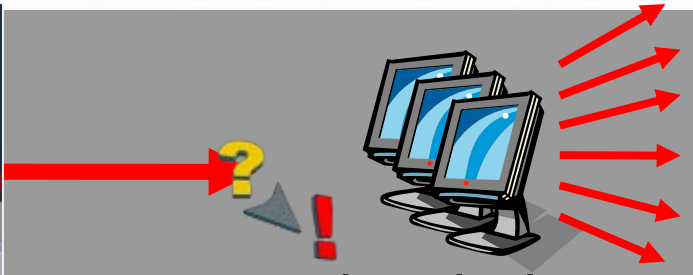


Observations

Simulation







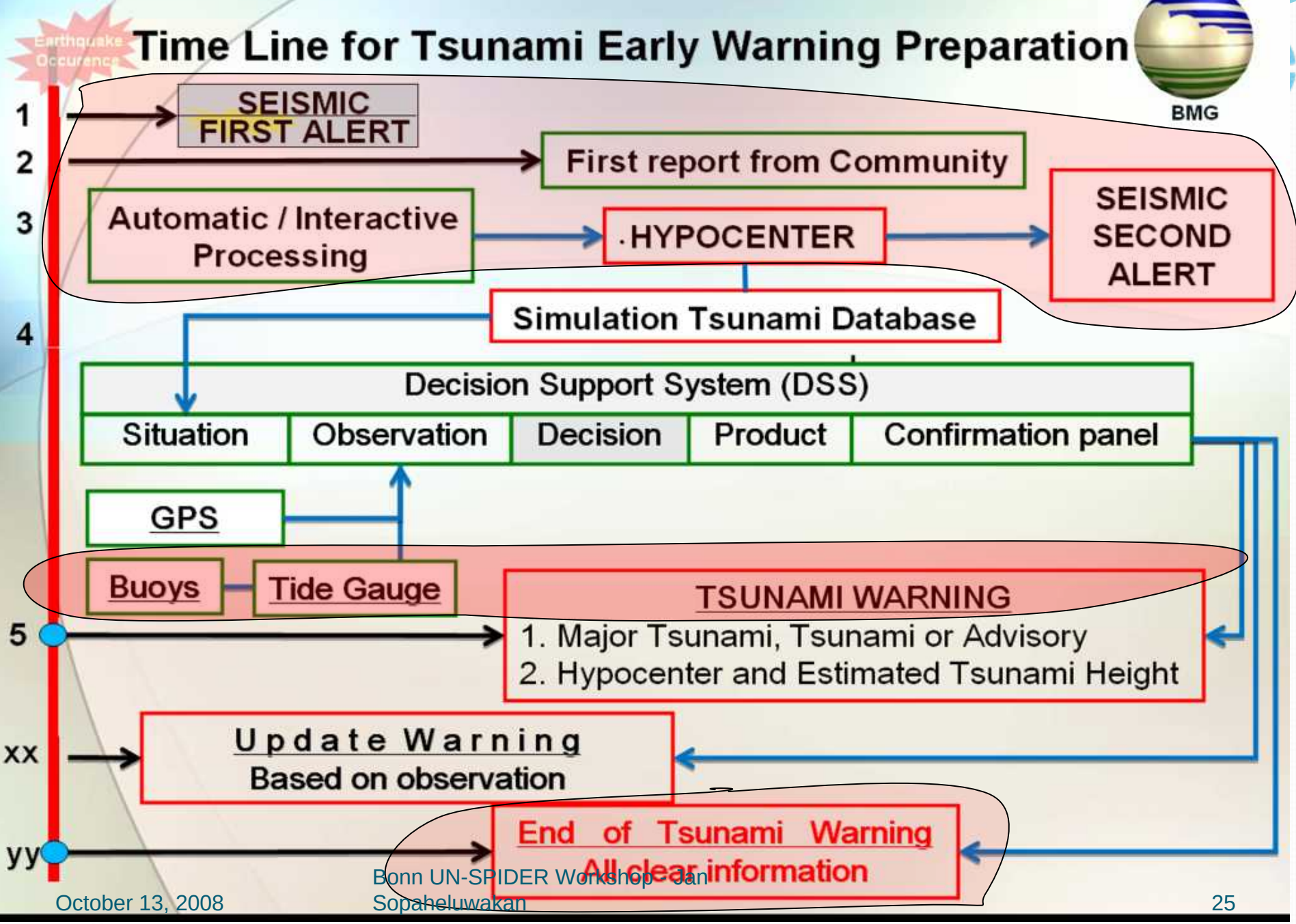
Dissemination System

DECISION

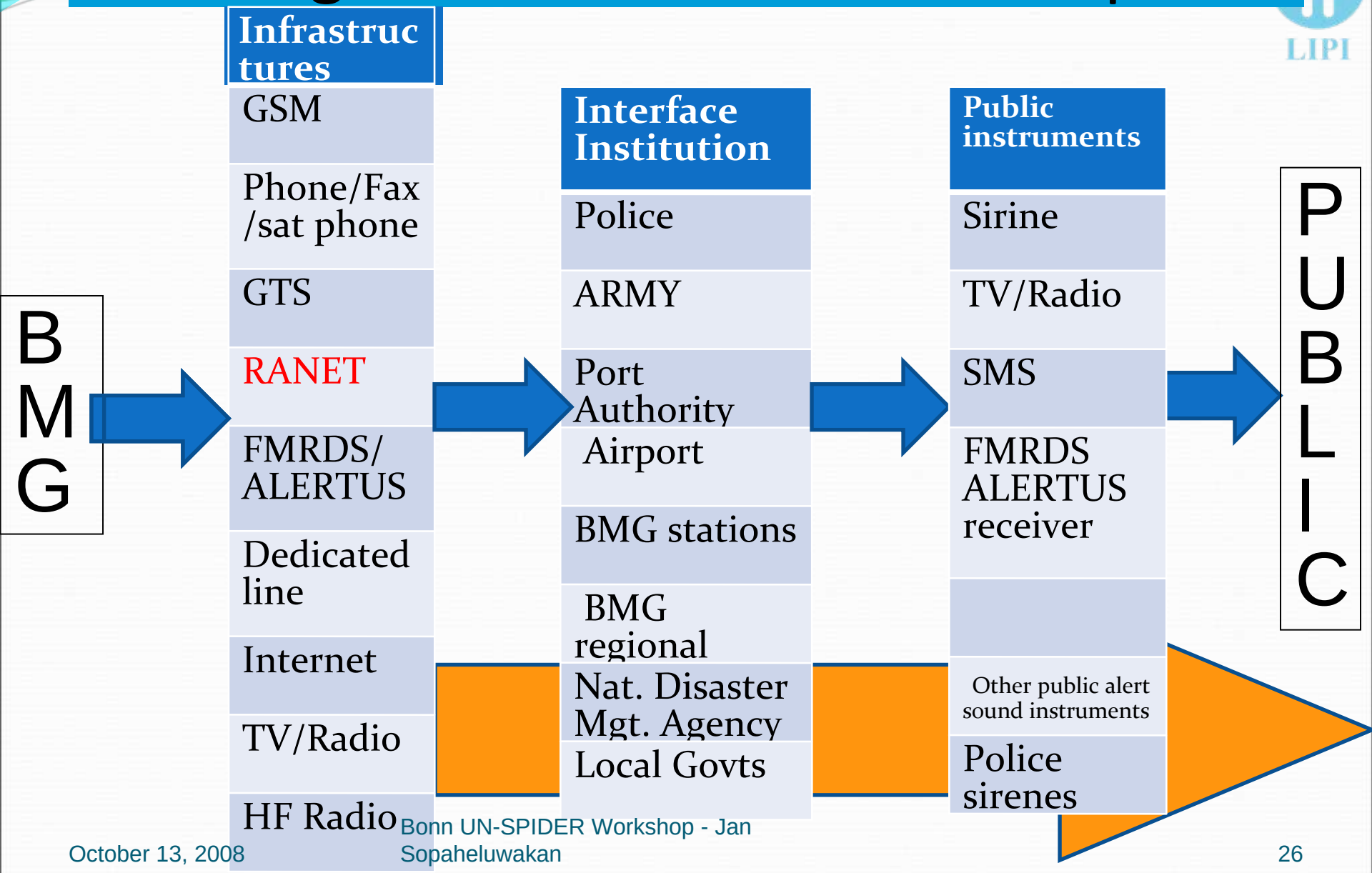
Risk- & Vulnerability Modelling

Geospatial Data Repository

Time Line for Tsunami Early Warning Preparation



Warning information flow to the public



MULTI MODA INFORMATION DISSEMINATION

BMG

LIPI

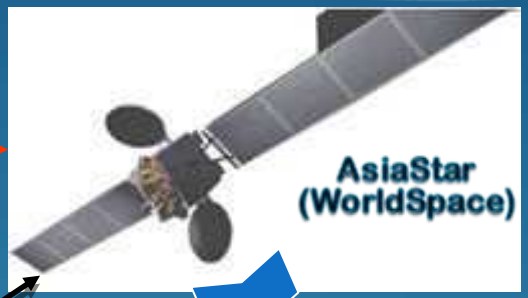
USA
nooa.gov

AUSTRALIA
bom.gov.au

NGO-USA
Ranet system.net

GTS Line

Internet



SERVERS

Earthquake/
Tsunami warning

Weather forecast

Climate forecast

FDRS

BMG

BMG

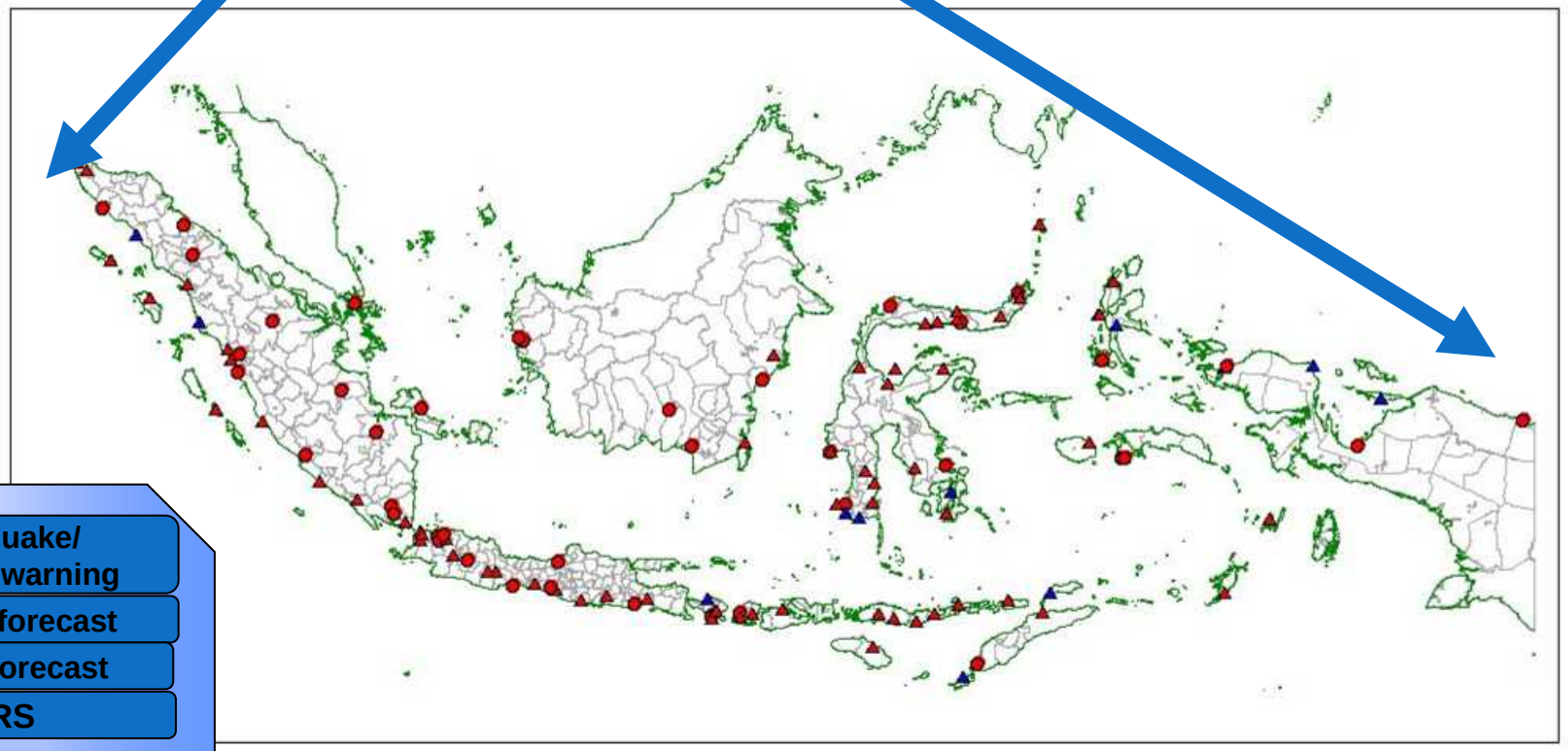
- INTERNET
- LEASED LINE (FO, RF)
- SMS
- FAX, PHONE

FO = Fiber Optic
RF = Radio Frequency

Interfacing Institutions

RANET in Local Gov offices and BMG stations

BMG



- Earthquake/ Tsunami warning
- Weather forecast
- Climate forecast
- FDRS

BMG

Legend :

- BMG Station
- Local Government
- Planning (13)
- Existing (117)

