BADAN INFORMASI GEOSPASIAL

# On the Use of Geospatial Information and Services for the Implementation of Sendai Framework for Disaster Reduction in Indonesia

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**Head**

**Geospatial Information Agency of Indonesia (BIG)**

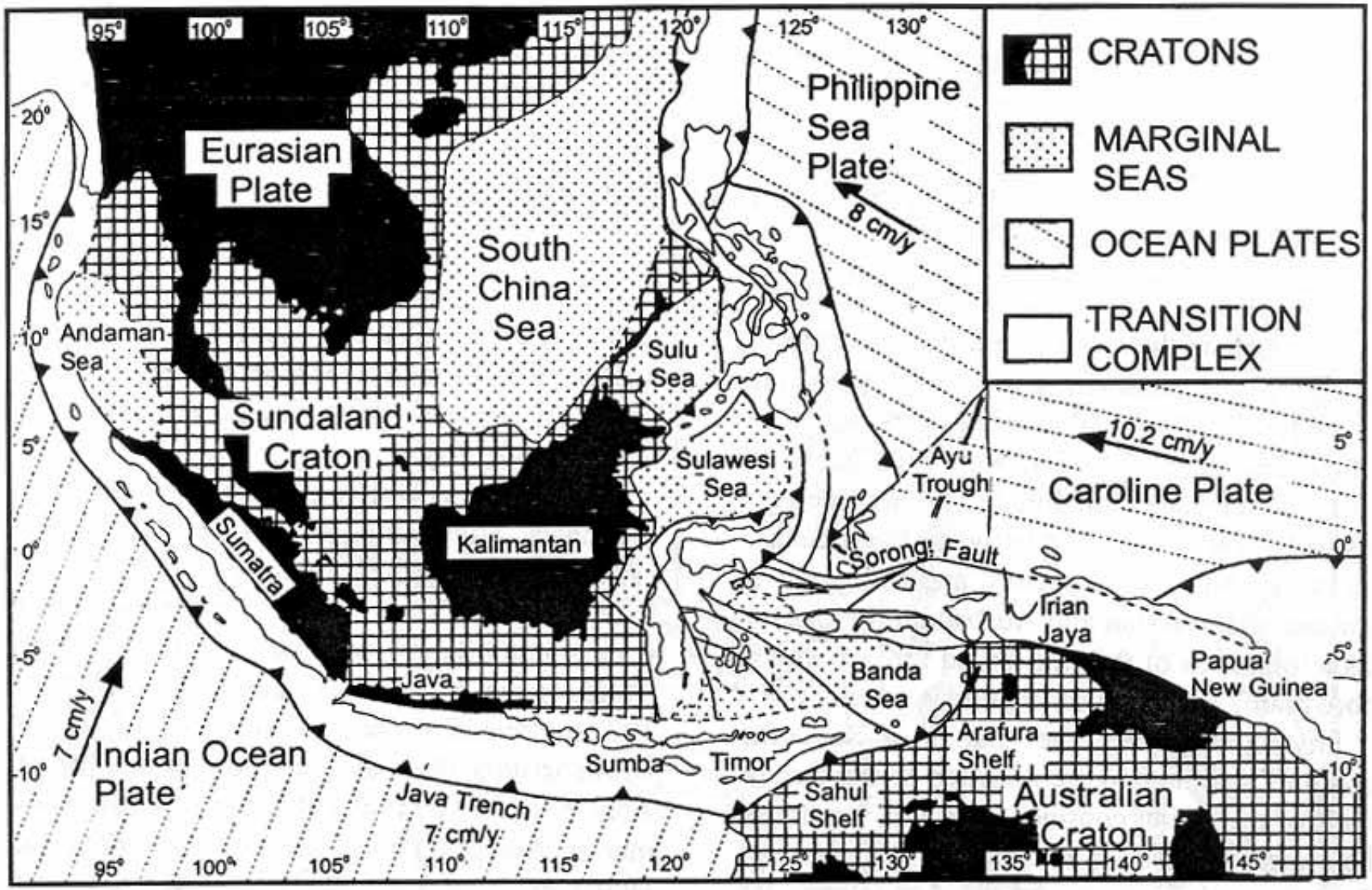

**8th Plenary Meeting of UN-GGIM-AP**

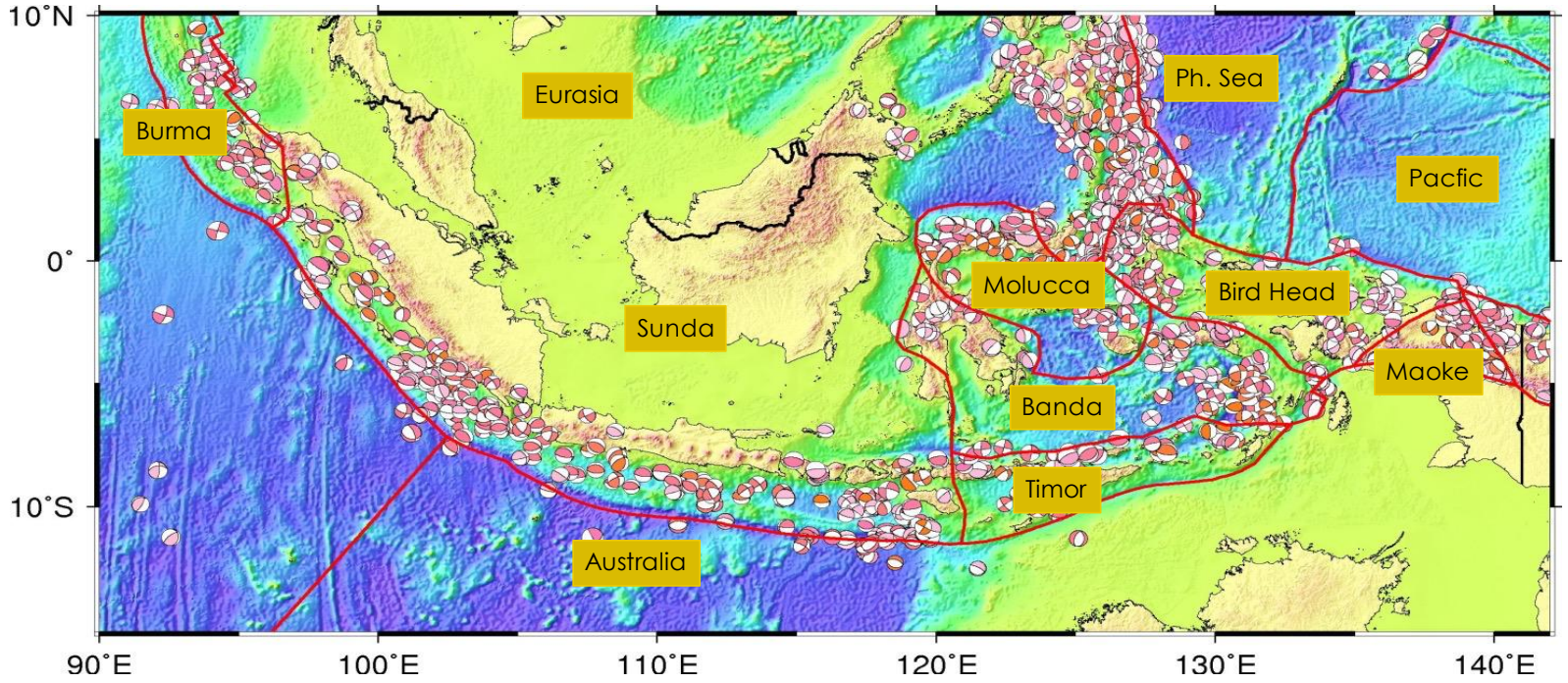
**Canberra, 3-5 November 2019**

# General Tectonic Settings of Indonesia

from *Simandjuntak and Barber* (1996)