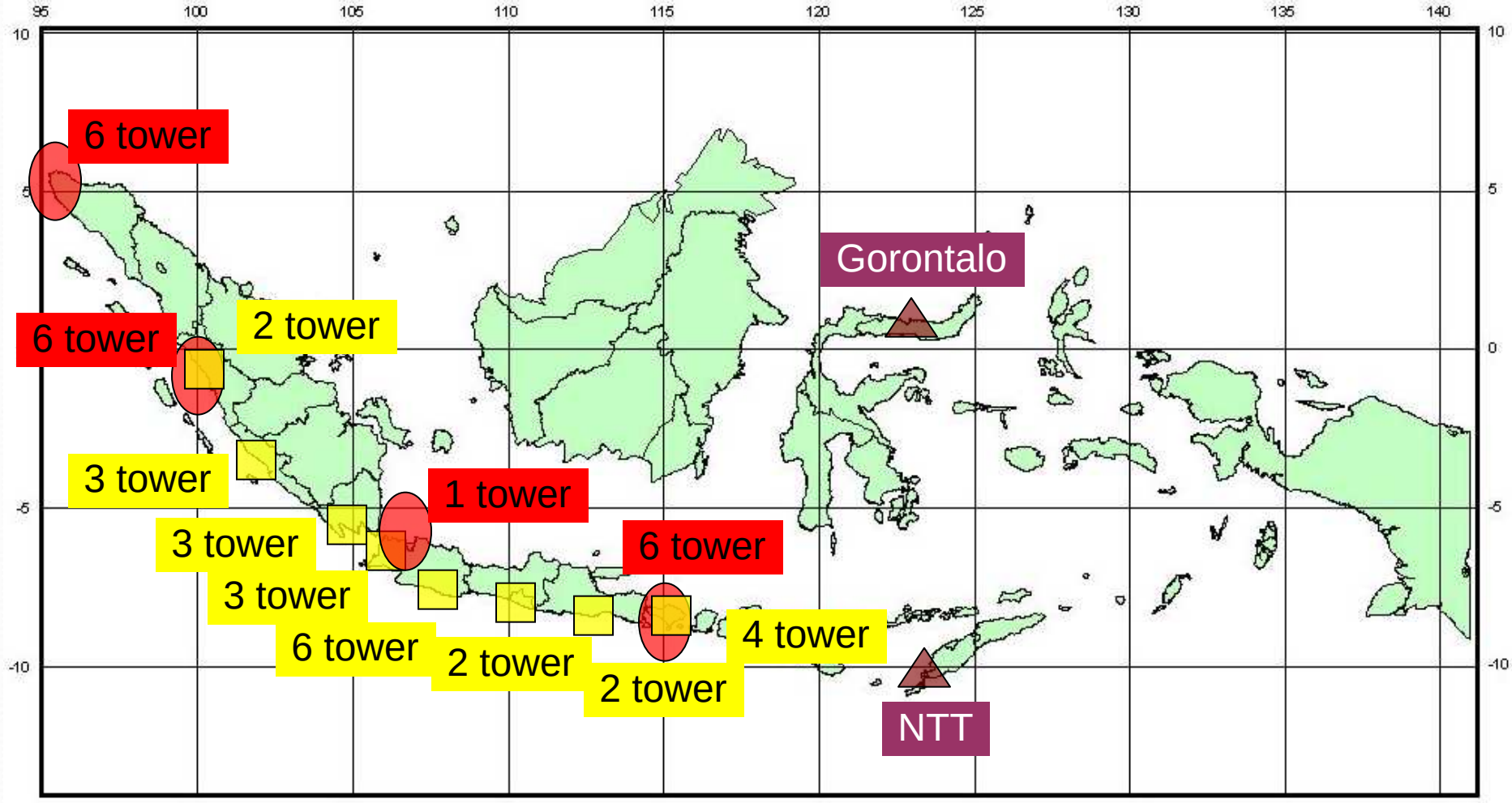
BMG 46 unit
Loc.Gov 75 unit
coastal radio office 5 unit

Tsunami Sirene network

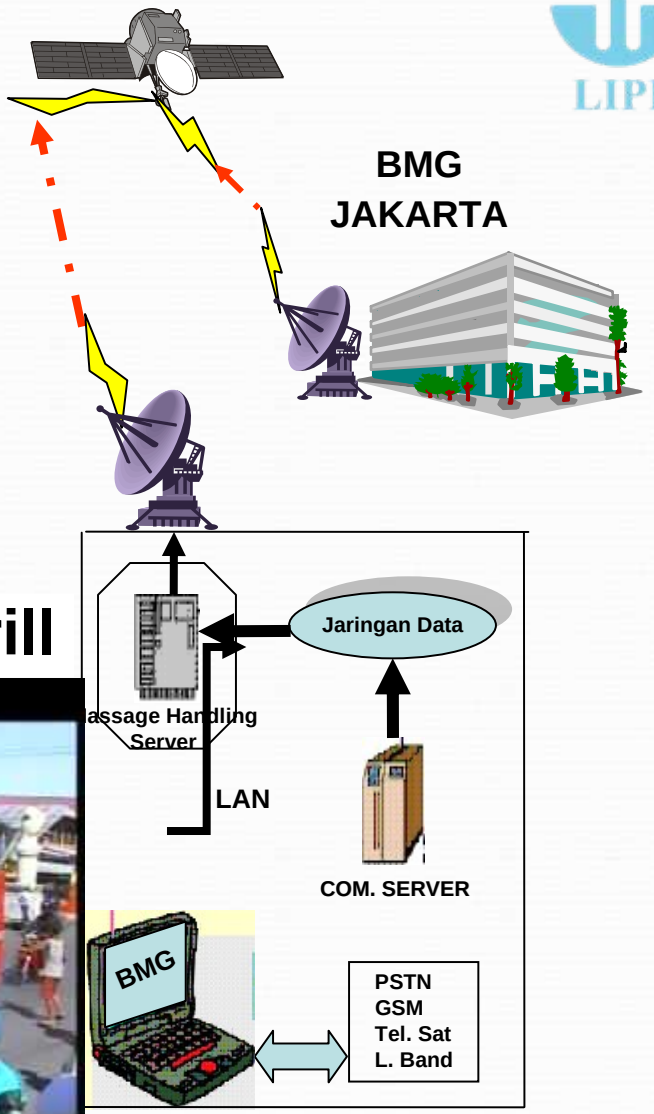
Sirene Federal Signal

Sirene Sanken/Milano (TELKOMSEL)

Plan



SIRENE NETWORK

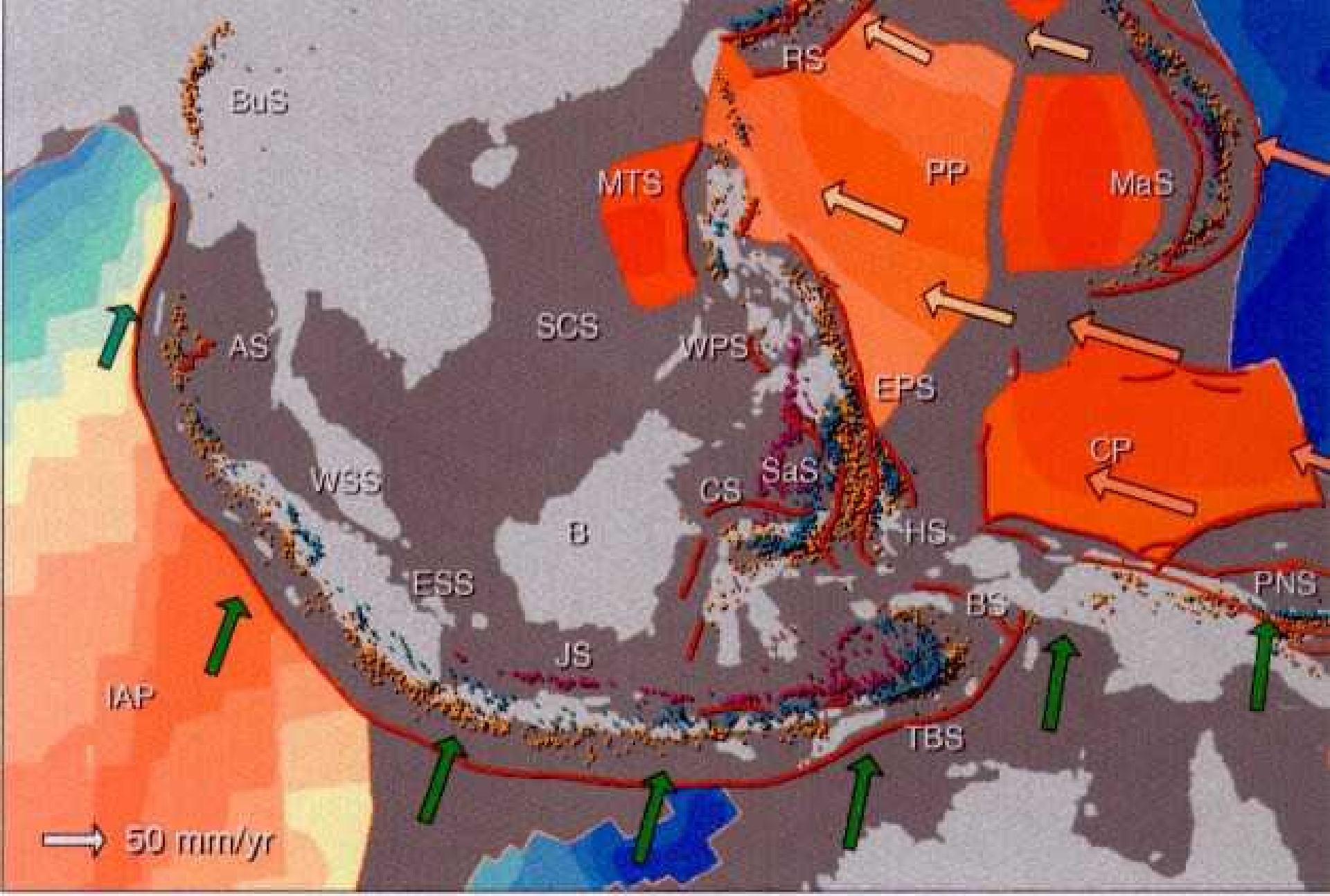


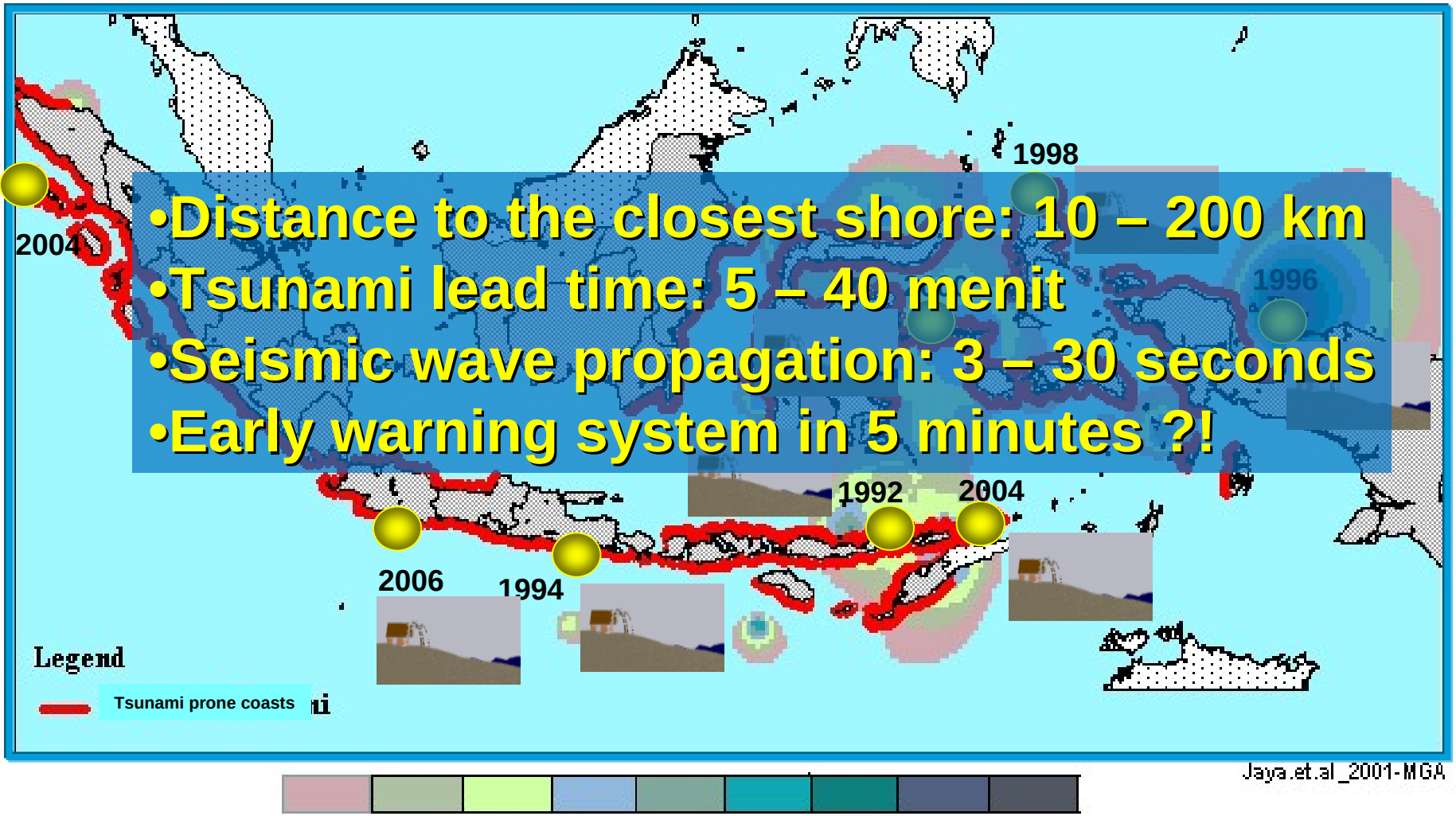
Tsunami Drill

MEDAN→→→→ PEMDA NAD
PADANG →→→→ PEMDA SUMBAR
DENPASAR →→→→ PEMDA BALI

Disasters are rarely accidental or sudden…

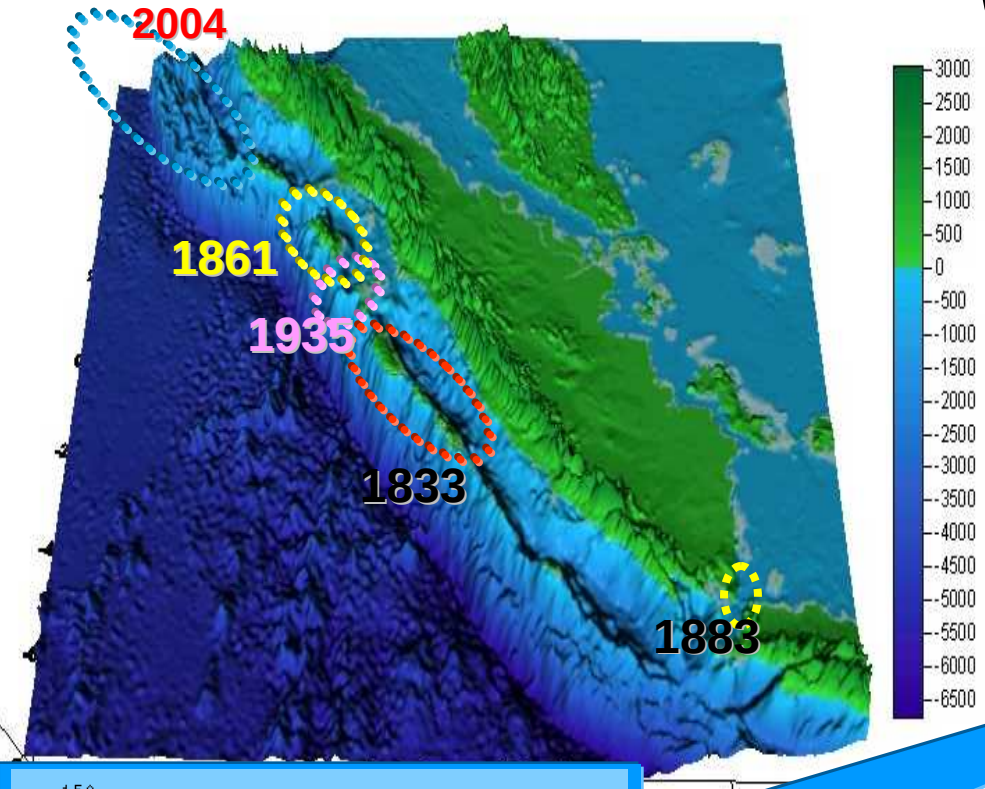
The way forward: learning from the past, preparing for the future

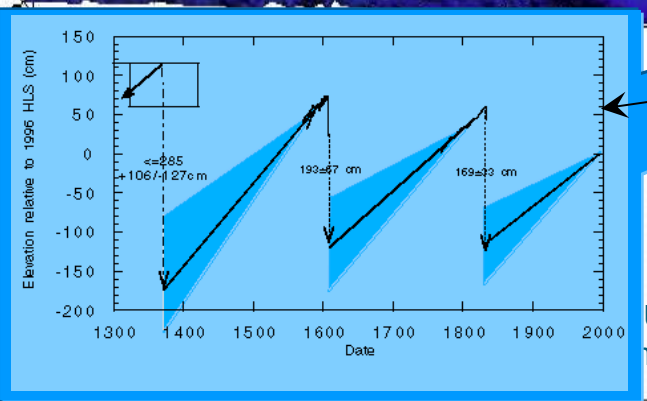

BuS
RS
MTS
PP
MaS
SCS
WPS
AS
EPS
CP
SaS
WSS
CS
B
HS
ESS
PNS
BS
JS
IAP
TBS
50 mm/yr
17 Ma
170 Ma

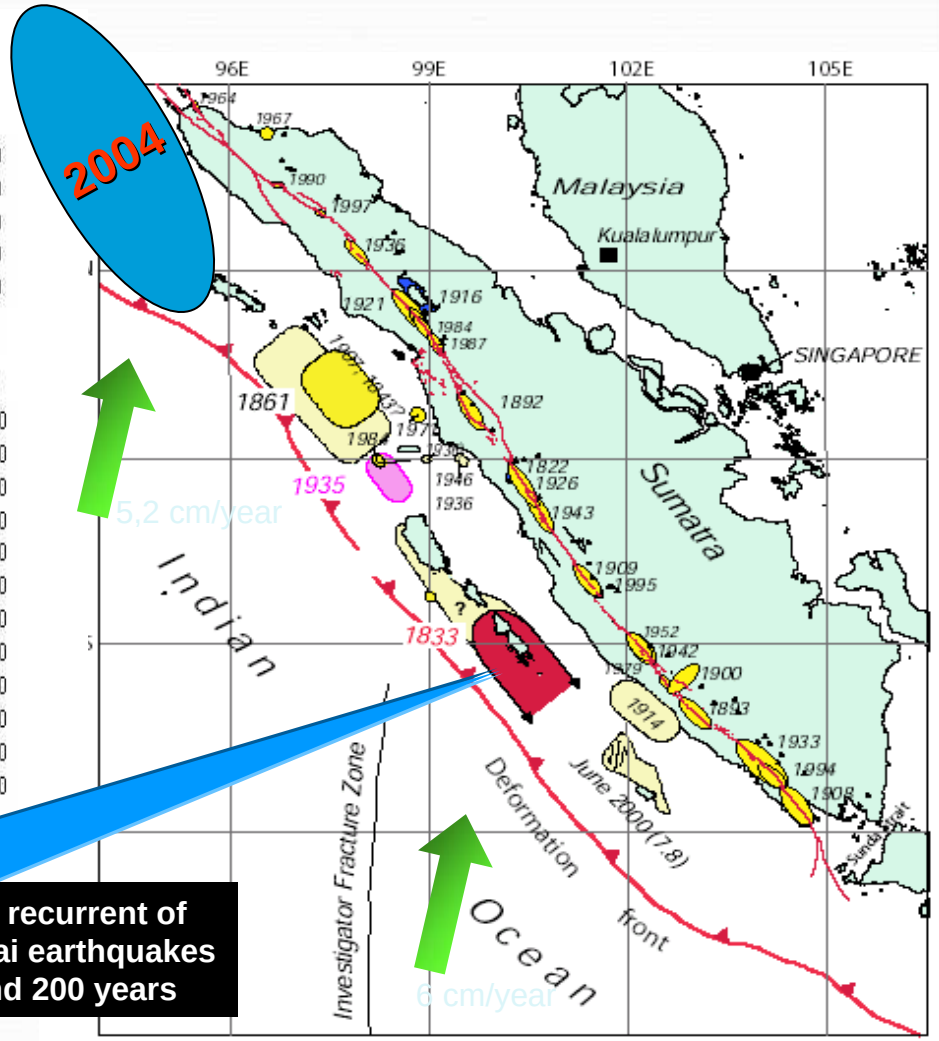


- Distance to the closest shore: 10 – 200 km
- Tsunami lead time: 5 – 40 menit
- Seismic wave propagation: 3 – 30 seconds
- Early warning system in 5 minutes ?!

Earthquake epicenters of Sumatra (Natawidjaja, 2002)



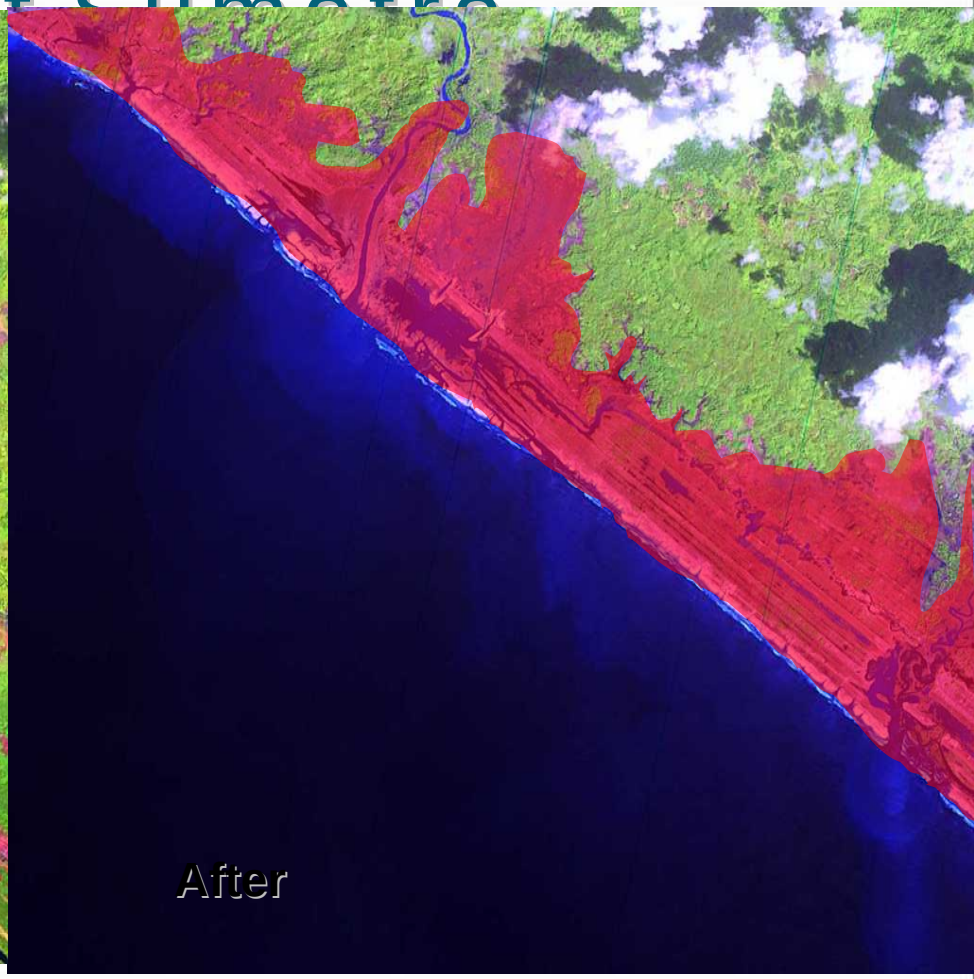




Cyclic recurrent of Mentawai earthquakes around 200 years

Earthquake +Tsunami:1381 (coral reef), 1608 (coral reef)
1833 (coral reef &book), 2004
Interval 200-220 years (Natawidjaja, 2000, LIPI – Caltech)

Subsided and heavily inundated western coast of Sumatra



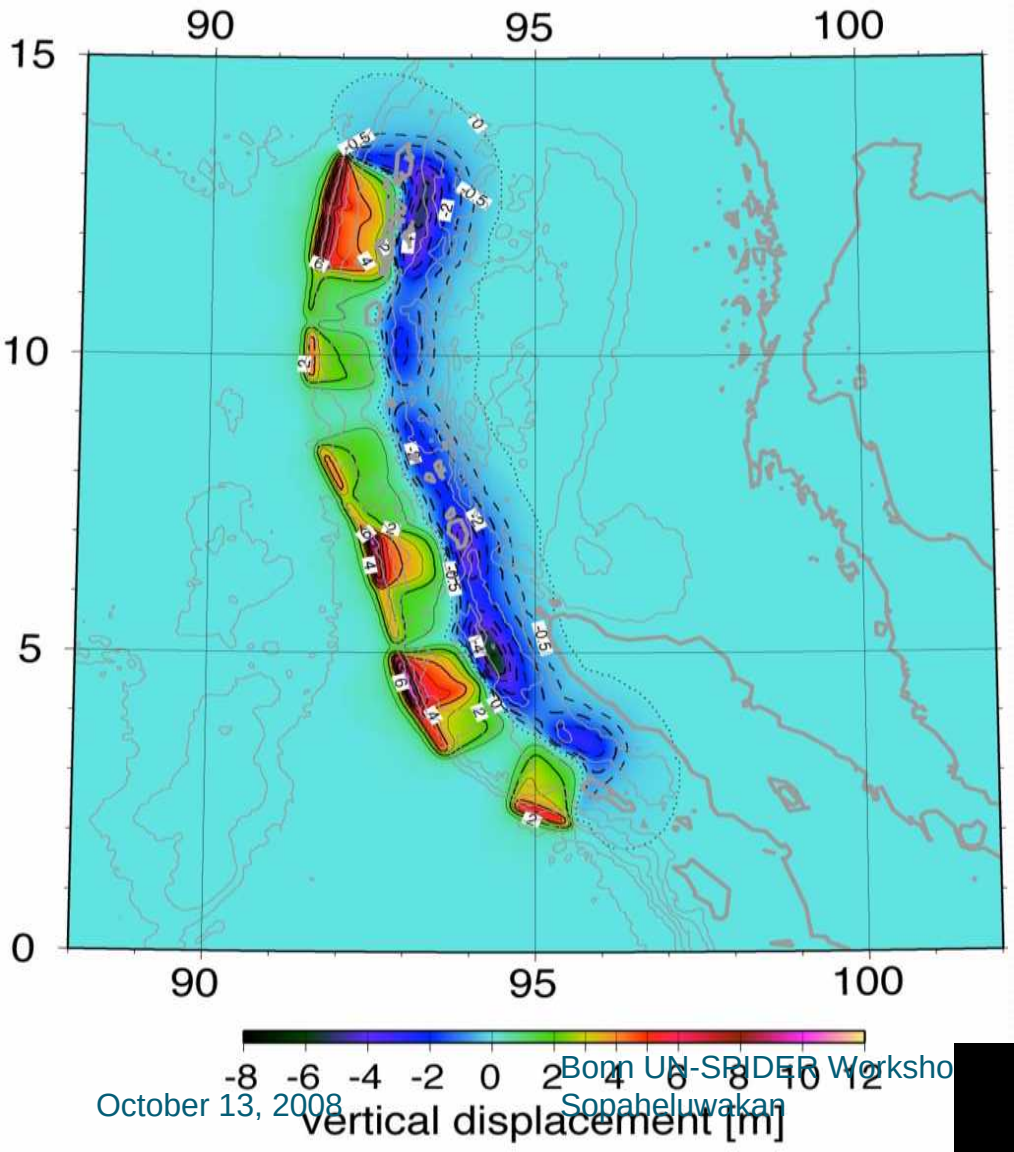
Rising island creating new land in Simelue during Aceh-Andaman earthquake