**INDONESIA**
**is an archipelago with tectonically active settings, and therefore prone towards many natural hazards.**

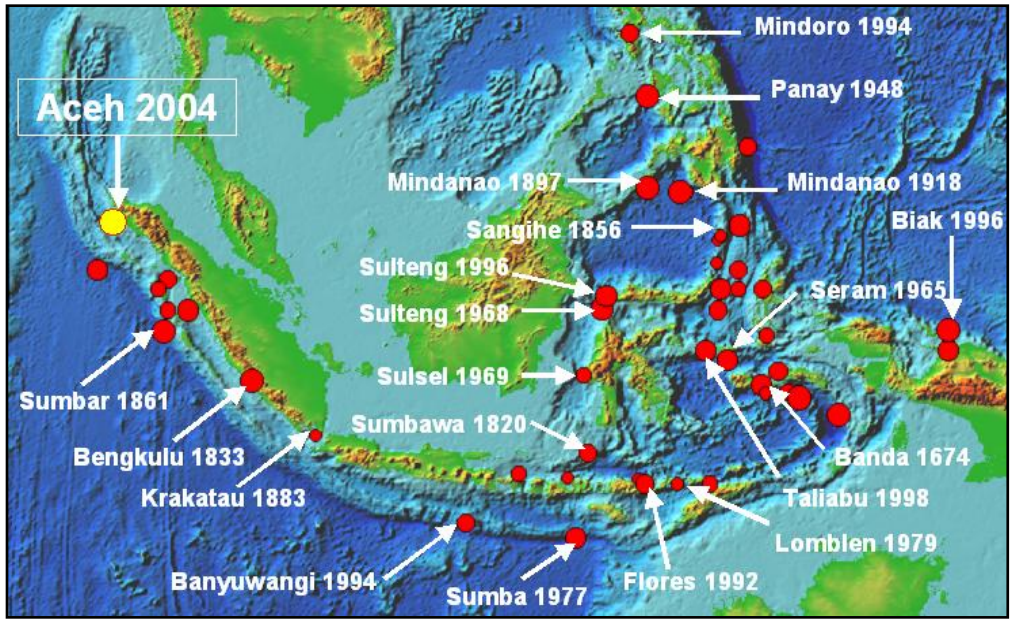





# INDONESIA

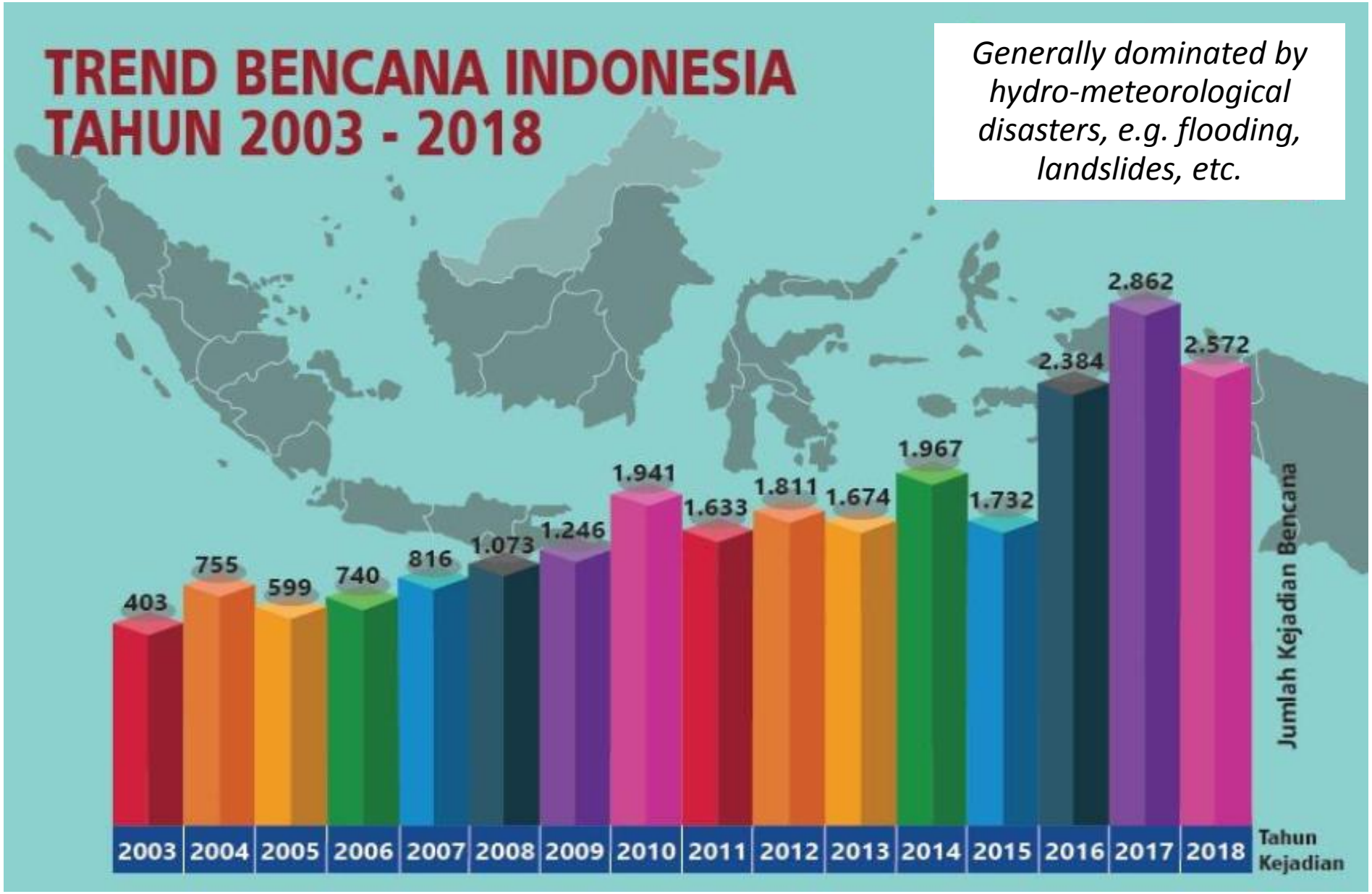
## Home of Natural Hazards

**Geospatial Information is compulsory for supporting Disaster Risk Reduction Management activities**




- *Earthquakes*
- *Tsunami*
- *Volcano Eruption*
- *Flooding*
- *Landslide*
- *Land subsidence*
- *Drought*
- *Flooding*
- *Forest fire*
- *Windstorm*

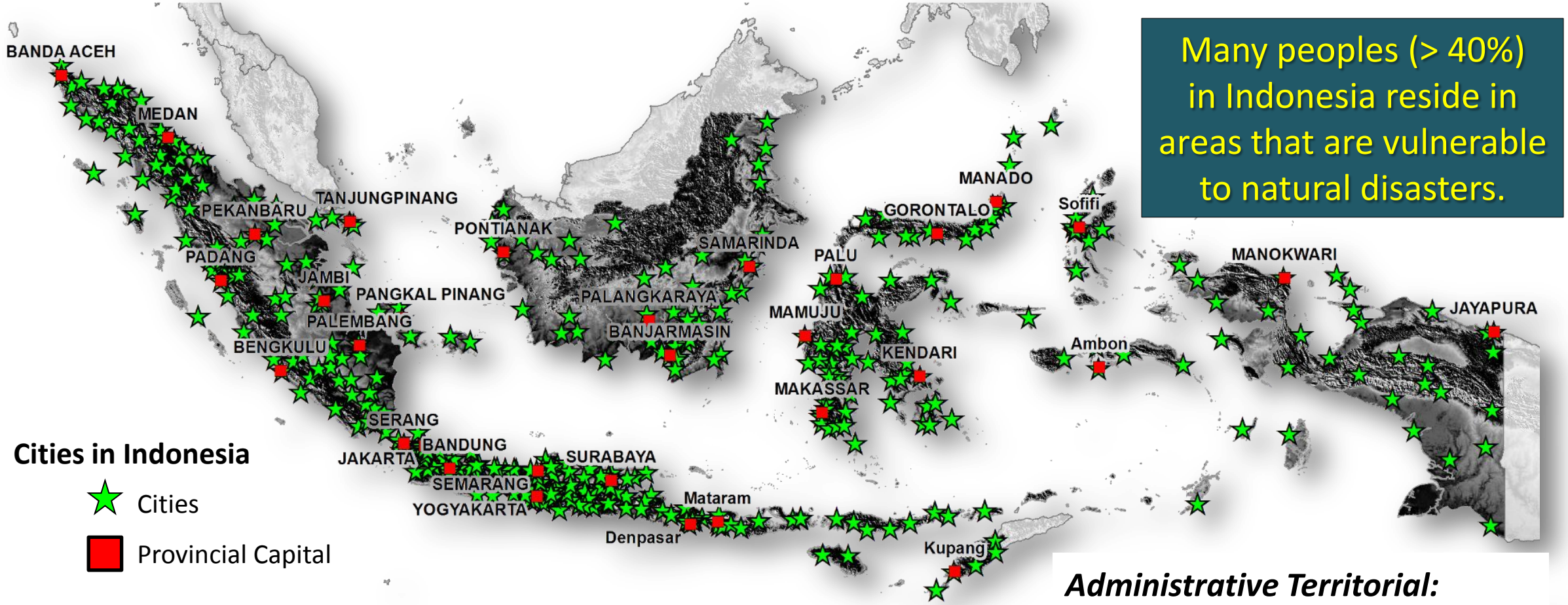
# Natural Disaster Occurrence Trends, 2003 - 2018




*Generally dominated by hydro-meteorological disasters, e.g. flooding, landslides, etc.*

Ref. BNPB (2019)

# Importance of Disaster Risk Reduction Management in Indonesia




Many peoples (> 40%) in Indonesia reside in areas that are vulnerable to natural disasters.

***Administrative Territorial:***

- ***34 Provinces***
- ***514 Cities***
- ***7094 Districts***
- ***83.447 Villages***

Natural disasters are latent hazards in Indonesia, and therefore its mitigation and adaptation must be handled properly by a sustainable disaster risk reduction management.

# Importance of Disaster Risk Reduction Management in Indonesia

**The impact of natural disasters is usually very damaging and costly !**

**Example of Estimated Loss and Damage Disaster of 28 Sept. 2018 Palu-Donggala-Sigi-Parigi Moutong**

| Estimated Loss and Damage (in Trillion Rupiah) | |
|---|---|
| **AREA** | **VALUE** |
| Palu | 8,3 |
| Sigi | 6,9 |
| Donggala | 2,7 |
| Parigi Moutong | 0,6 |
| **TOTAL** | **18,5** |

| Estimated Loss and Damage (in Trillion Rupiah) | |
|---|---|
| **SECTOR** | **VALUE** |
| Settlement | 9,4 |
| Infrastructure | 1,1 |
| Economic | 4,2 |
| Social | 3,4 |
| Cross | 0,4 |
| **TOTAL** | **18,5** |

| No | Disaster | Time | Loss & Damage (Billion Rp.) |
|---|---|---|---|
| 1 | Aceh-Nias Earthquake and Tsunami | Dec. 2004 | 41.400 |
| 2. | Yogyakarta Earthquake | May 2006 | 29.100 |
| 3. | Sidoarjo Mud Volcano | May 2006 | 7.300 |
| 4. | Pangandaran Tsunami | July 2006 | 403 |
| 5. | Jakarta Flood | Feb. 2007 | 5.160 |
| 6. | West Sumatra Earthquake | March 2007 | 1.081 |
| 7. | Bengkulu-West Sumatra Earthquake | Sept. 2007 | 1.791 |
| 8. | Central-East Java Flood & Landslides | Jan. 2008 | 1.692 |
| 9. | Tasikmalaya Earthquake | Sept. 2009 | 6.900 |
| 10. | West Sumatera Earthquake | Sept. 2009 | 20.867 |
| 11. | Wasior Flash Flood | Oct. 2010 | 278 |
| 12. | Mentawai Earthquake and Tsunami | Oct. 2010 | 315 |
| 13. | Merapi Volcanic Eruption | Oct. 2010 | 3.558 |
| 14. | North Sulawesi Flash Flood | Jan. 2014 | 1.439 |
| Losses and damages from from several previous disasters (BNPB, 2019) | | | |

Also there will be tremendous **intangible loss and damage** due to **death of many victims**, **social network destruction**, **environmental destruction**, etc.

# Priorities in Disaster Risk Reduction Management

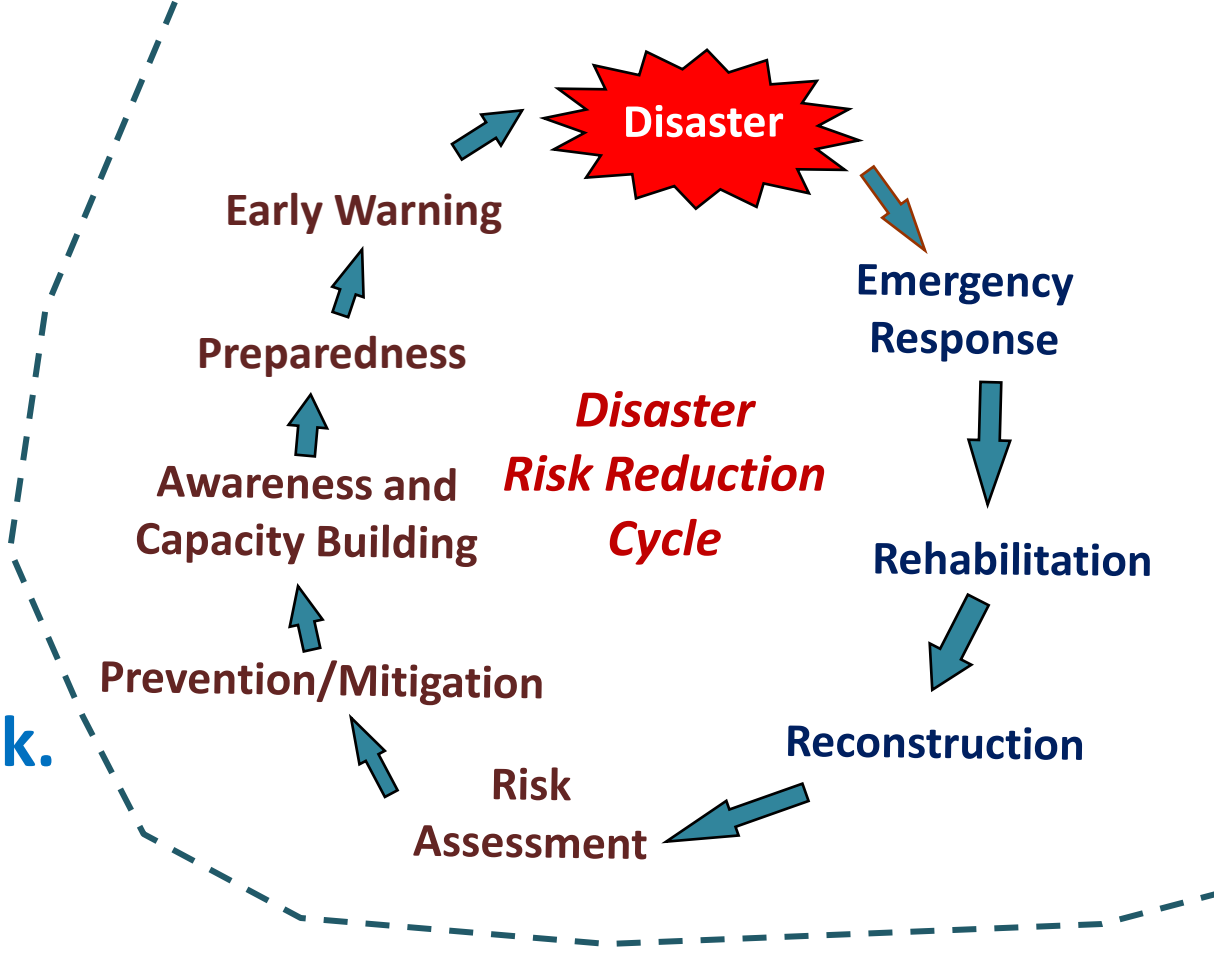
(Sendai Framework 2015)

**P-1: Understanding disaster risk.**

**P-2: Strengthening disaster risk governance to manage disaster risk.**

**P-3: Investing in disaster risk reduction for resilience.**

**P-4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.**




***Geospatial Information** will have important roles for several activities of the DRRM Priorities.*

# Parties involved in DRRM in Indonesia

**BNPB**
National Disaster Management Agency

**Formulating and establishing disaster management and refugee handling policies**, by acting quick, precise, effective, and efficient; and Coordinating the implementation of disaster management activities in a planned, integrated and comprehensive manner.