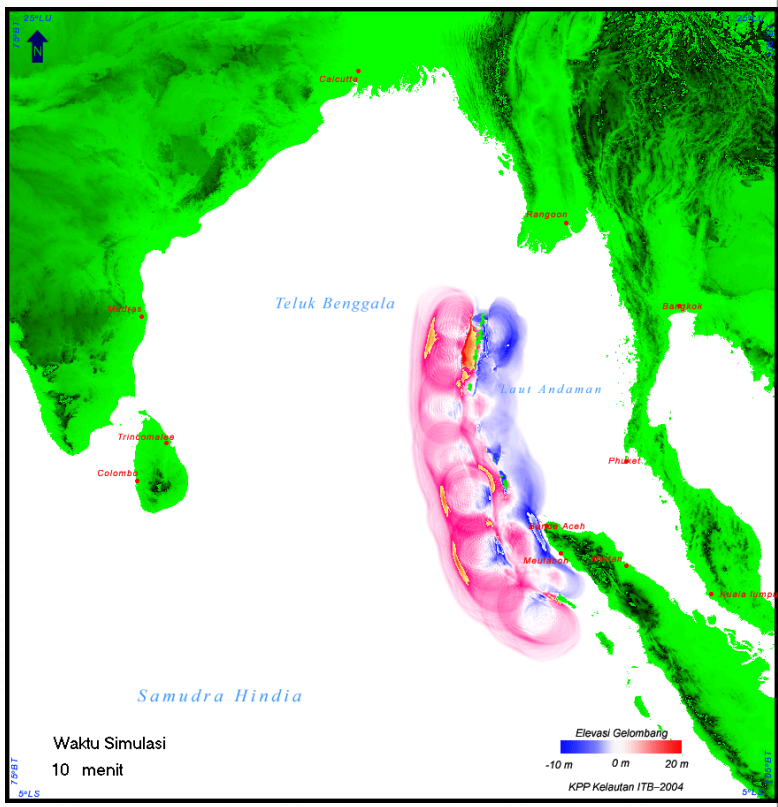
Intertidal reefs were out of the water and died


Haloban in
Banyak Island
Sinked about 30 cm

Desa HALOBAN, P. Tuanku, Kep. Banyak

The 2004 Aceh Tsunami and vertical displacement of seafloor

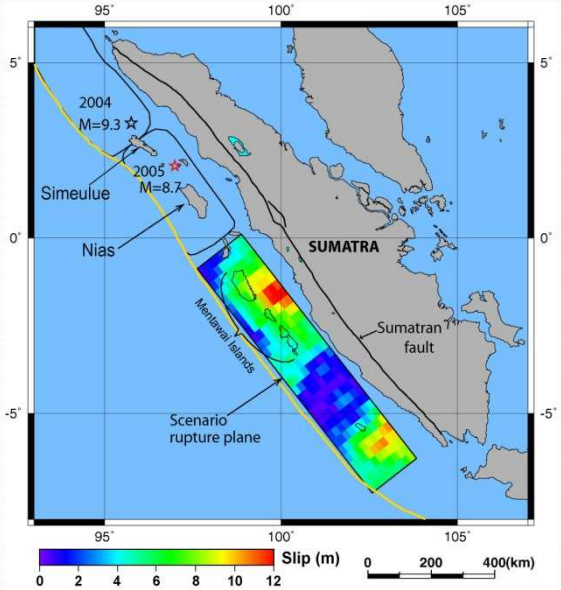


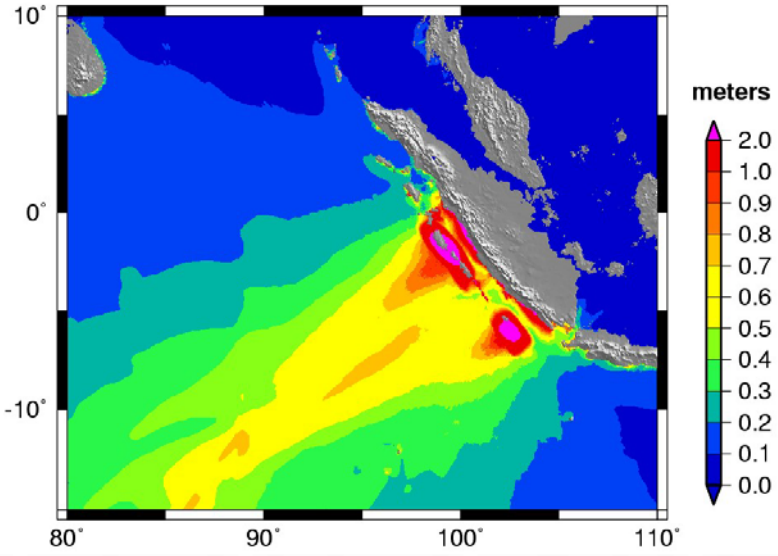


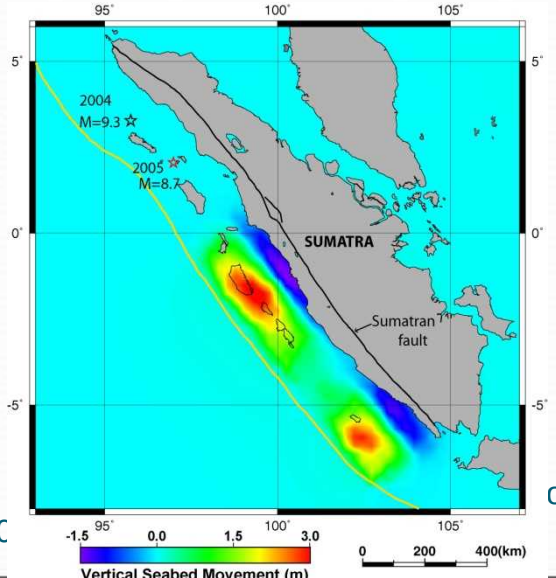
Tsunami animation (Tsunami Research Group Marine Research Center, Bandung Institute of Technol.)

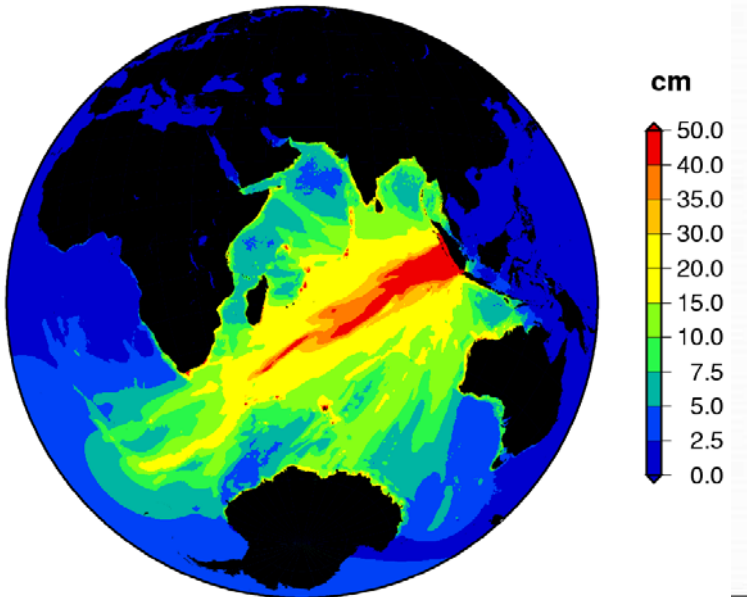
Tsunami wave modeling of Mentawai – Bengkulu EQ

(John Mc Klosky et al., 2006)

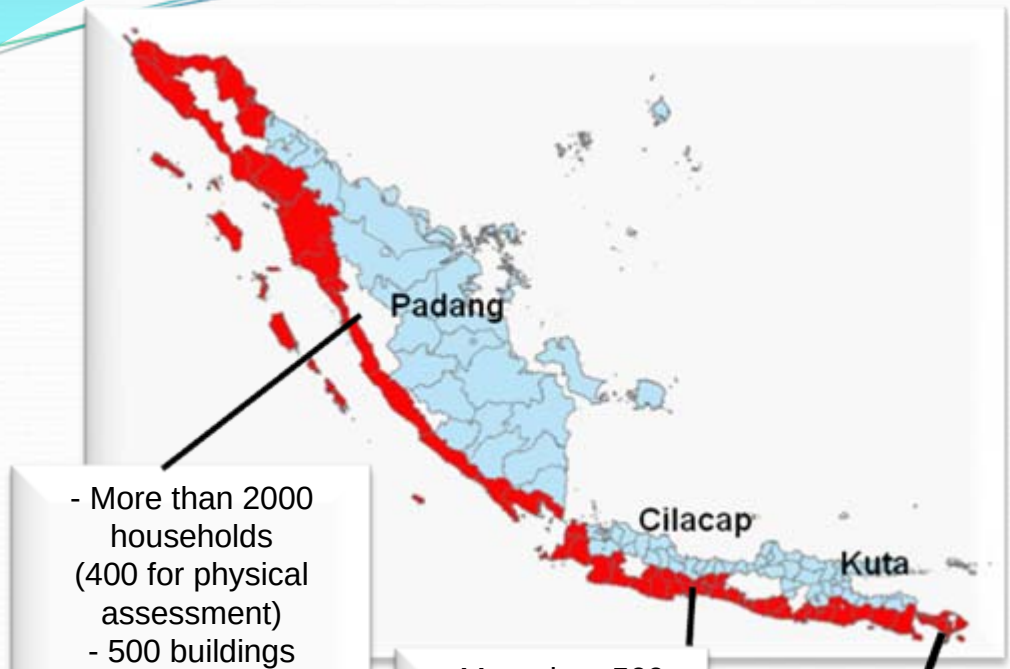








Pilot areas



- More than 2000 households (400 for physical assessment)
- 500 buildings
- 200 critical facilities

- More than 500 households (400 for physical assessment)
- 500 buildings
- 100 critical facilities

-More than 2000 households
- 100 buildings
- 100 critical facilities

Time frame for surveys
March 2008 - End June 2008

Structure of surveys / questionnaires

A. Building evaluation

1. Function, height, accessibility of building
2. Structural properties (material, structure, column, hammer and ferro-scan test)
3. Engineered building
4. Condition of foundation
5. Suitablility for evacuation, capacity

B. Household survey

1. Socio-economic properties
2. Pattern of behaviour of daily activities (dynamic exposure)
3. Knowledge about Tsunamis and early warning
4. Receiving and understanding the warning
5. Evacuation decision and behaviour
6. Rehabilitation and recovery

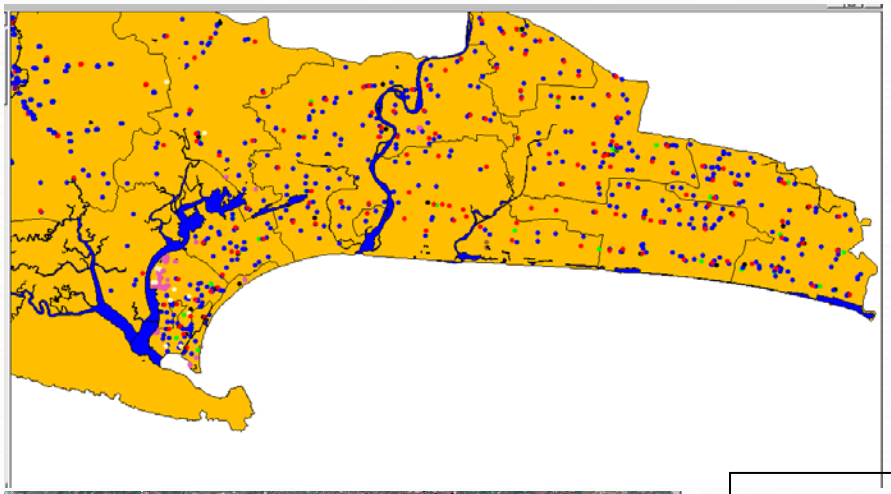
C. Critical facilities and infrastructure / economic sectors

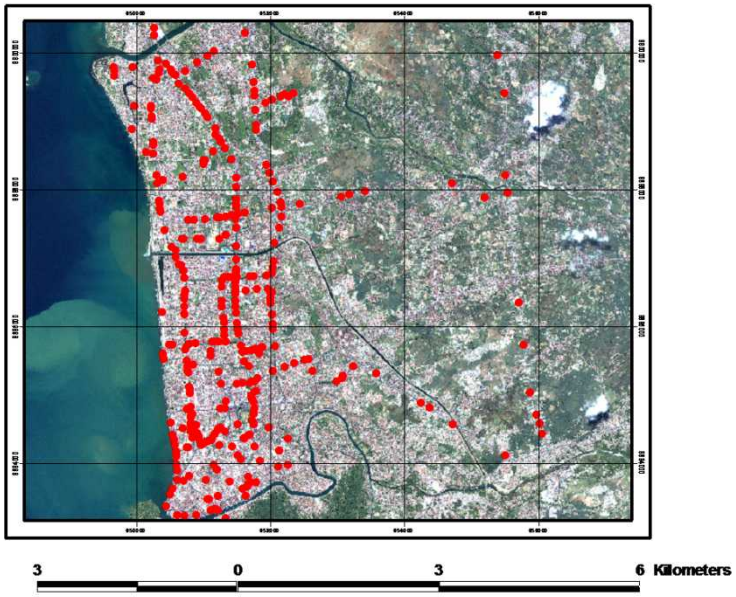
1. Amount of staff and customers for different times of day / occupancy rates
2. Receiving of warning
3. Decision to evacuate
4. Catastrophe precautions
5. Suitability for evacuation