**BMKG**
Meteorological, Climatological and Geophysical Agency

Carry out governmental duties in the fields of Meteorology, Climatology, Air Quality and Geophysics in accordance with applicable law and regulation, e.g.
→ **Submitting information and early warning to agencies and related parties as well as the public regarding disasters** due to meteorological, climatological and geophysical factors.

## Some Supporting Ministries

## Some Supporting Agencies

BADAN INFORMASI GEOSPASIAL
Geospatial Information Agency

BADAN GEOLOGI
KEMENTERIAN ENERDI DAN SUMBER DAYA MINERAL

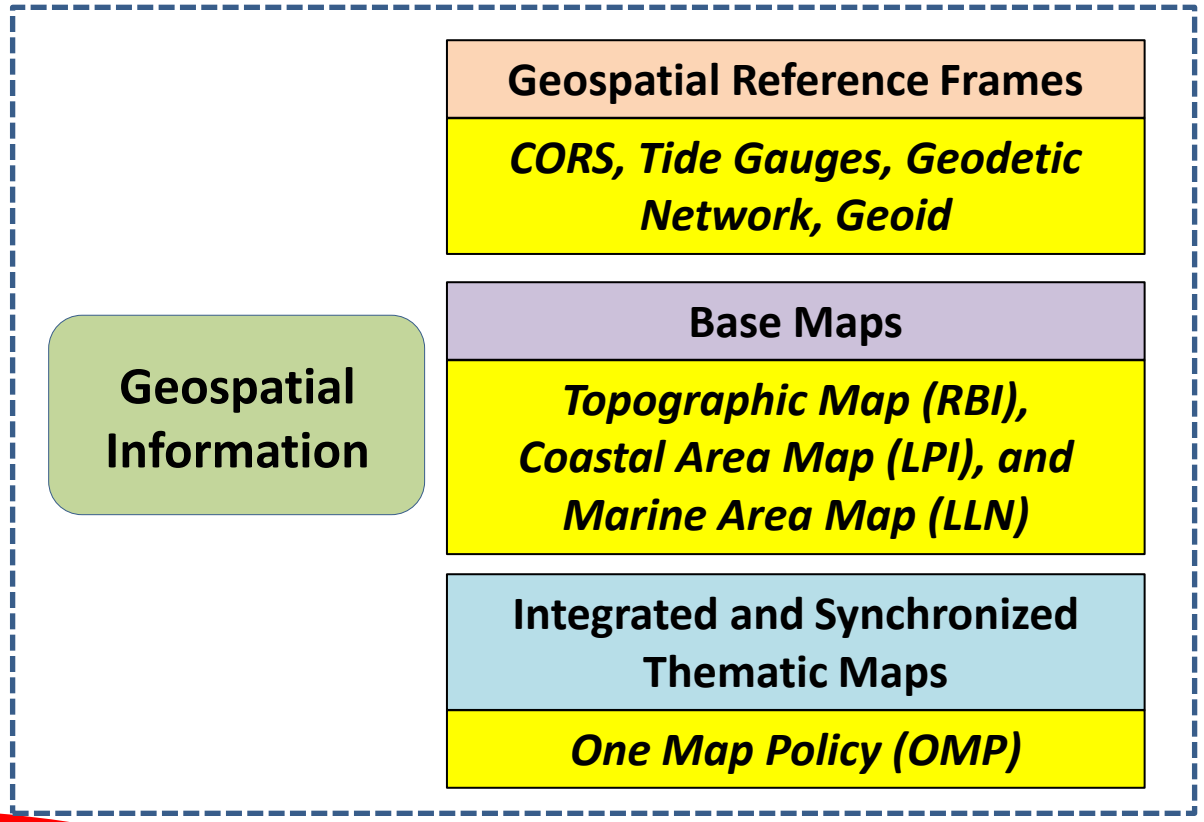
Badan Pengkajian dan Penerapan Teknologi

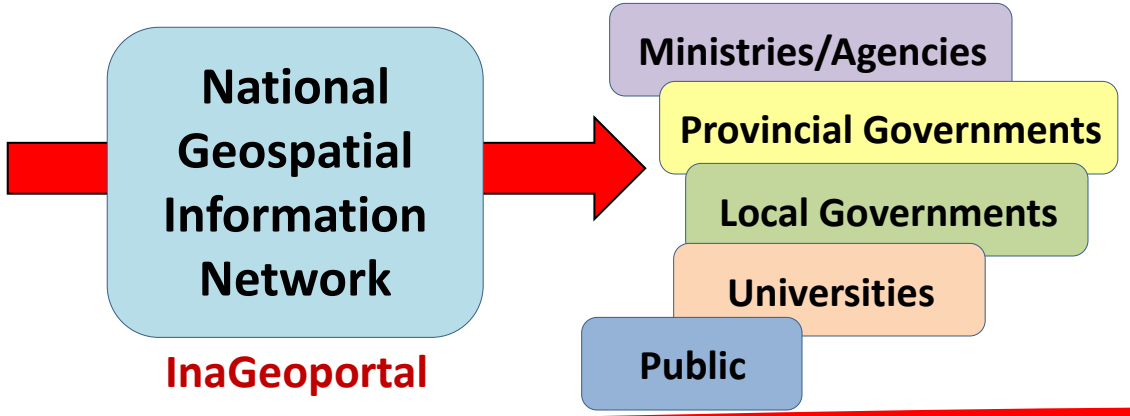
LAPAN

LIPI

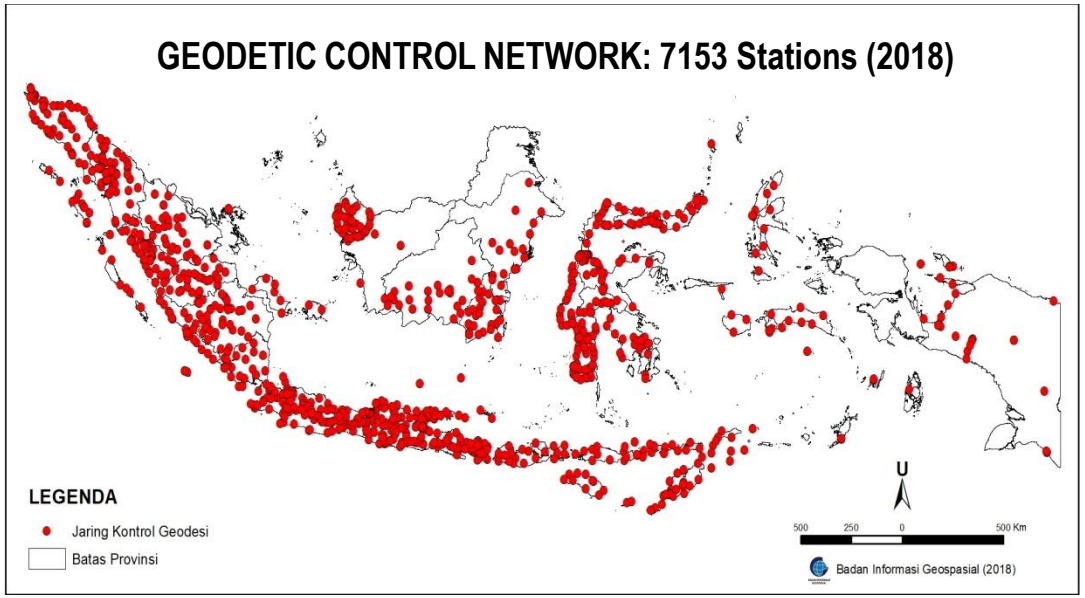
## Some Universities

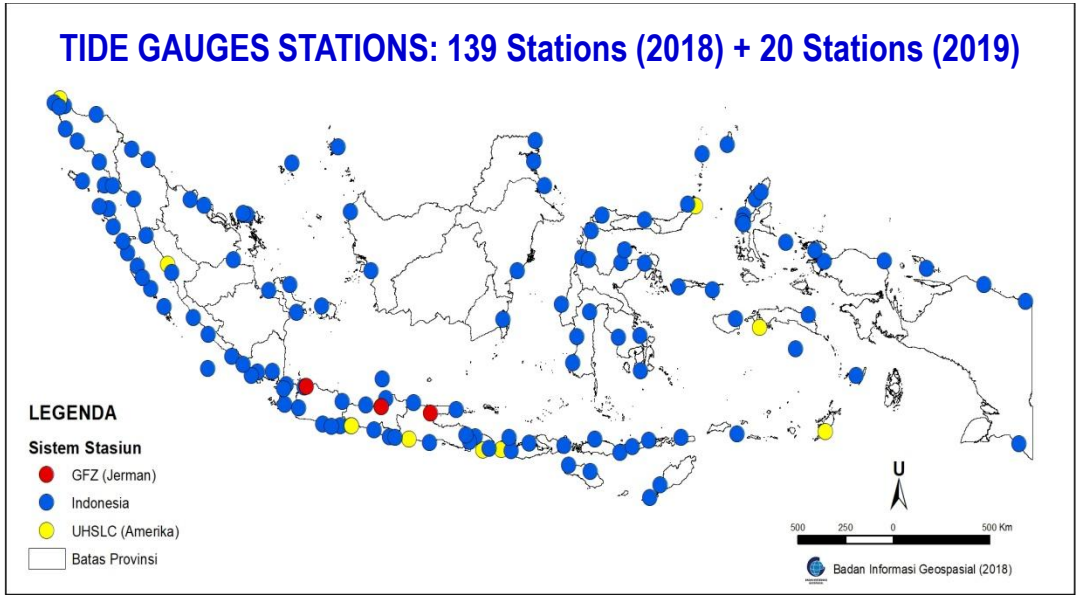
# Geospatial Information for Disaster Risk Reduction Management (Indonesian Case)

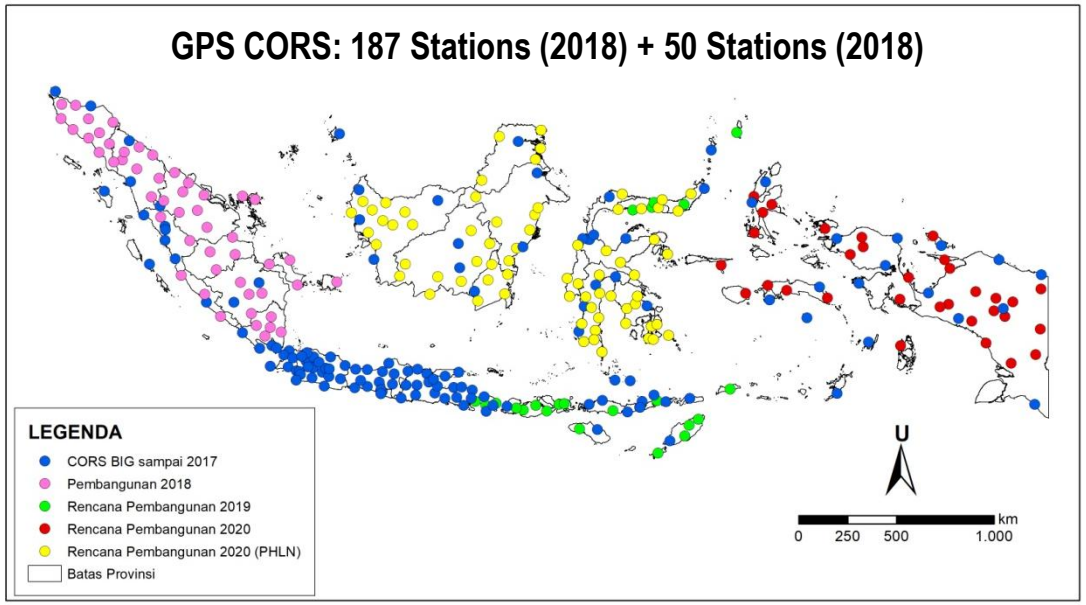


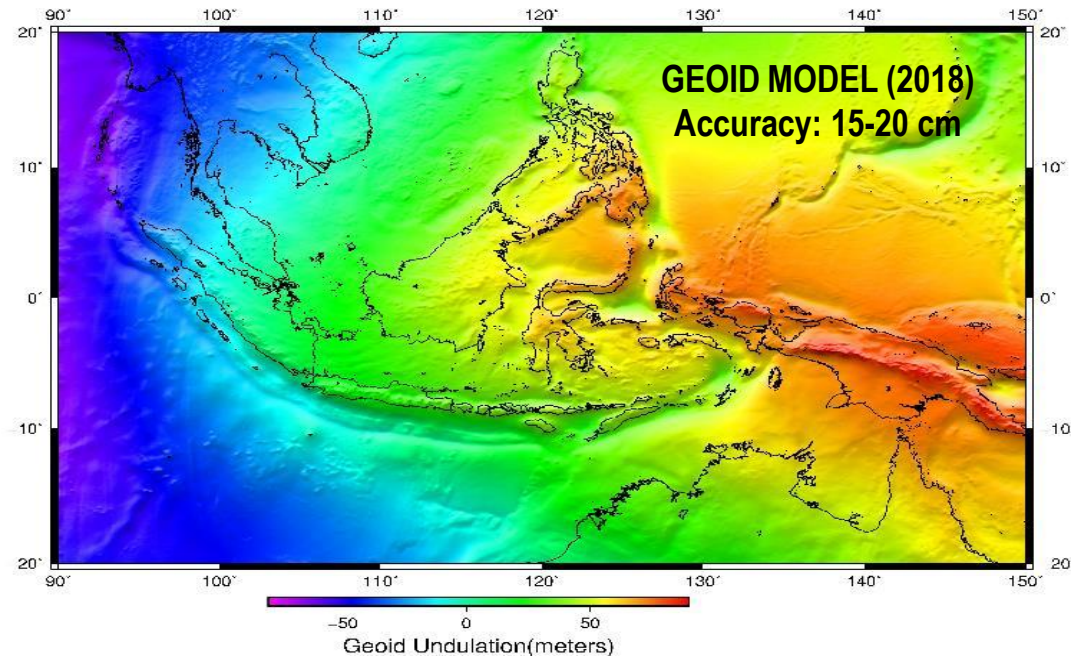


# Geospatial Reference Frames of Indonesia



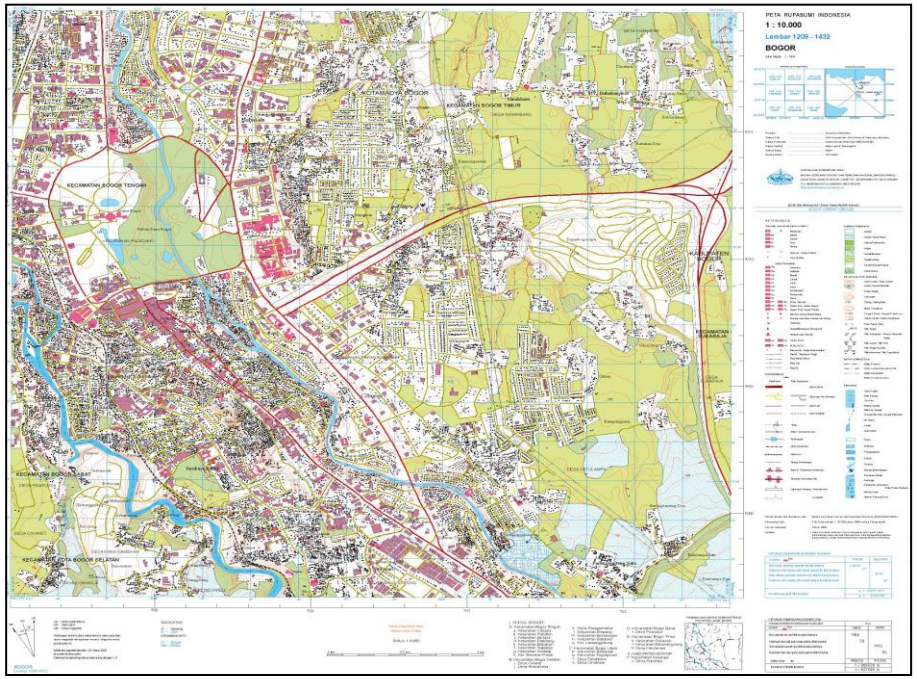



# Basemaps of Indonesia

- Topographic Map
- Coastal Area Map
- Marine Area Map

Scales of
1:1000 to 1:1.000.000

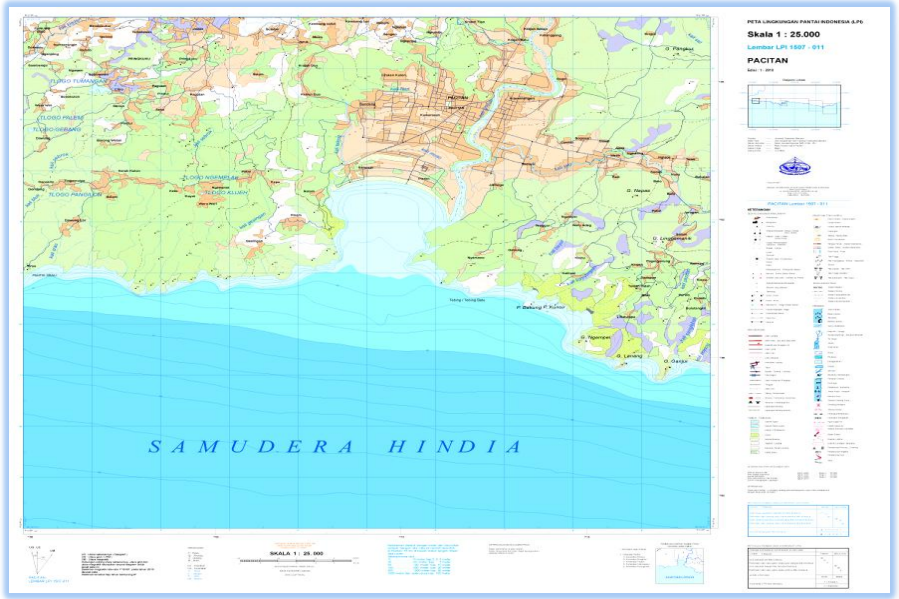



Topographic Map

**Topographic layers:**

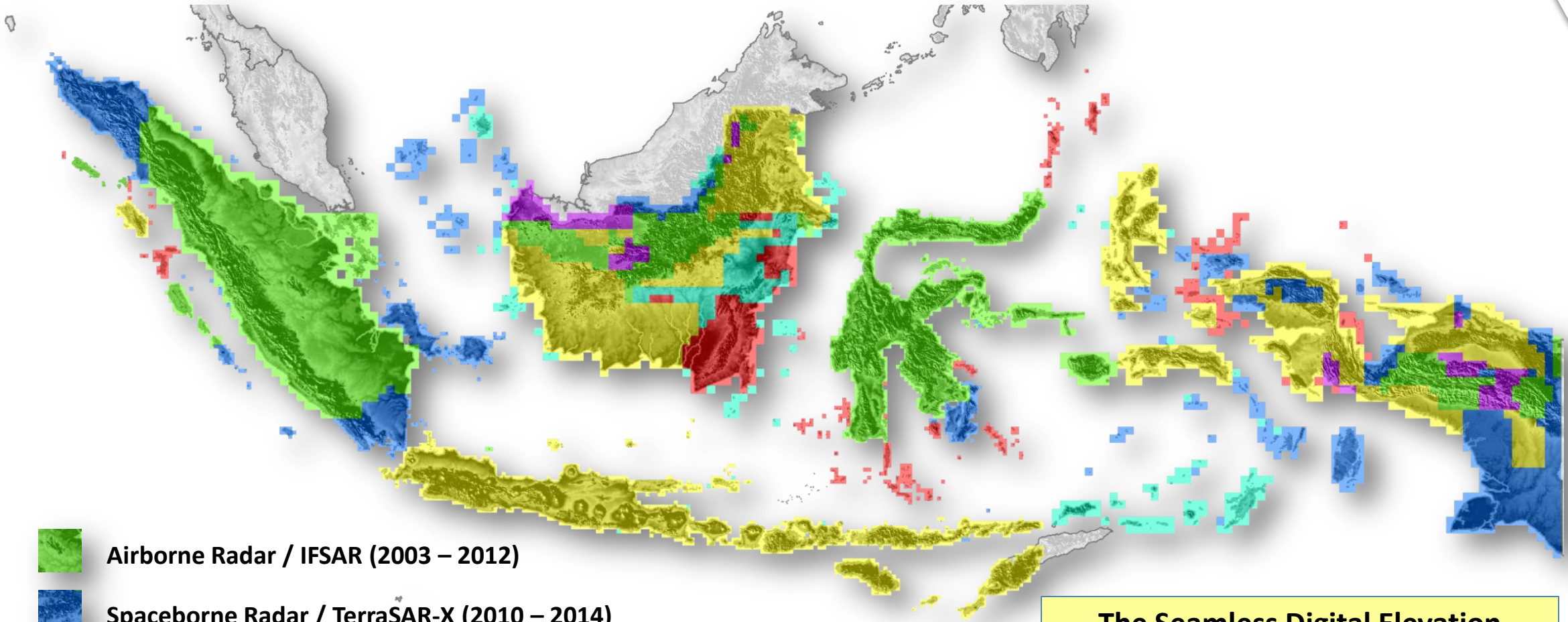
1. Coastline
2. Hipsography
3. Hidrography
4. Topographic names
5. Administrative boundary
6. Transportation and utility
7. Building and public facility
8. Land cover

Coastal Area Map




Marine Area Map

# DEM (Digital Elevation Model) for DRRM Activities



Airborne Radar / IFSAR (2003 – 2012)

Spaceborne Radar / TerraSAR-X (2010 – 2014)

Spaceborne Radar / ALOS PALSAR

Aerial Photos (1992 – 1994)

**The Seamless Digital Elevation Model (DEM) and Bathymetry of Indonesia, is free and publicly accessible from the following link: http://tides.big.go.id/DEMNAS/**

# ONE MAP POLICY of Indonesia

**Presidential Regulation No. 9/2016:**
**Regarding the acceleration of implementation of One Map Policy on 1:50.000 scale map accuracy.**
**Issued on 4 February 2016.**