Padang

DTM of Padang

Critical Facilities



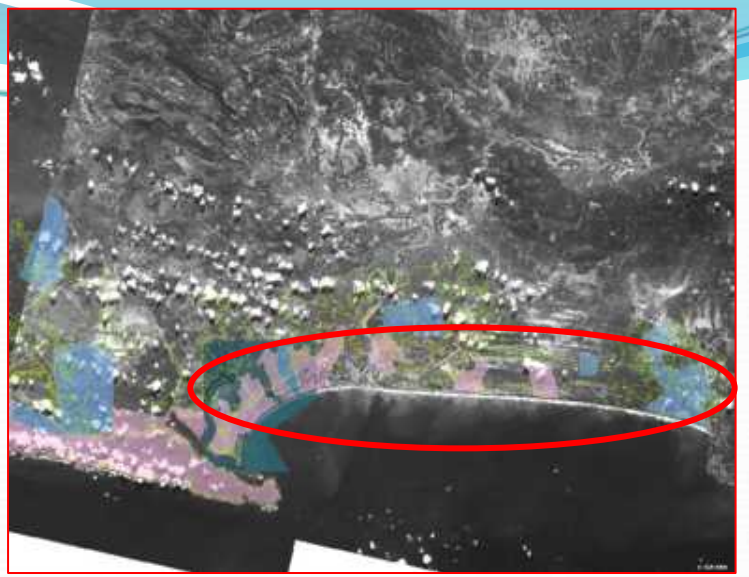


- Position
- Name
- Address

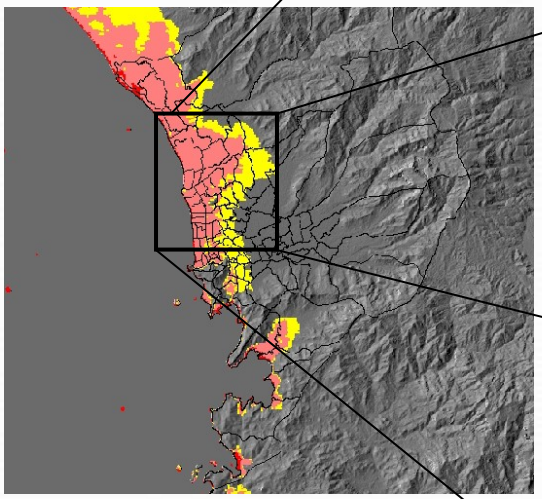
Criteria

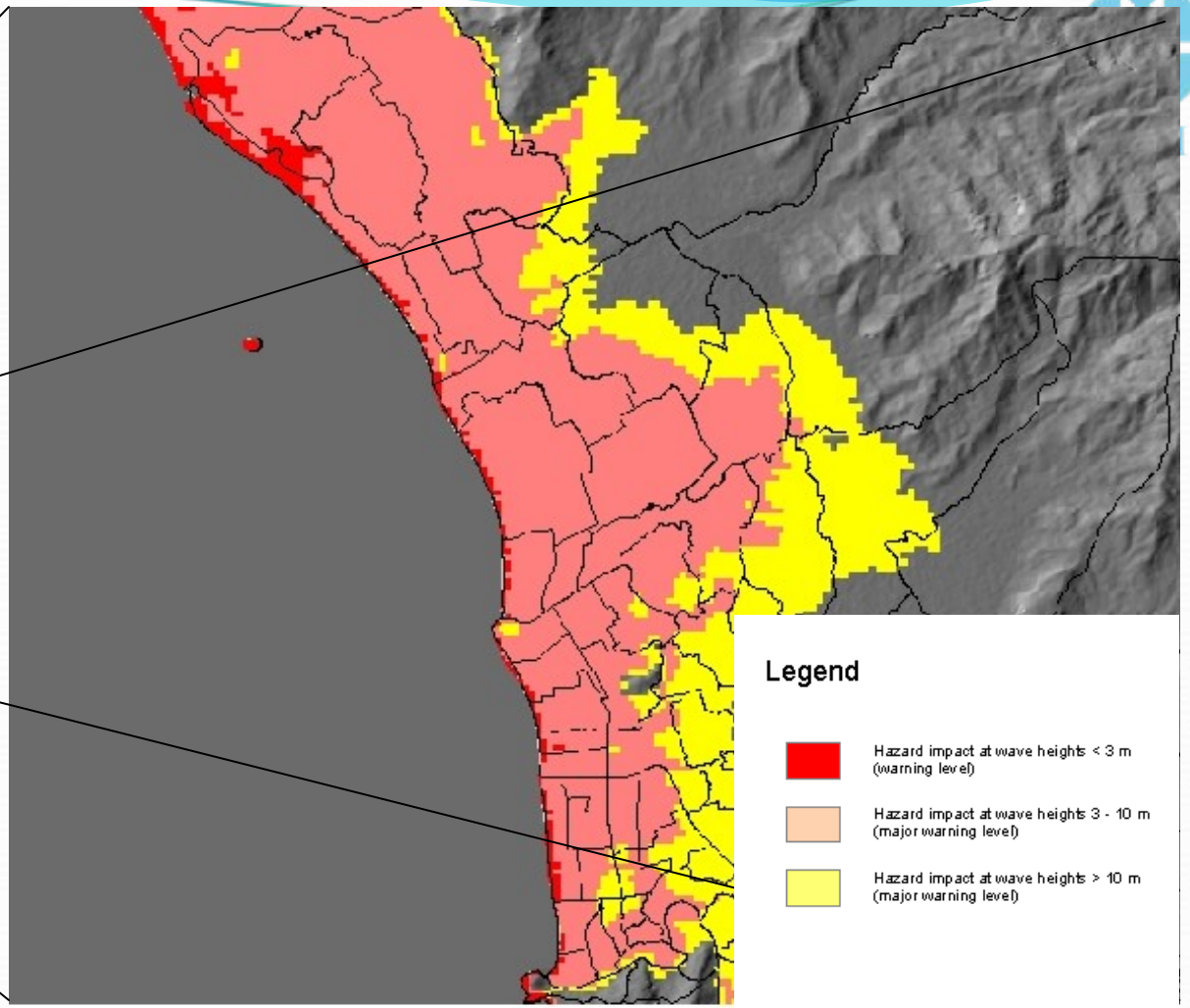
- School
- Hospital
- Government Facilities
- Shelter
- Fire Brigade
- Police Station

Survey location detailed

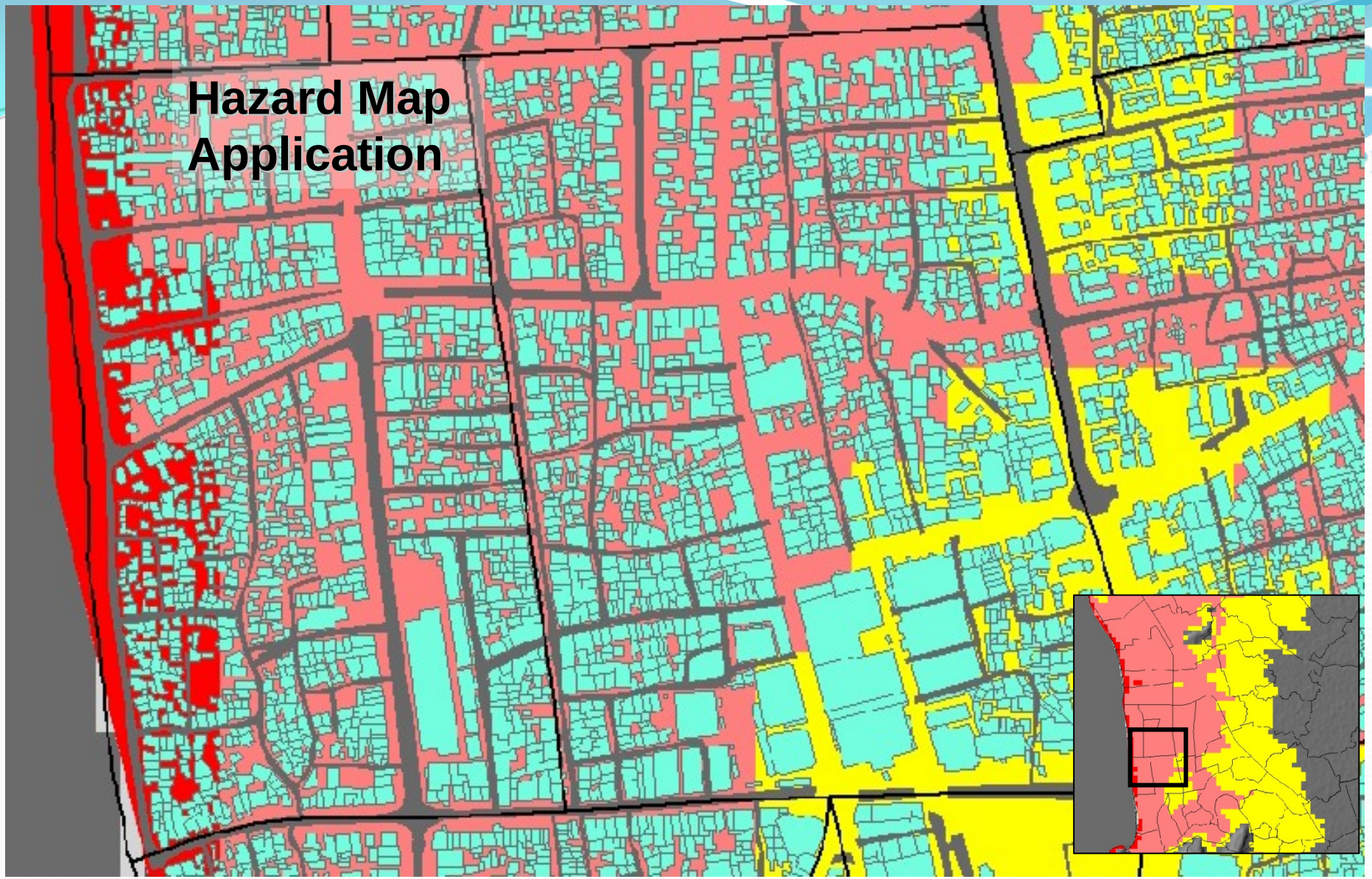


HAZARD PROJECTION AT PADANG CITY



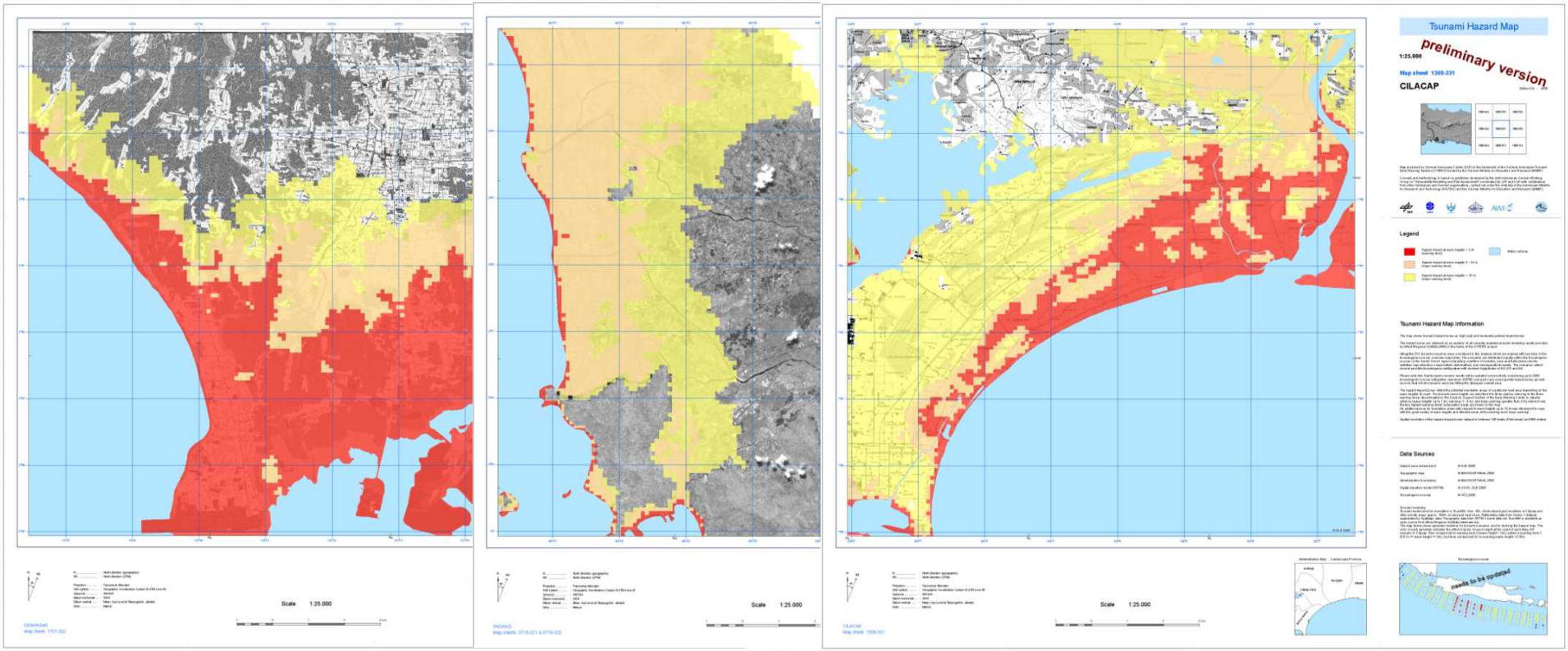


Hazard Map Application



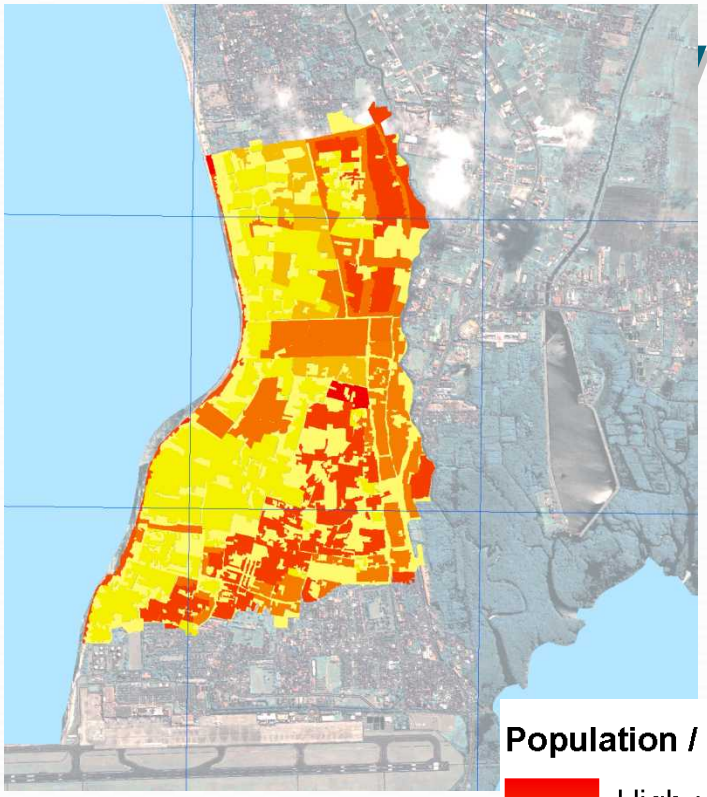
- 1:25000 map examples Padang – Cilacap – Bali