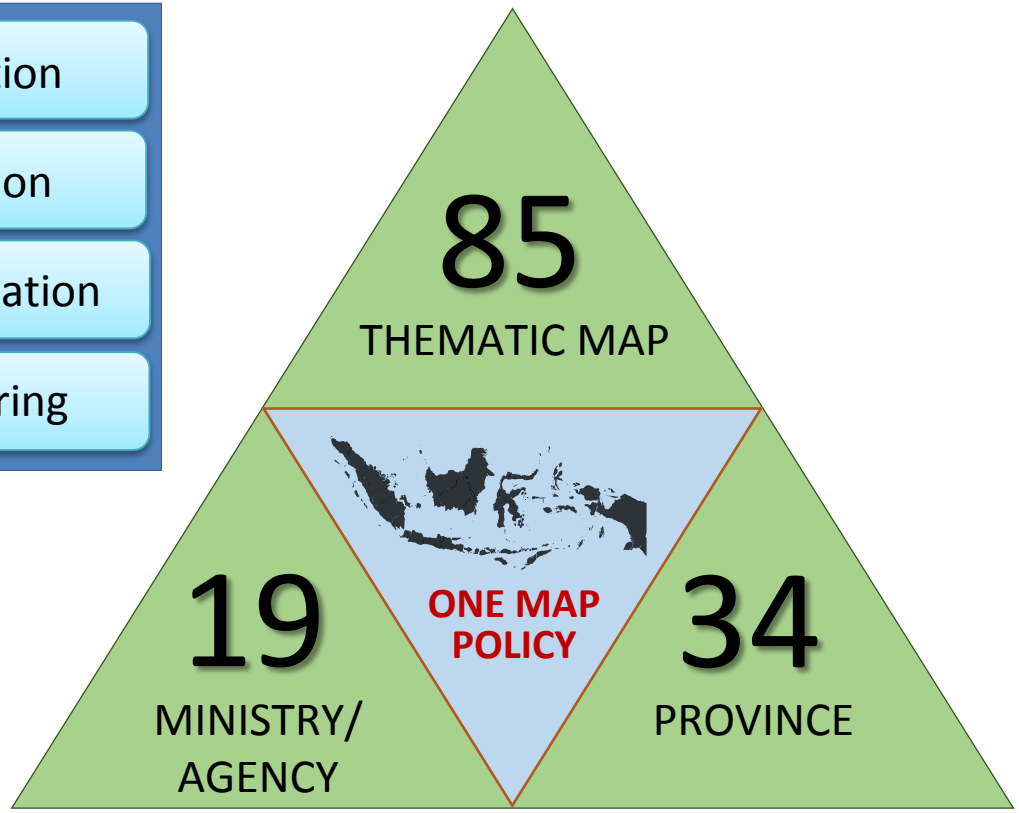
# Thematic Maps of Indonesia

## ONE MAP POLICY GOALS

1 GEOREFERENCE
STANDARD
DATA BASE
GEOPORTAL

## ONE MAP POLICY MAIN PROGRAM

- Compilation
- Integration
- Synchronization
- Data Sharing



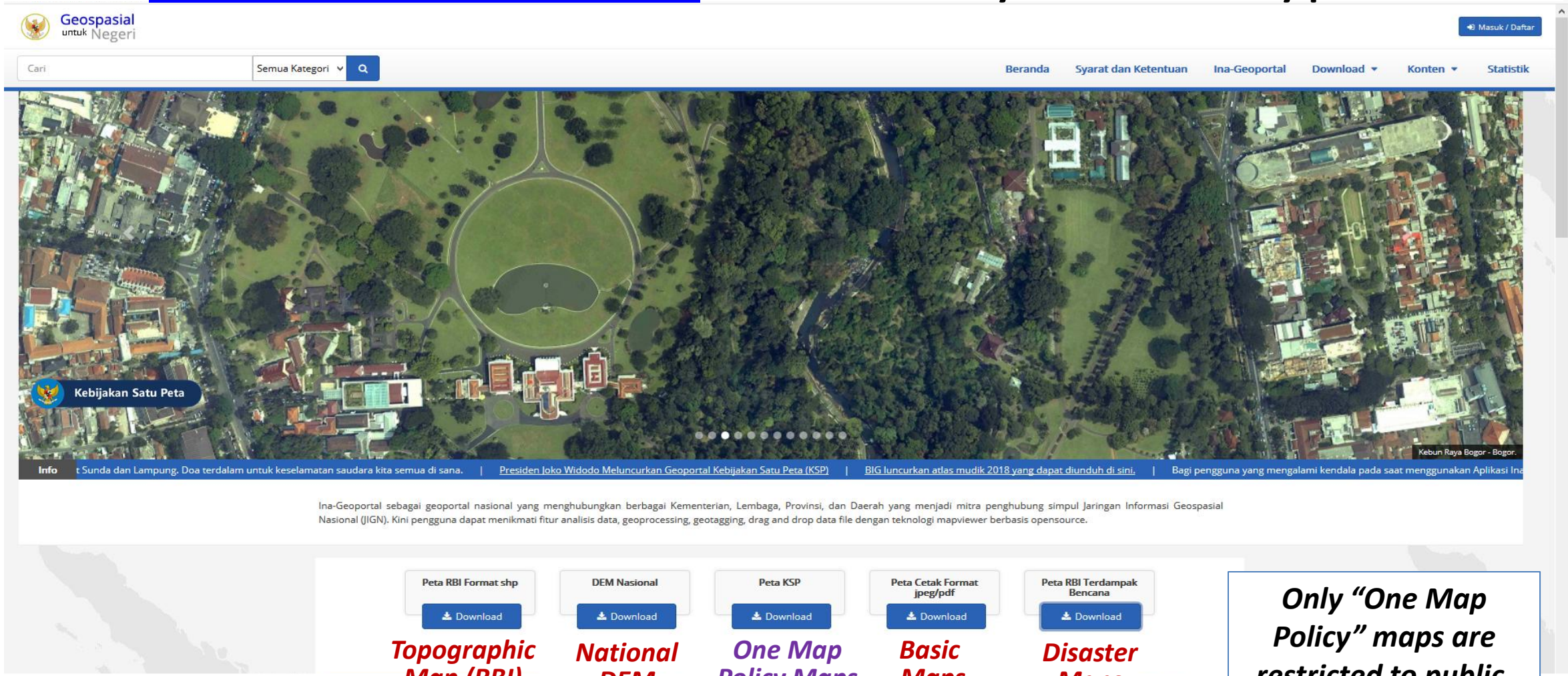

## ONE MAP POLICY UTILITY

**As Reference for Improving the quality of :**

- Spatial Planning
- National Resources Management
- Sustainable Development
- Disaster Risk Reduction Management
- Policy and Decision Making
- Digital Economy Development

# Geospatial Data Sharing

**Geospatial Data and Information is housed in InaGeoportal: http://tanahair.indonesia.go.id and can be freely downloaded by public**




*Topographic Map (RBI)*

*National DEM*

*One Map Policy Maps*

*Basic Maps*

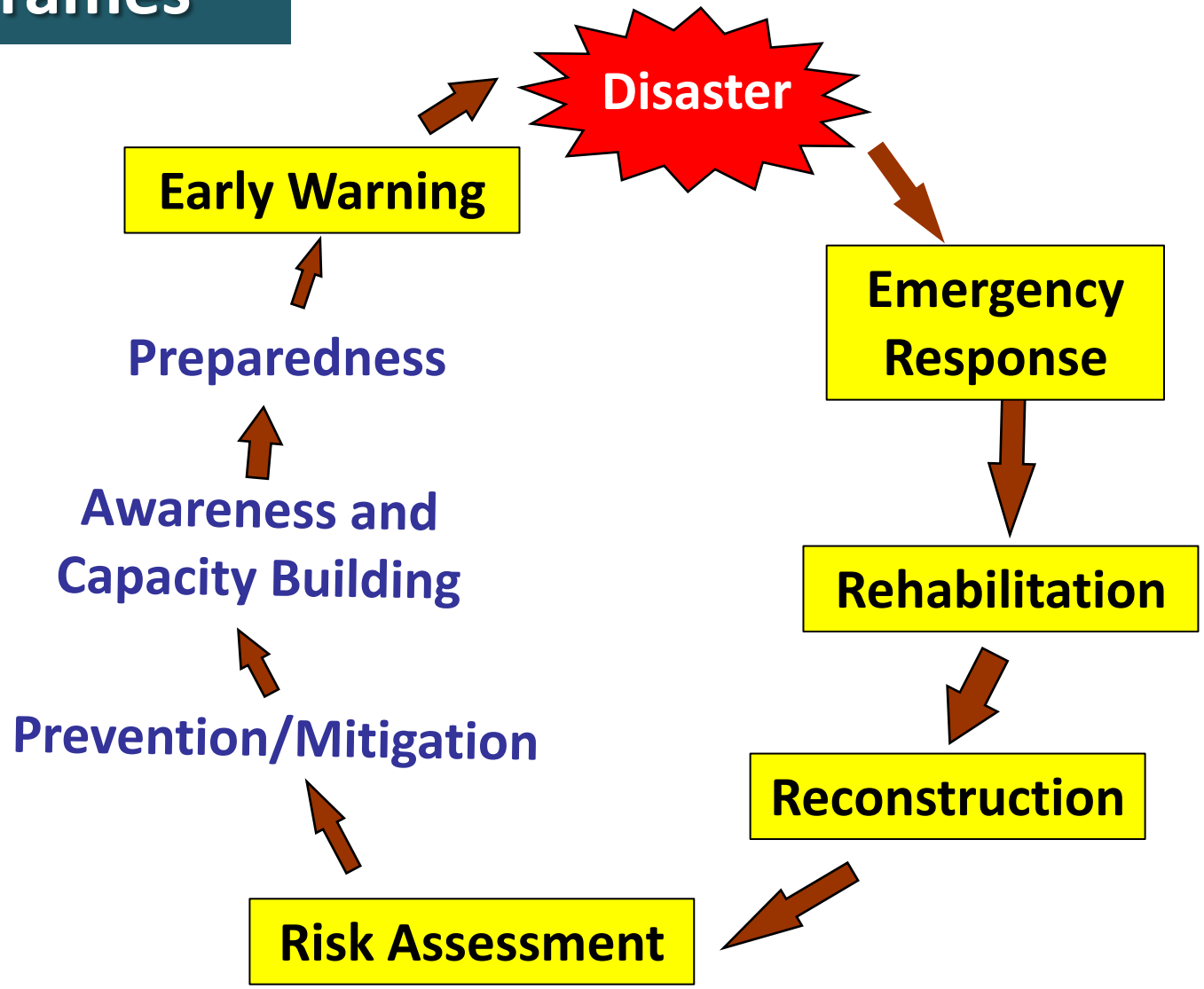
*Disaster Maps*

***Only "One Map Policy" maps are restricted to public.***

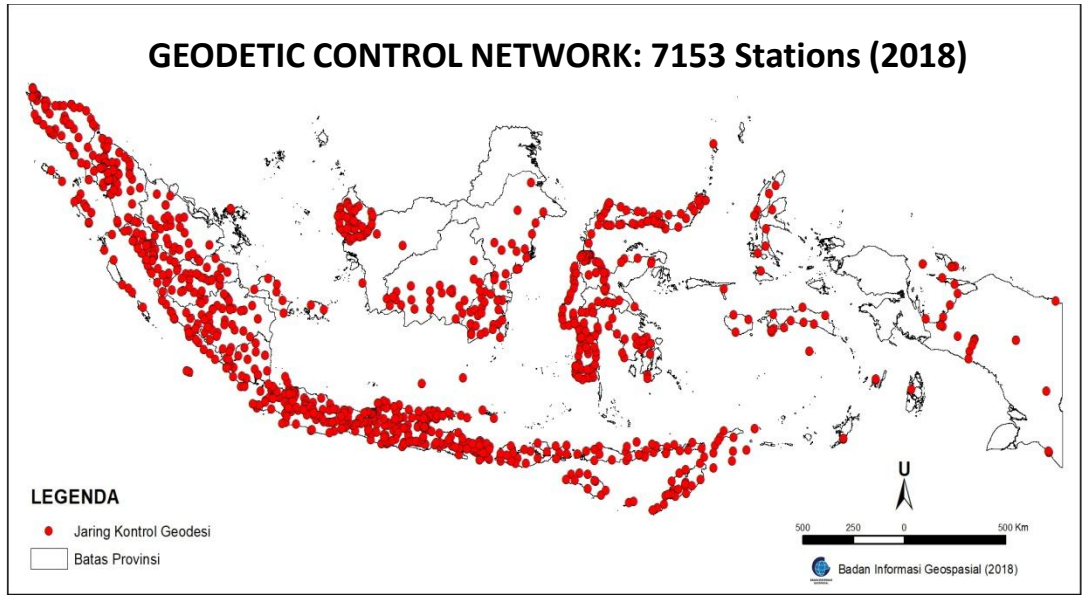
# Roles of Data and Information from Geodetic Reference Frames