Hazard

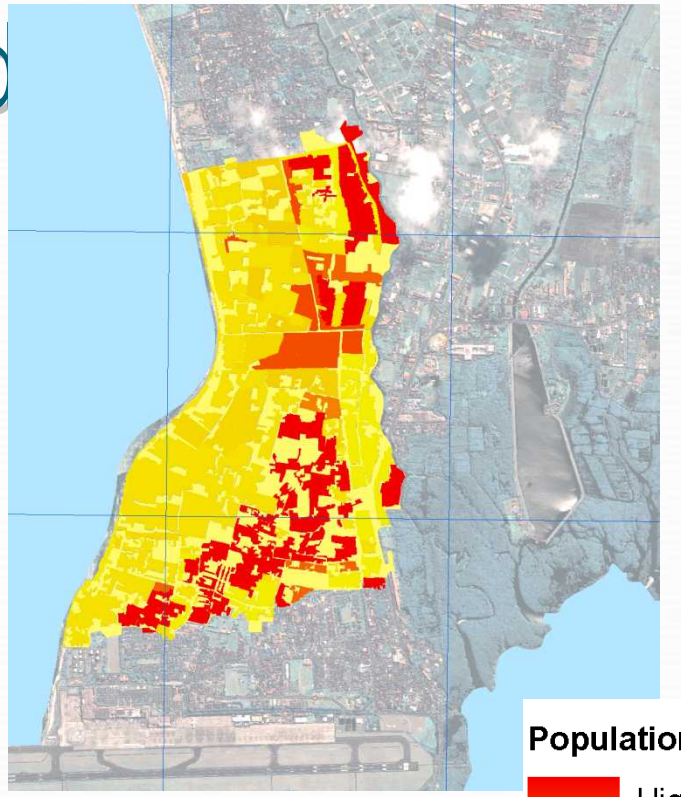


BUT: Will be improved soon through detailed simulation GKSS / DHI

Dynamic exposure – y and



DAY



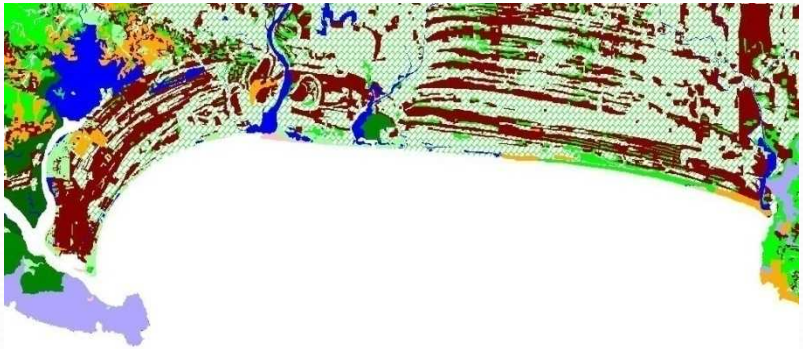
NIGHT

Improvement of population distribution

Population from census data

+

Landuse



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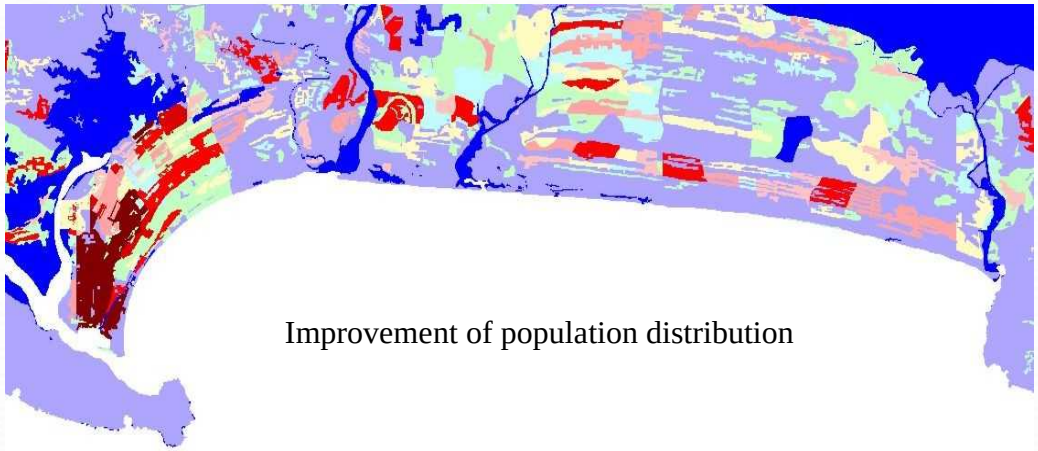


Improvement of population distribution

Needs and gaps

Robust and integrated space- and airborne based information to cover the extensive and diverse maritime continent geography of Indonesia;

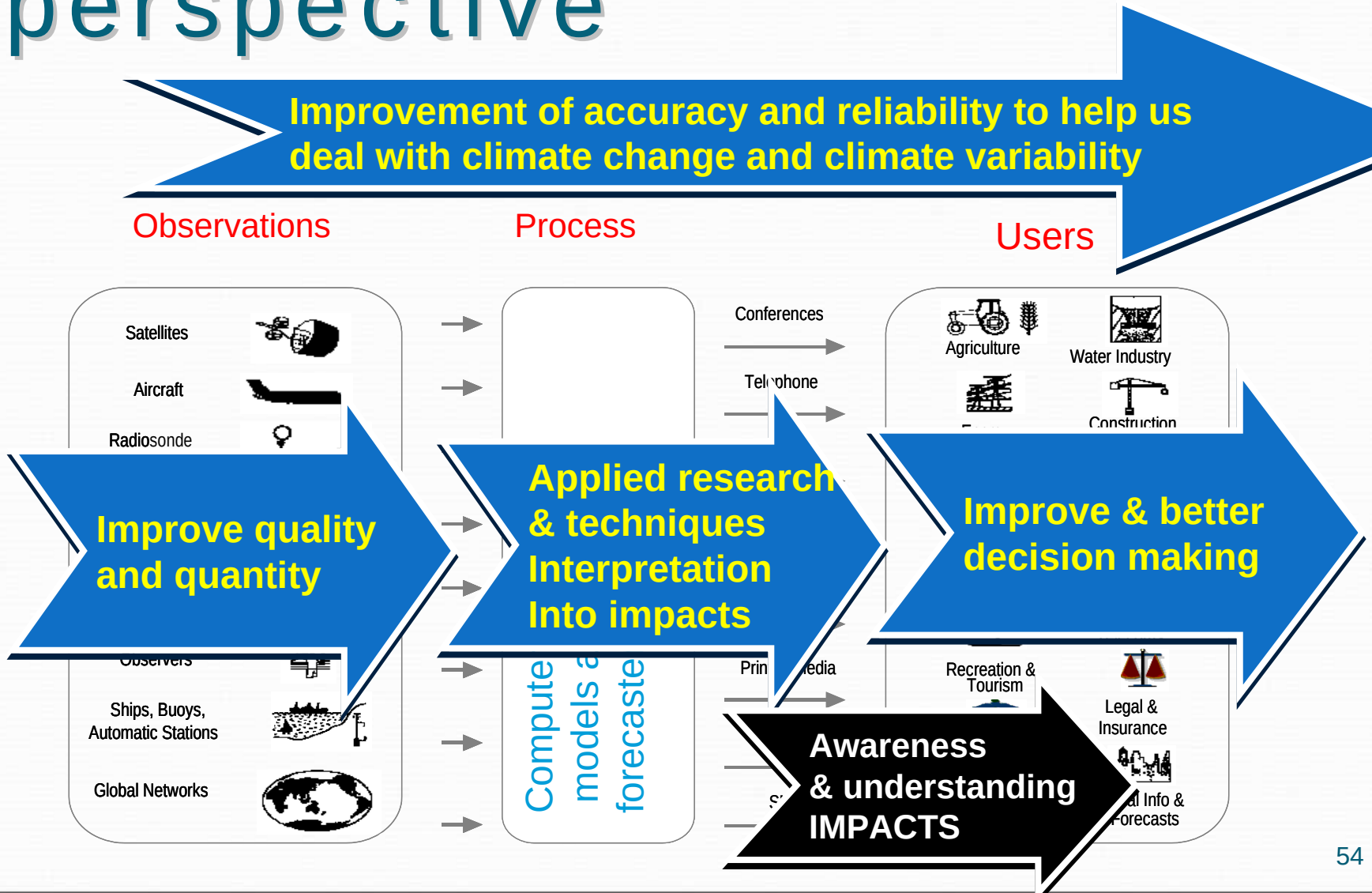
Ever growing need on utilization of progresing space technology and application for sustainable national development:

- Telecommunication (first domestic satellite telecommunication system in operation in 1976);
- Earth observation (natural resources, urban and rural land use development, environment, weather, climate and others);
- Disaster management;
- Navigation;
- Search and Rescue;
- Health;
- Education;
- Others;

Needs and gaps

- **Unintegrated space based information**
- **(high) Cost incurred in the data transmission**
- **Tailor made products for end users**
- **Distributed but integrated system of systems like GEOSS**

Developing countries perspective

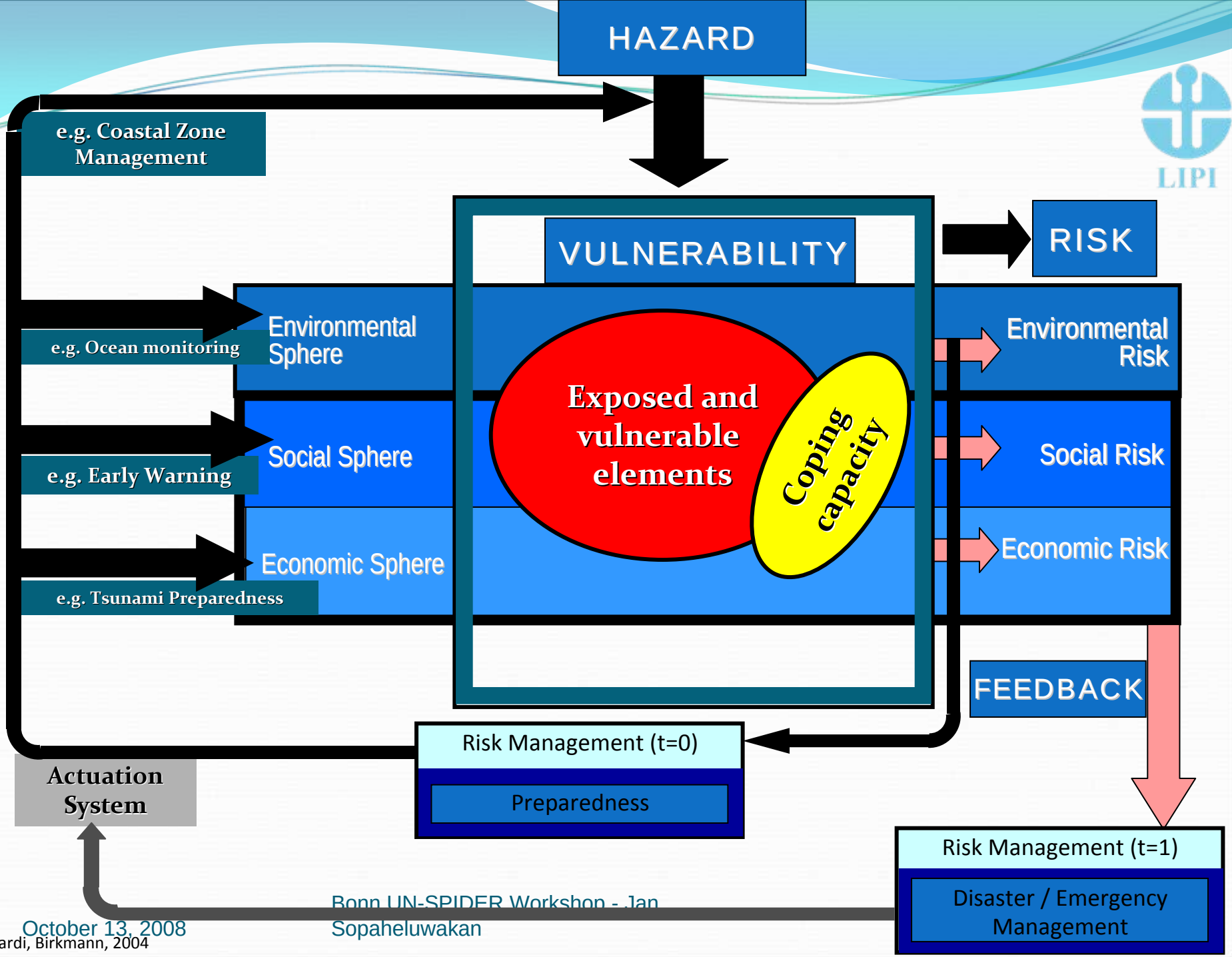


Strategies

- Paradigm shifts
  - From response to preparedness
  - From government driven to community driven initiatives
  - 5 principles
    - Centralization – decentralization synergy
    - Public participation
    - Integrated coordination
    - Comprehensive approach
    - Partnership at all levels
      - Public – private
      - Scientists-engineers – decision makers