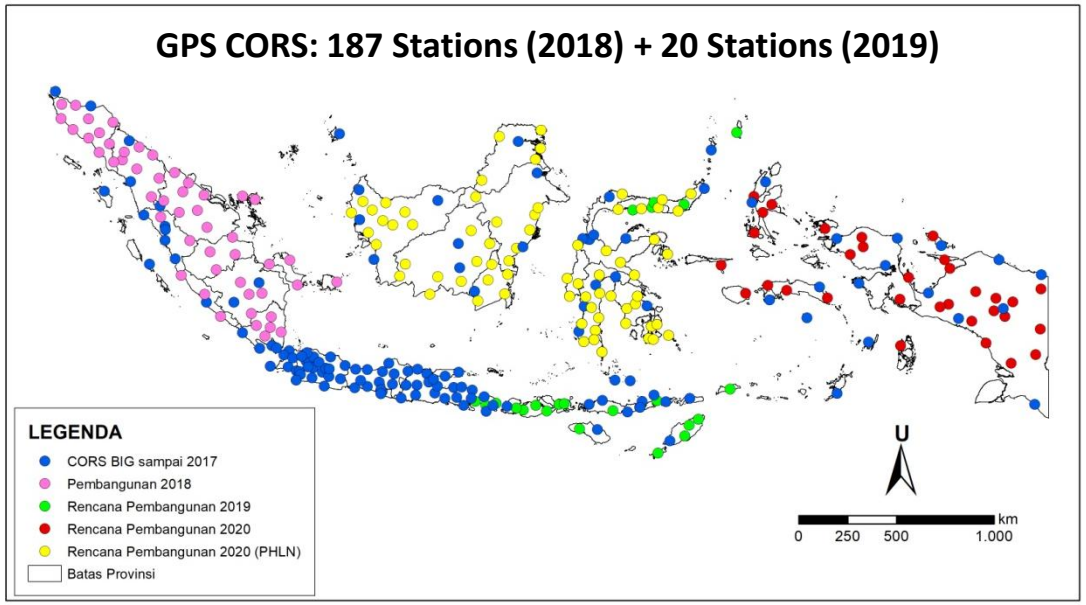
- ***GPS and Leveling Data***
- ***GPS CORS Data***
- ***Tide Gauge Data***

*Data and Information from the Geodetic Reference Frames are mainly important for* ***Risk Assessment, Early Warning, Emergency Response, Rehabilitation and Reconstruction*** *stages*



# GPS CORS and Geodetic Data for DRRM Activities

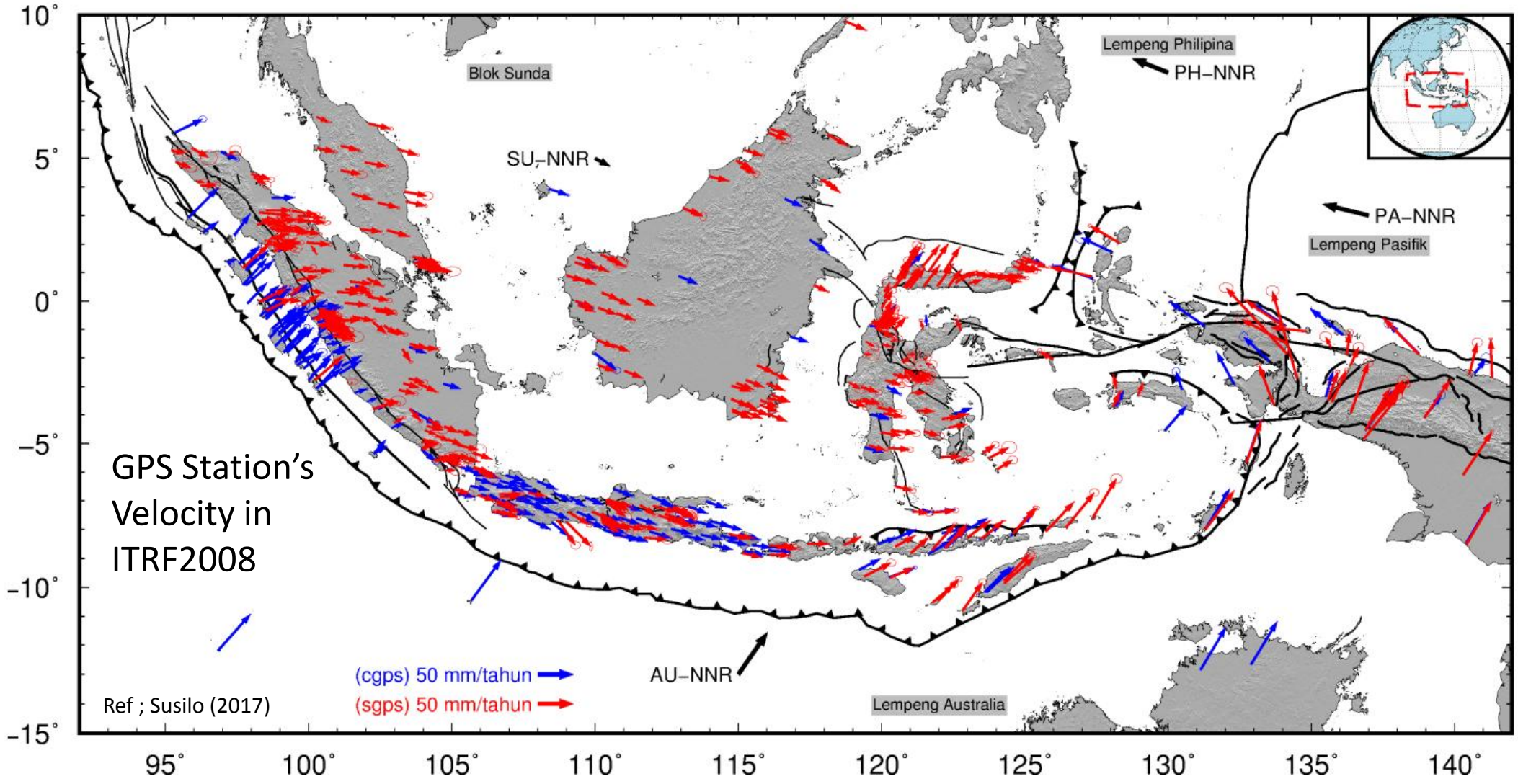


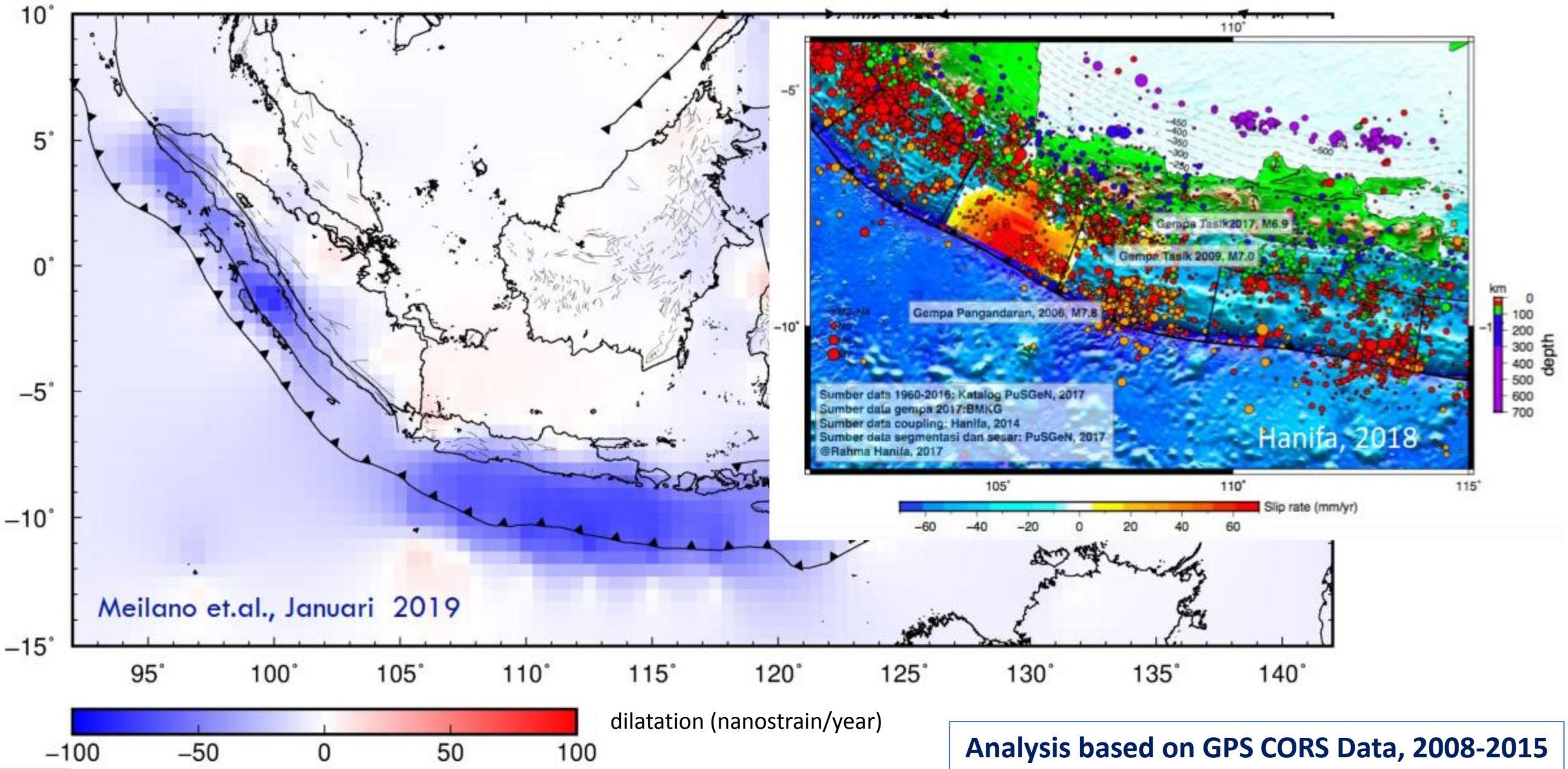

**Data from GPS CORS and Geodetic Control Network will be useful for supporting several activities of Disaster Risk Reduction Management (DRRM), such as:**

- ✓ ***Risk assessment for potential occurrence of several natural hazards, such as earthquake, landslide, and land subsidence.***
- ✓ ***Positioning and navigation of vehicles and persons involved in Emergency Response activities***
- ✓ ***Surveying and mapping for post-event rapid assessment.***
- ✓ ***Surveying and mapping supporting various rehabilitation and reconstruction activities.***