Strategies

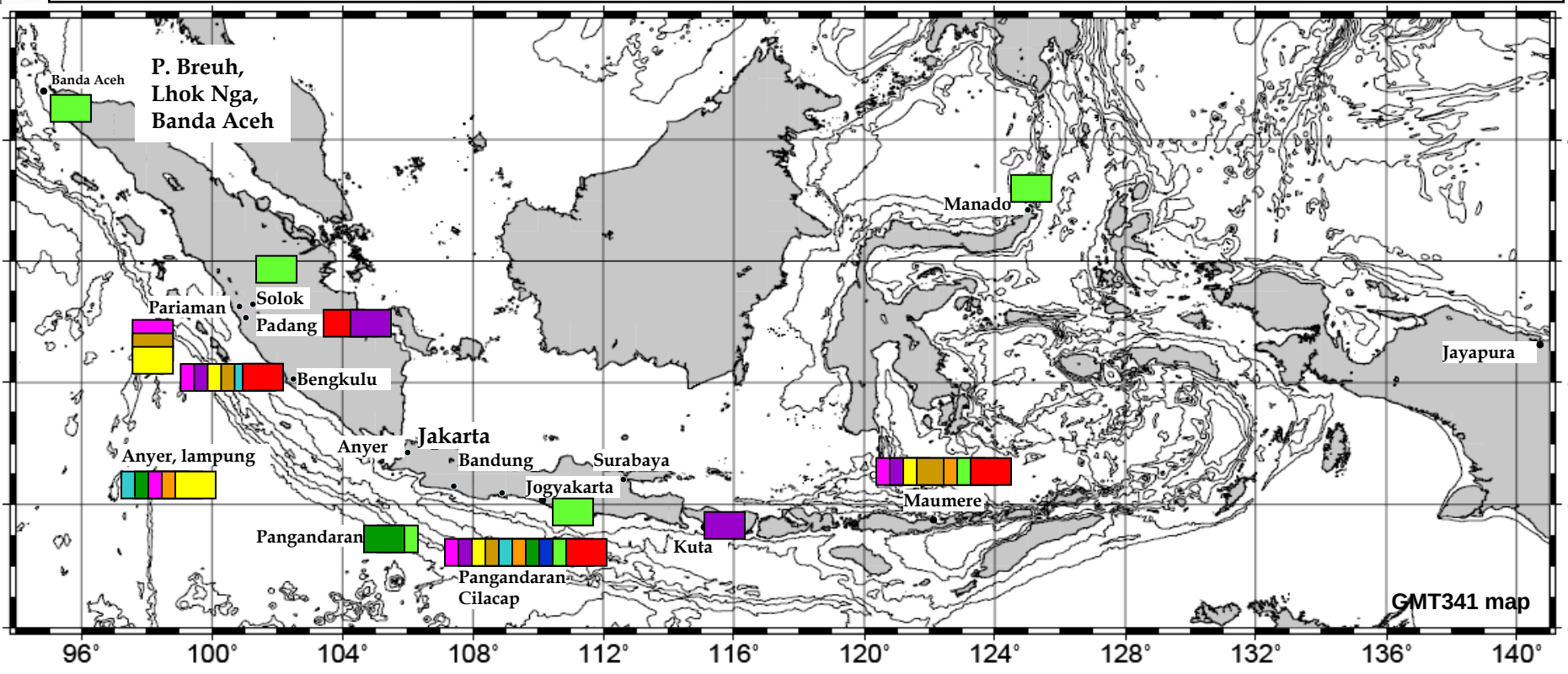
- Observe and monitor: learn from the past and and get ready for the future
  - Use of space based information for multiple approach
    - Multidisciplinary
    - Multisectoral
    - Multiplatforms
    - Multitemporal and multispatial
    - Multiusers
- Combined space based and field studies information for simulation, modeling and scenarios development → predictive capability and capacities
- Cost effective, mobile, user friendly space and air based technology and information
  - Combined use of HAA for end-to-end disaster management and other user communities
- User friendly – tailor made information products for end users



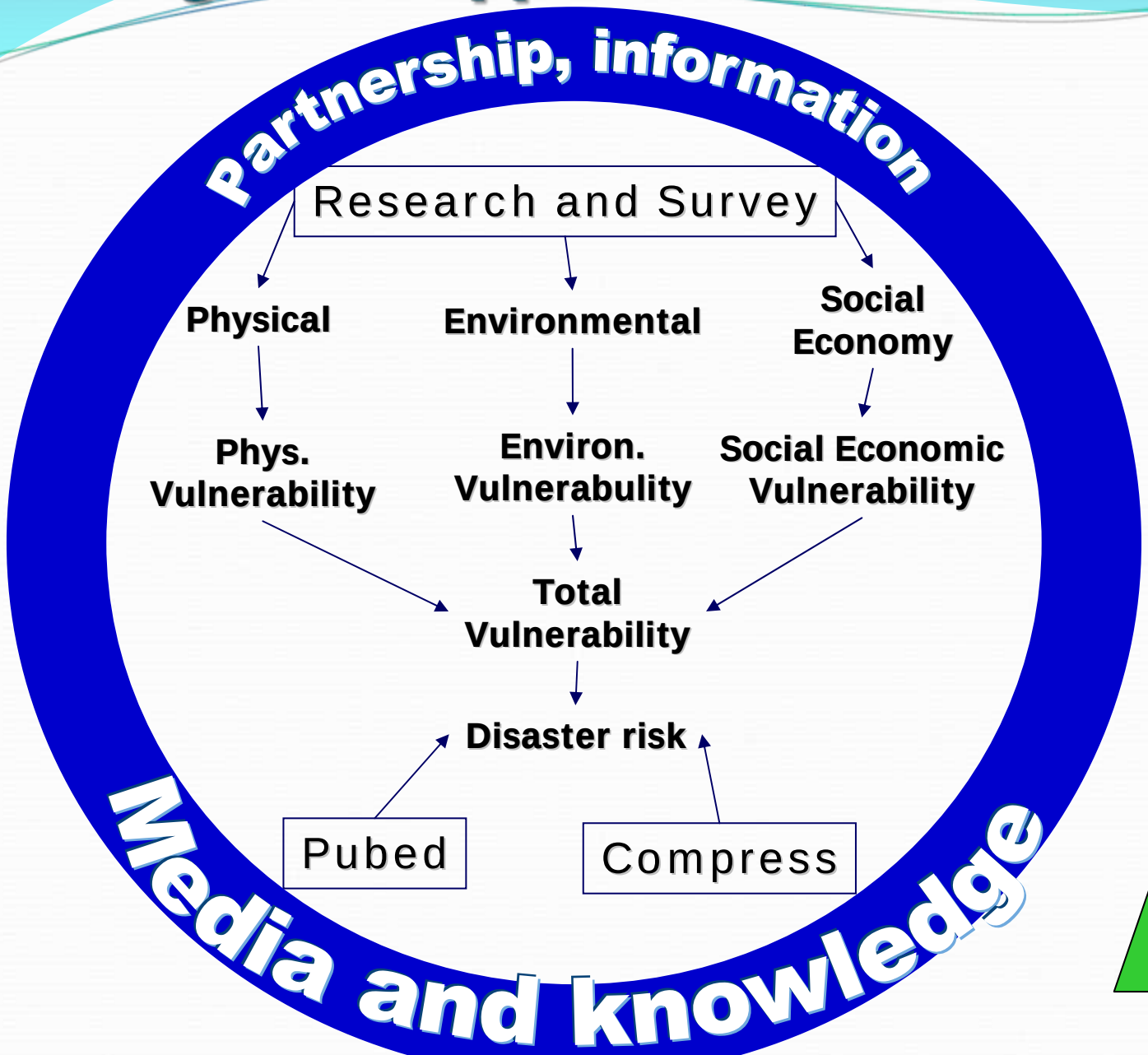
Bogardi, Birkmann, 2004

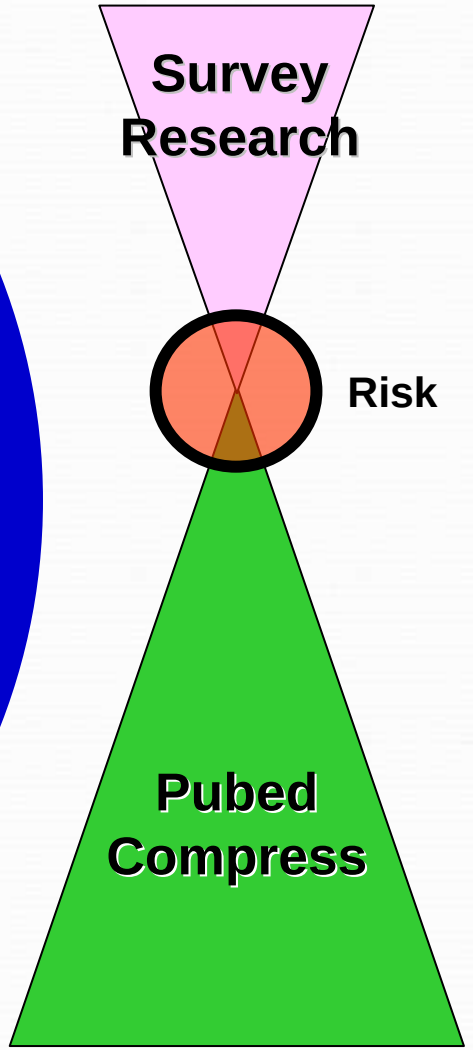
Current integrated geoscience, human and social sciences supported project activities in public education and community preparedness in Indonesia

- Paleotsunami & Environment
- Tsunami Modeling
- Engineering geology, groundwater
- Infrastructure
- Vulnerability & Risk Modeling
- Social Economy
- Post Disaster Assessment
- Public Education & Awareness
- Exhibition
- Bathymetry



Integrated approach between components



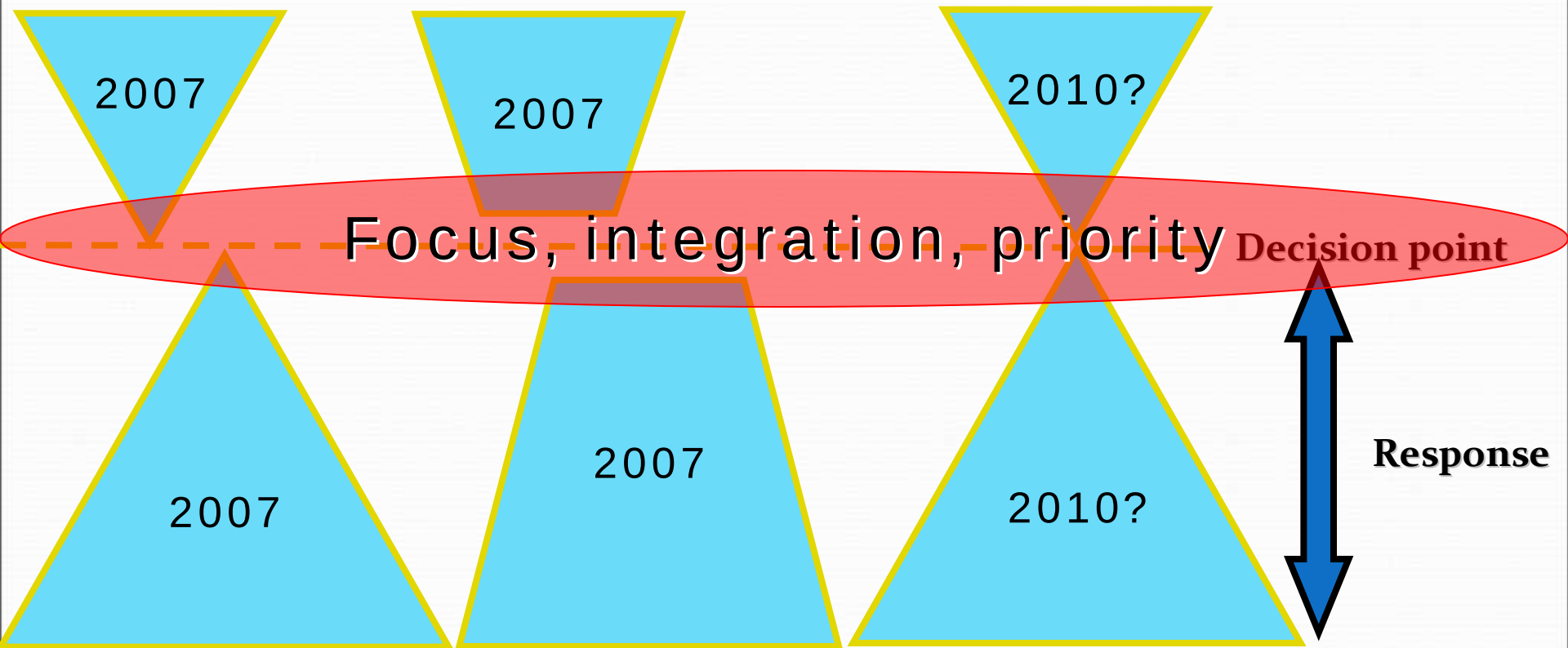


"The last mile" in INA end-to-end warning system

EQ
EQ Record
Automatic Processing (1st warning)
No tsunamigenic
Tsunami genic
Back to normal
Warning
Evacuate
Emergency relief
Mitigation-preparedness
Recovery-reconstruction
Storage
Models-scenarios
SOPs
Tide gage Buoys
Risk Assessment
Contingency plan
Geohazards Assessment
Social-econ-institut. vulnerability
Vulnerable Groups, Infrastructures, Sectors
Geohazards Identification
Social-economic-institut. assessment
Public Education and Preparedness Training
Geohazards Behaviour
Historical EQ-Tsunami studies
Social-economic Institut. fabric
Target Group Mapping
Geodynamics, seismotectonics
Local Sosial-economic dynamics