# **Risk Assessment:** Based on GPS (CORS+Episodic) Data



# **Earthquake Potential in the Future** (Hanifa 2018, Meilano 2019)

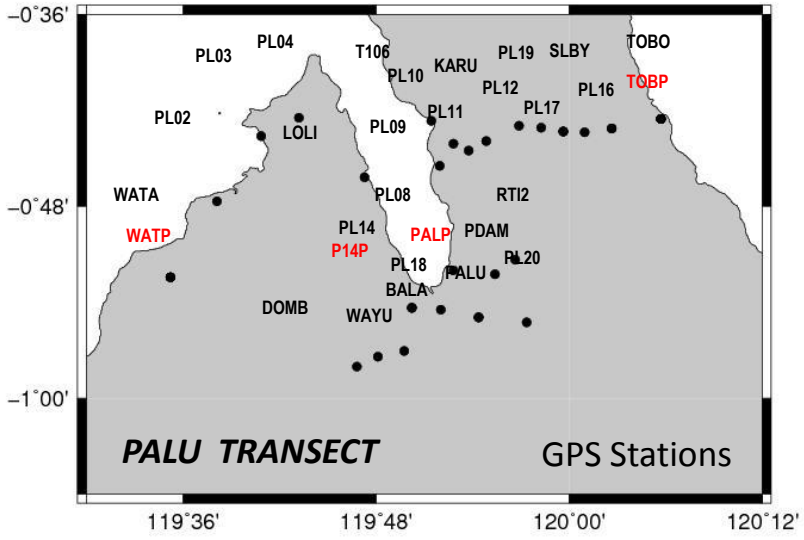


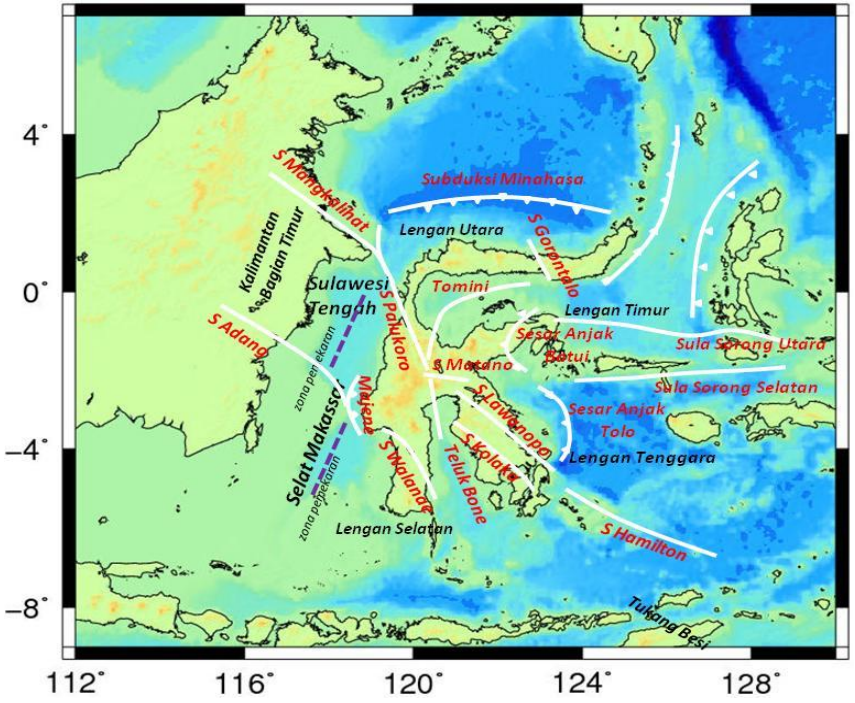

**Analysis based on GPS CORS Data, 2008-2015**

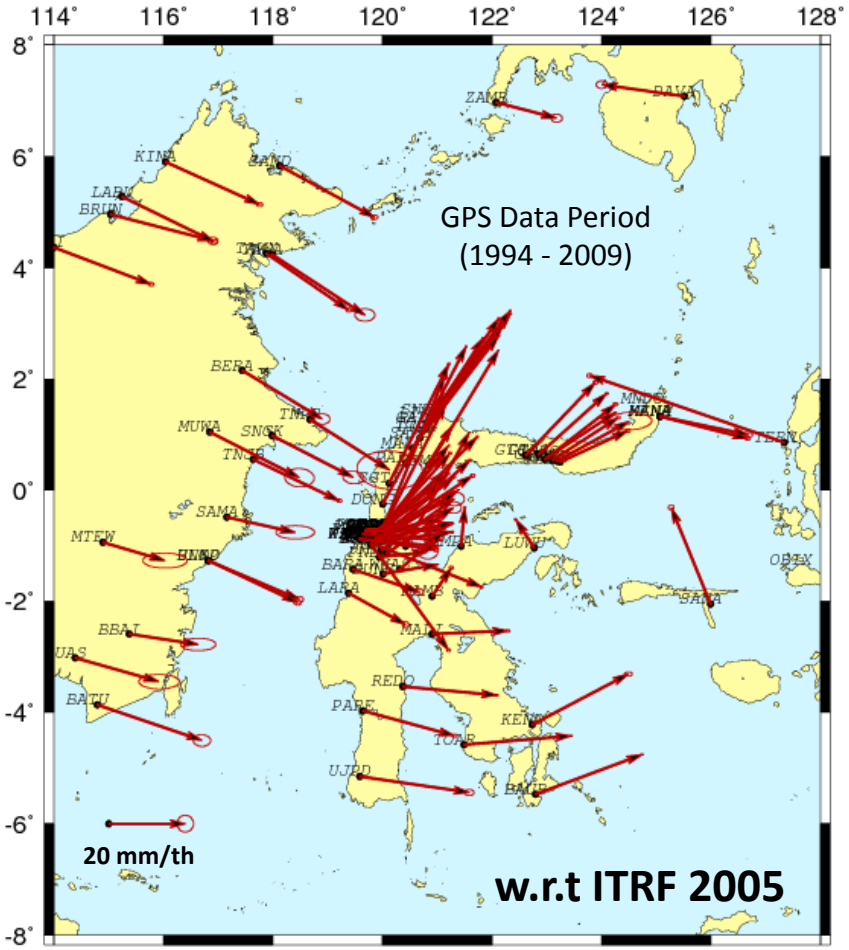
# Risk Assessment:

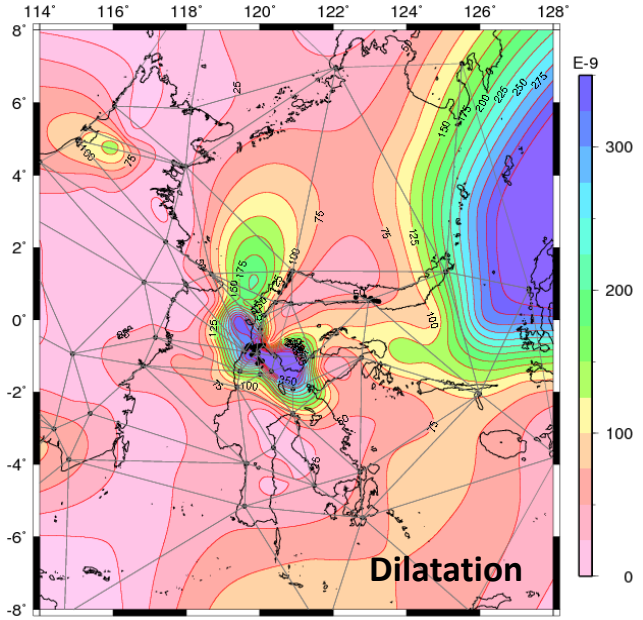
## Based on GPS CORS and GPS Episodic Data

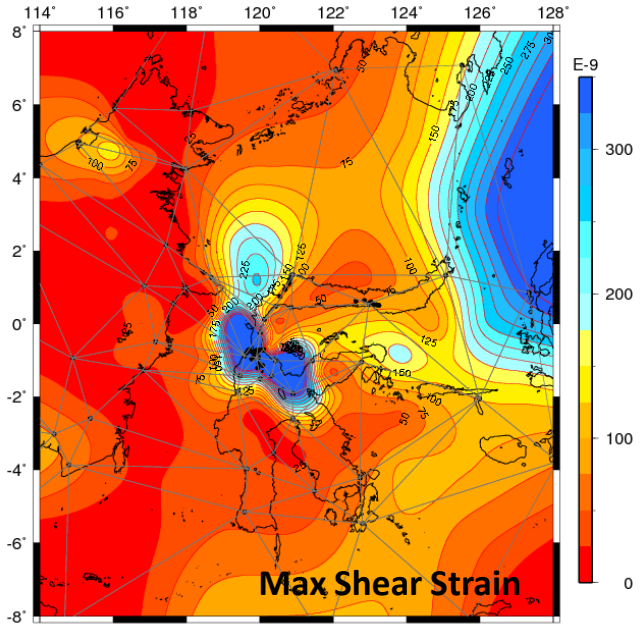
### (Dina A. Sarsito, 2010)



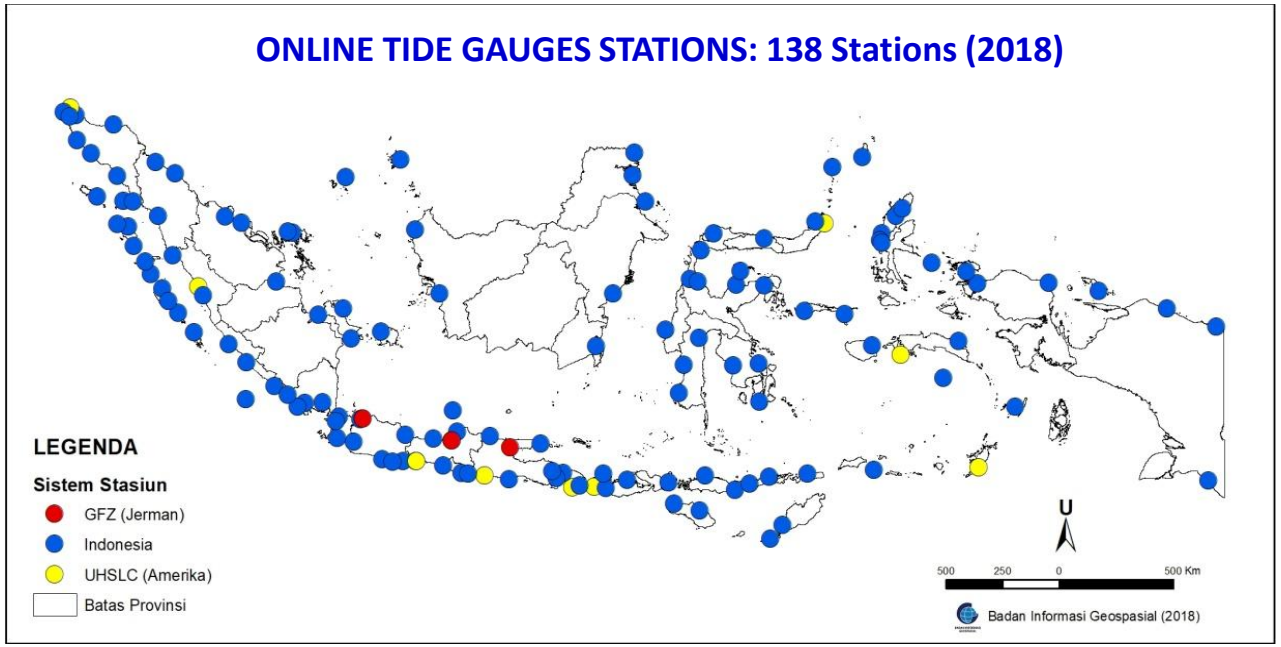



# Tide Gauge Data for DRRM Activities



**Data from Online Tide Gauge Stations will be useful for supporting several activities of Disaster Risk Reduction Management (DRRM), such as:**

- ✓ ***Tsunami Early Warning System.***
- ✓ ***Risk assessment for potential impacts of several coastal hazards, such as coastal flooding, coastal abrasion, and tsunami.***
- ✓ ***Surveying and mapping for post-event rapid assessment of coastal hazards.***

# GNSS-Controlled Tide Gauges

## *for Indonesian Tsunami Early Warning System (InaTEWS)*

**Sensor 3**
Radar Gauge

**Sensor 2**
Float Gauge

**Sensor 1**
Pressure Gauge

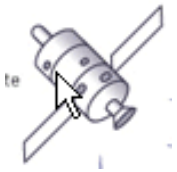
**GNSS CORS**

**Data Logger**

Comm 2

Comm 1

Satcom



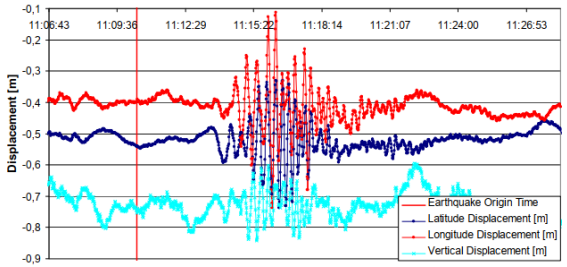
Internet

**BIG**

Near Real time Information

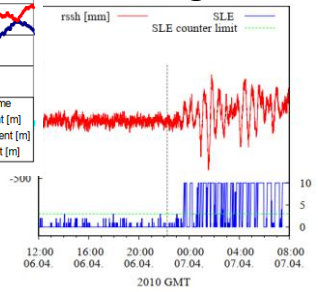
**BMKG**

**Processing & Analysis Center (BIG)**




**Displacement**

**Rapid Sea Level Changes**




**Contributions of BIG:**

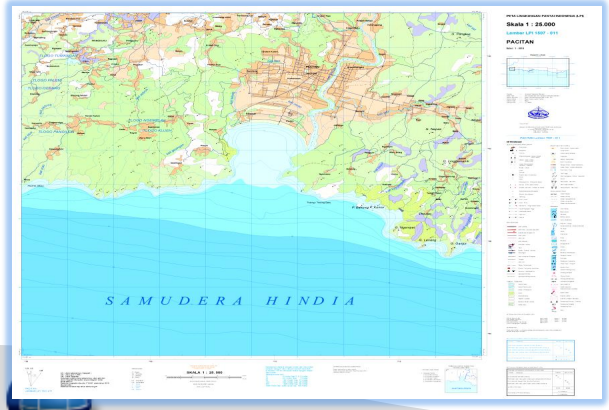
1. **GPS CORS:**
   http://inacors.big.go.id/
2. **Tide Gauges:**
   http://tides.big.go.id/pasut