The present state of INA TWS science and community integration

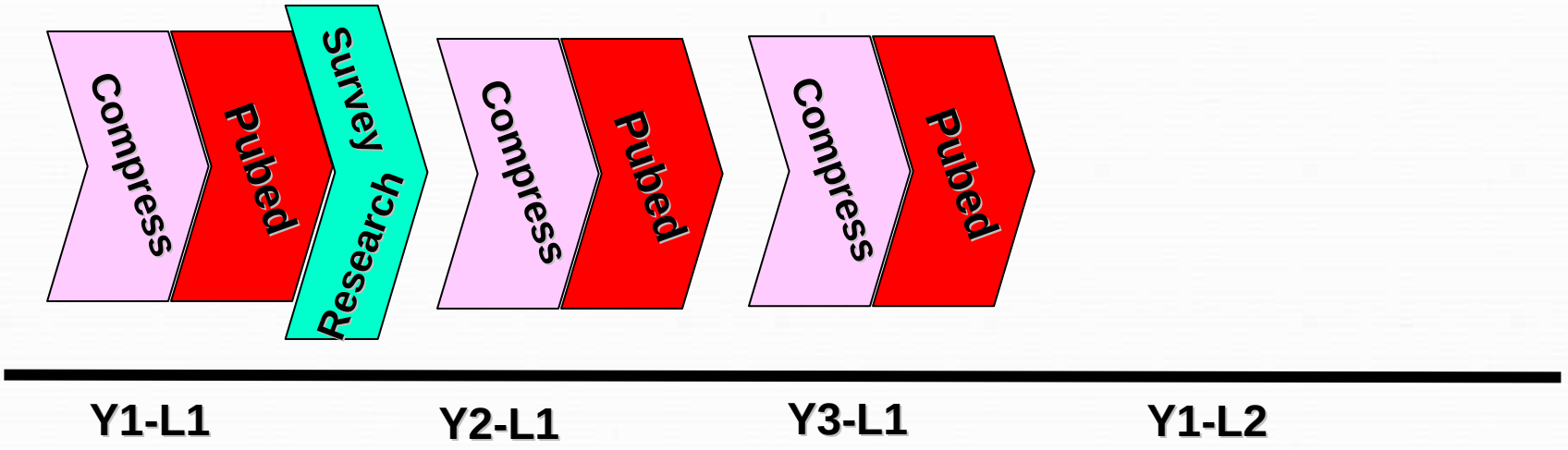
Science and Technology Predictive Capability



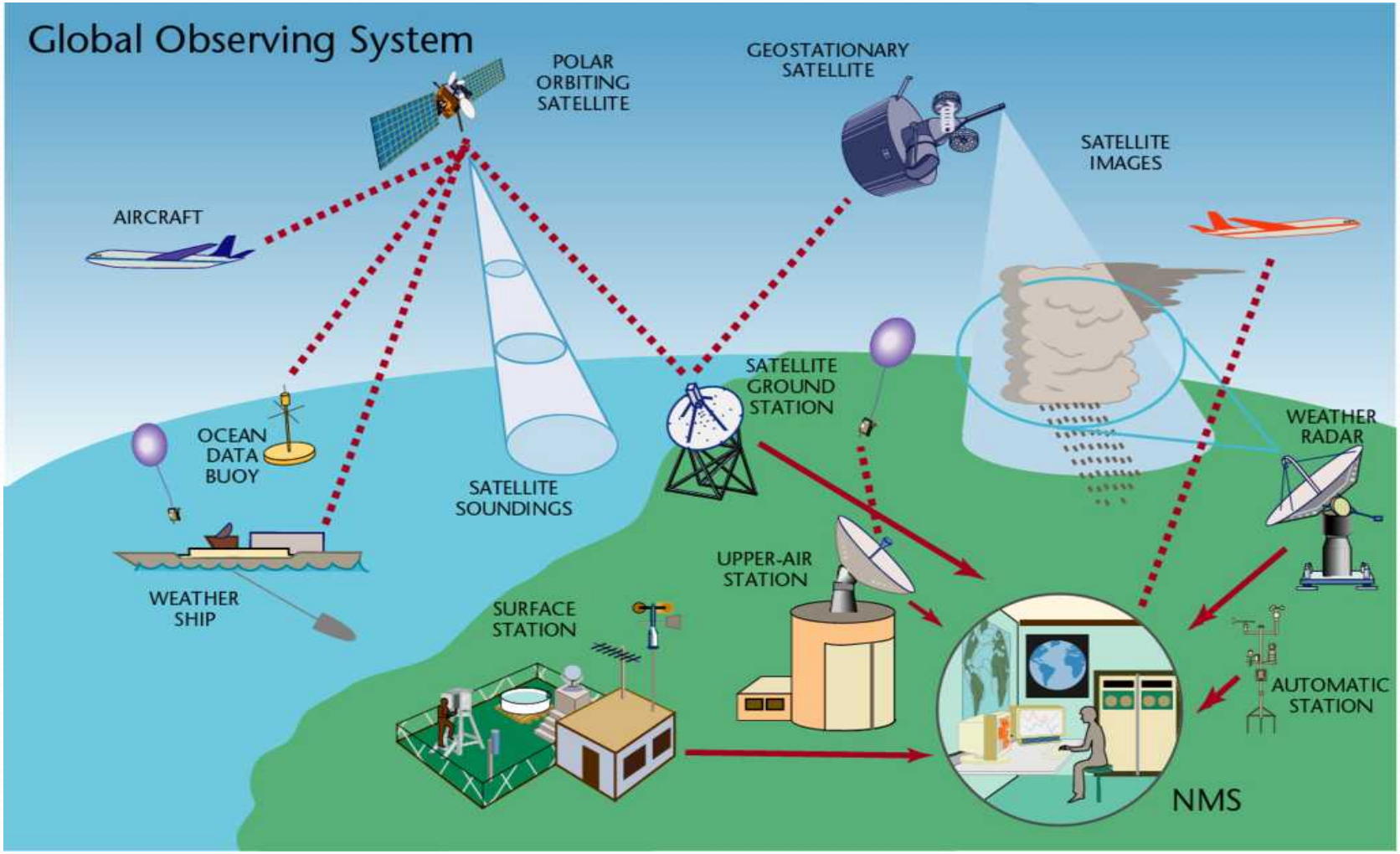
Communities

3+1 years of sequential strategic planning

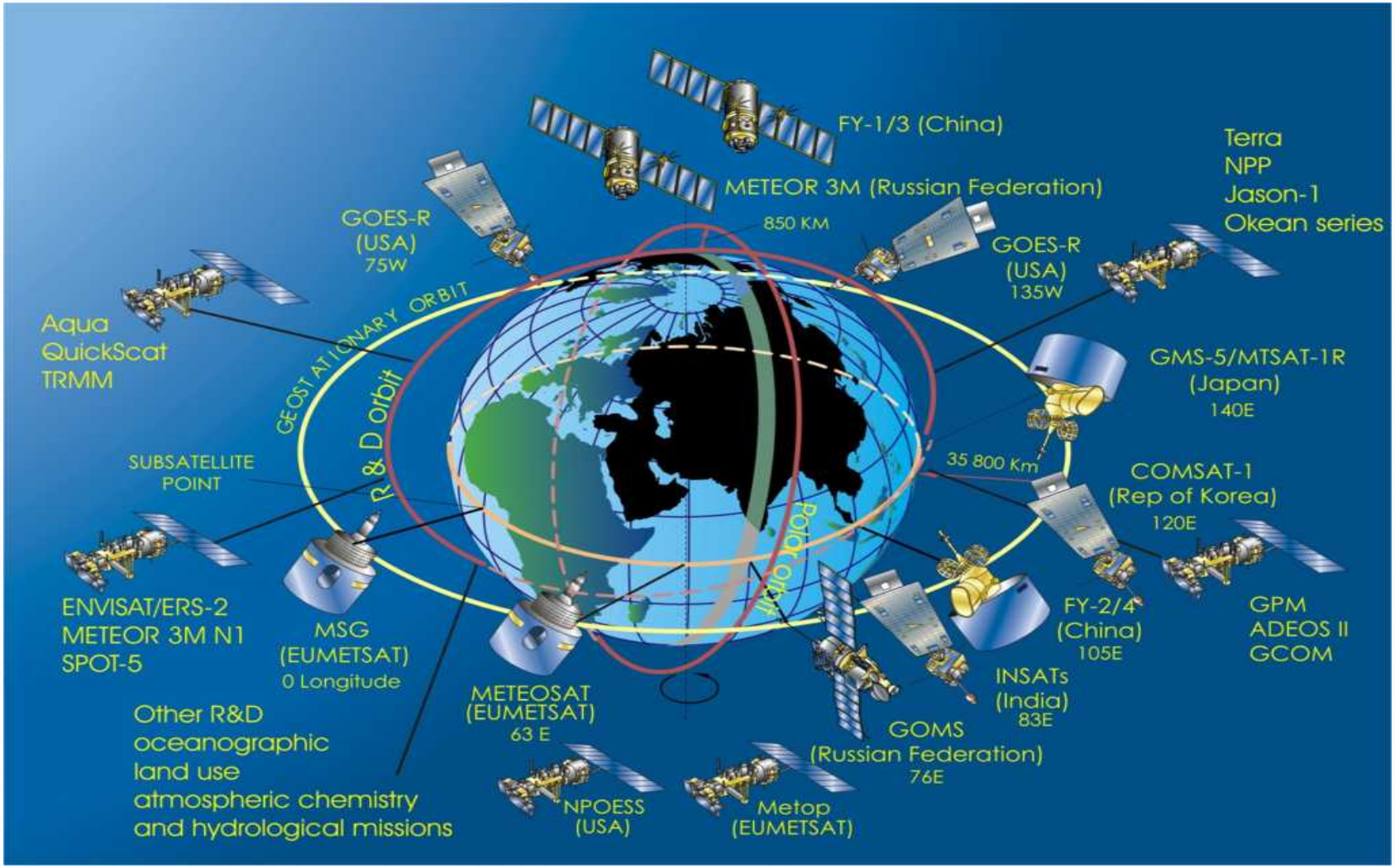
Principal reference to vulnerability and risks



COMPONENTS OF THE GOS



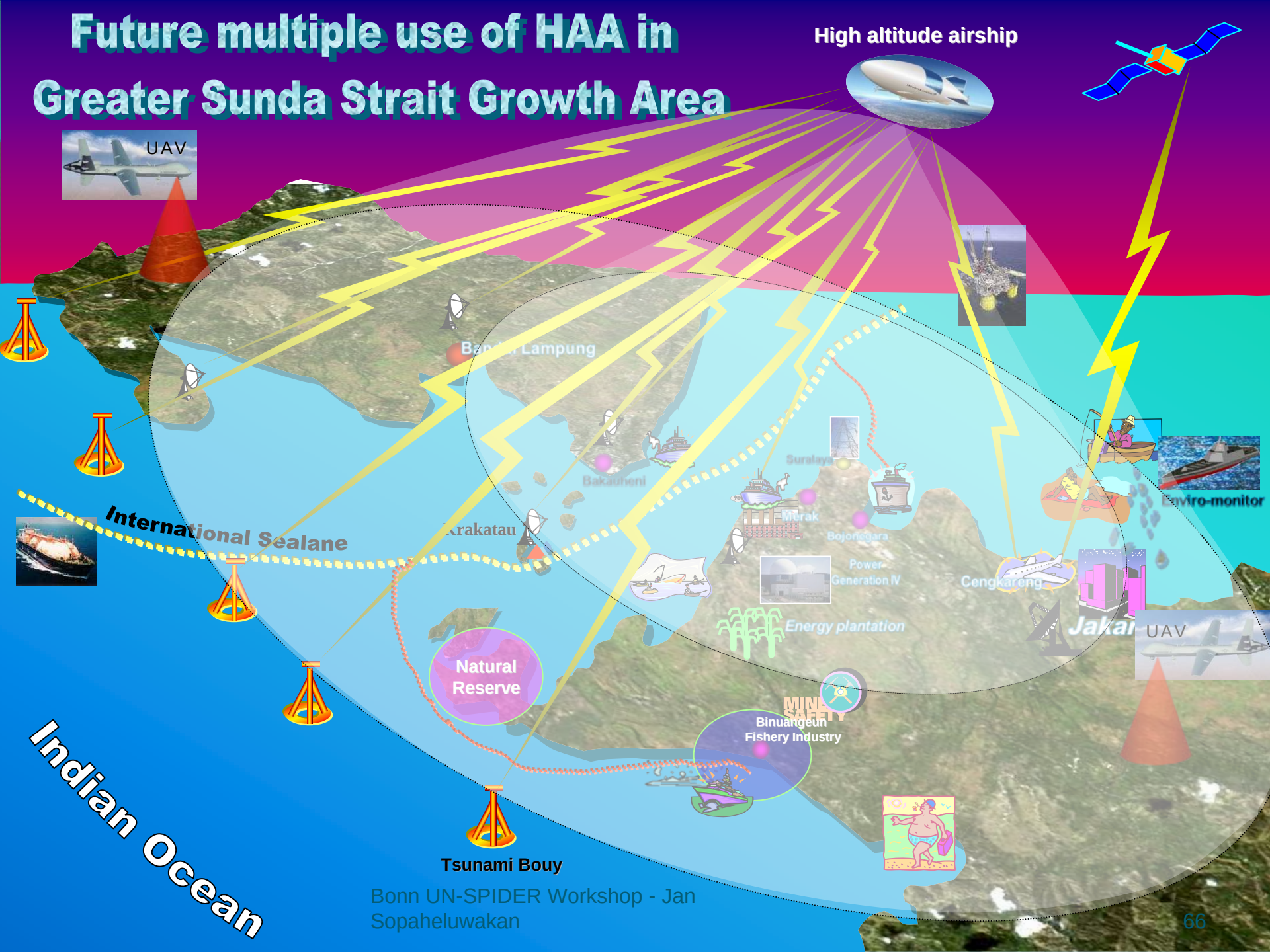
The spaced- based system



GEOSS: the top-down provision

- A distributed system of systems like GEOSS (Global Earth Observation System of Systems)
  - Improve coordination of strategies and observation systems
  - Links all platforms: in situ, aircrafts, and satellites
  - Identifies gaps in our global capacity
  - Facilitates exchange of data and information
  - Improves decision maker's ability to address pressing policy issues

Future multiple use of HAA in Greater Sunda Strait Growth Area



Closing remarks

- The 261204 Indian Ocean tsunami has changed totally the way we look at disaster
- We need a global and distributed system of systems and robust, cost effective space based technology and information to address both rapid-and slow-onset disasters
- The highly diverse geographic setting of Indonesian Maritime Continent bears also all sorts of rapid- and slow-onset disasters
- The global cooperation in contributing the Indonesian experience in building “home grown” tsunami warning system has been a remarkable best practice to be implemented elsewhere in the world