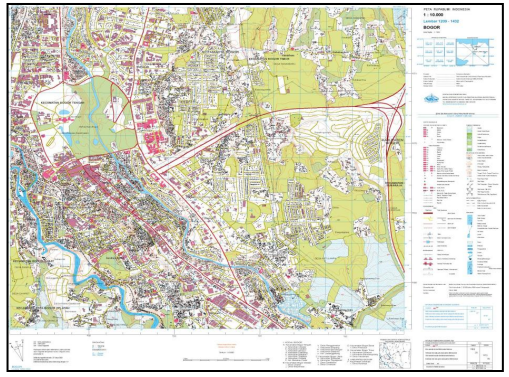
# Roles of Base and Thematic Maps for Disaster Risk Reduction Management

**Developed by BIG in cooperation with other Ministries and Agencies**

- ***Basic maps (RBI, LPI and LLN).***
- ***Various thematic maps.***
- ***DEM, Aerial Photos, and Satellite Images.***

***Basic and Thematic Maps can have important contribution for supporting several stages of Disaster Risk Reduction.***



## Prevention and Mitigation

- Susceptibility Map, Hazard Map, Vulnerability Map, and Risk Map
- Disaster-considering Spatial Planning Map

## Preparedness

- Contingency Map
- Early Warning System

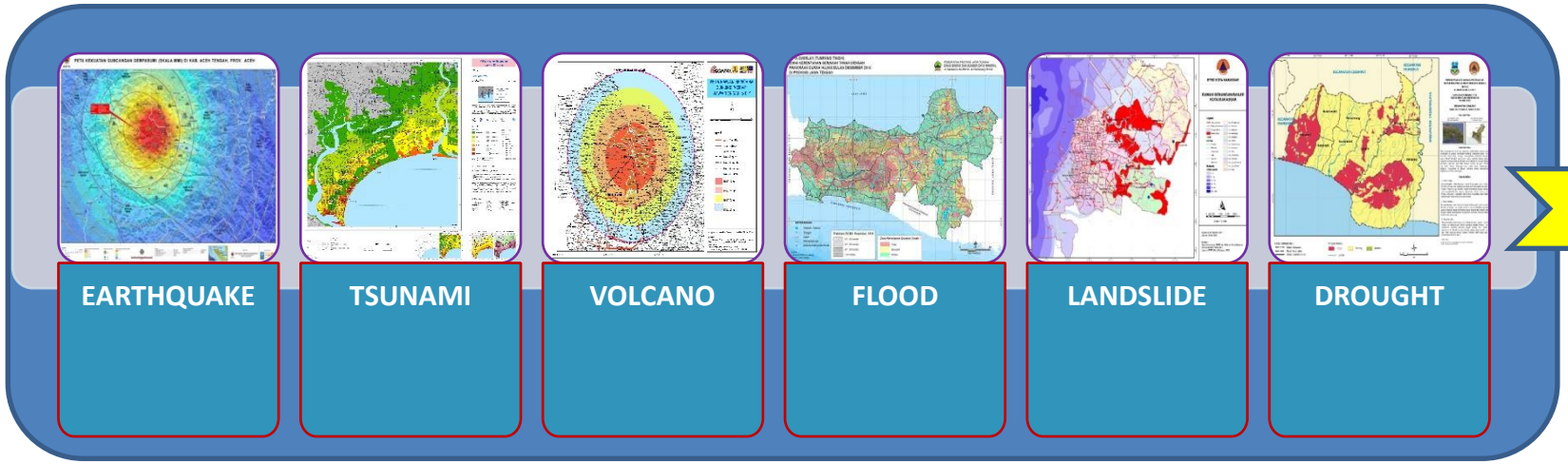
## Emergency Response

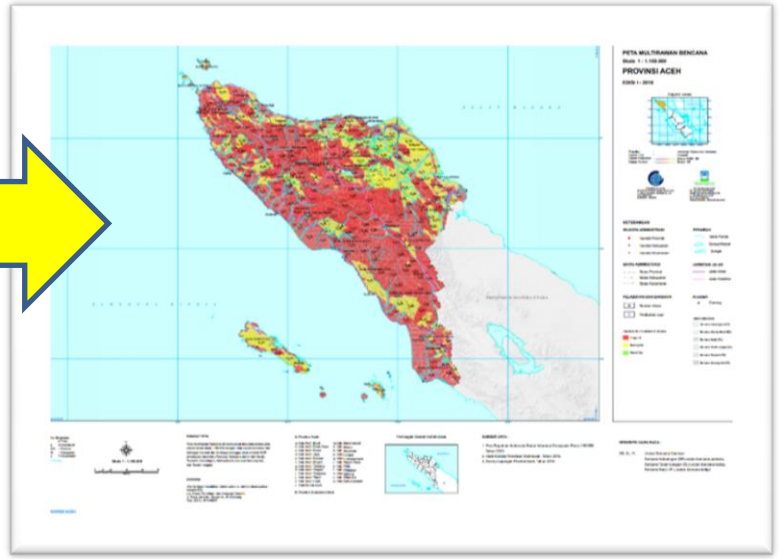
- Map of Damage (Infrastucture, Settlement, Landuse)
- Disaster Affected Area Map

## Rehabilitation and Reconstruction

- Rehabilitation and Reconstruction Planning Map

# Multi Hazard Map

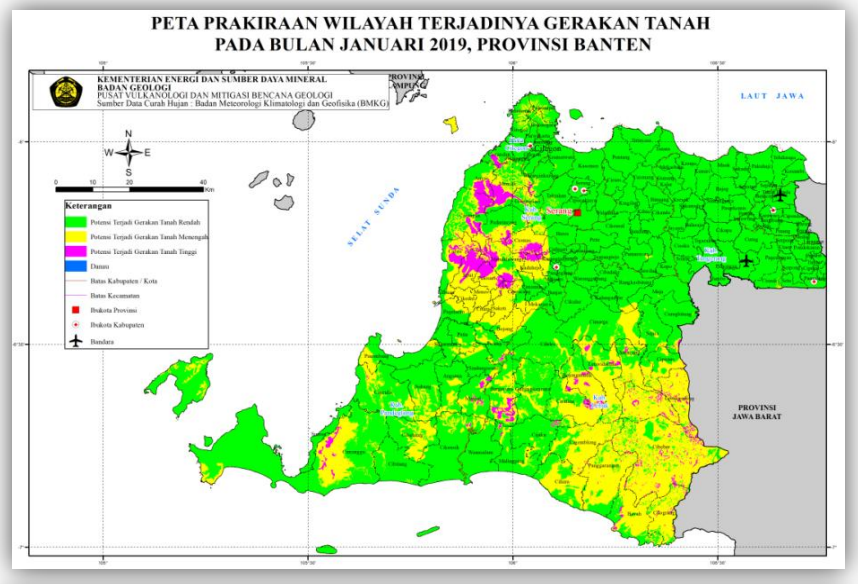


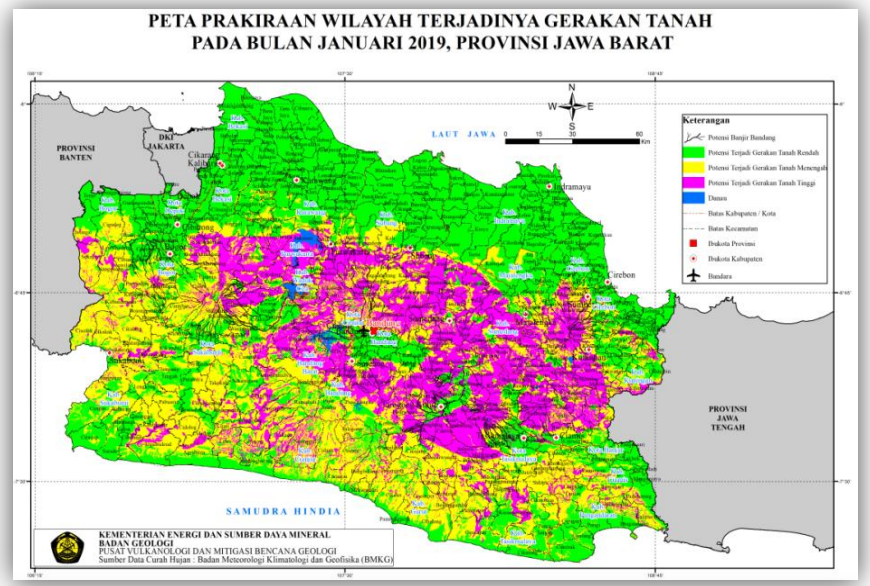



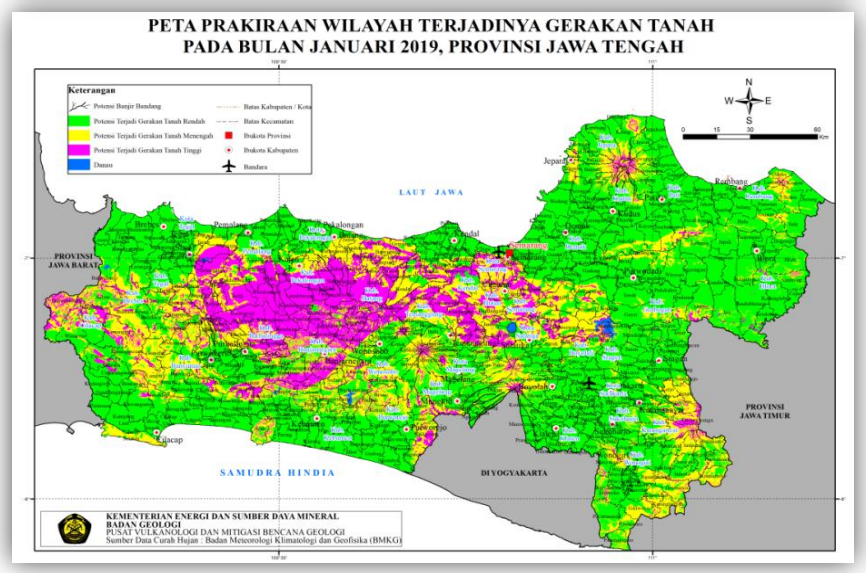

- Six (6) types of disaster : Earthquake, Tsunami, Volcano Eruption, Flood, Landslide, And Drought.
- Based on geographic assessment and landscape analysis to evaluate the suscepbility of any areas.
- Using Analitycal Hierarchy Process

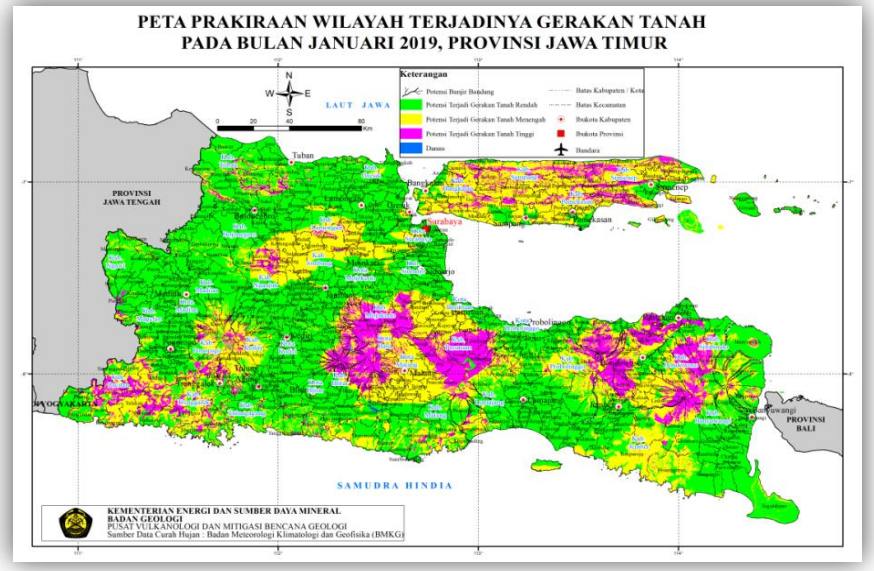
**The Multi Hazard map is produced by cooperation of several relevant Ministries and Agencies**

# Example of Map of Landslide Vulnerability Zone

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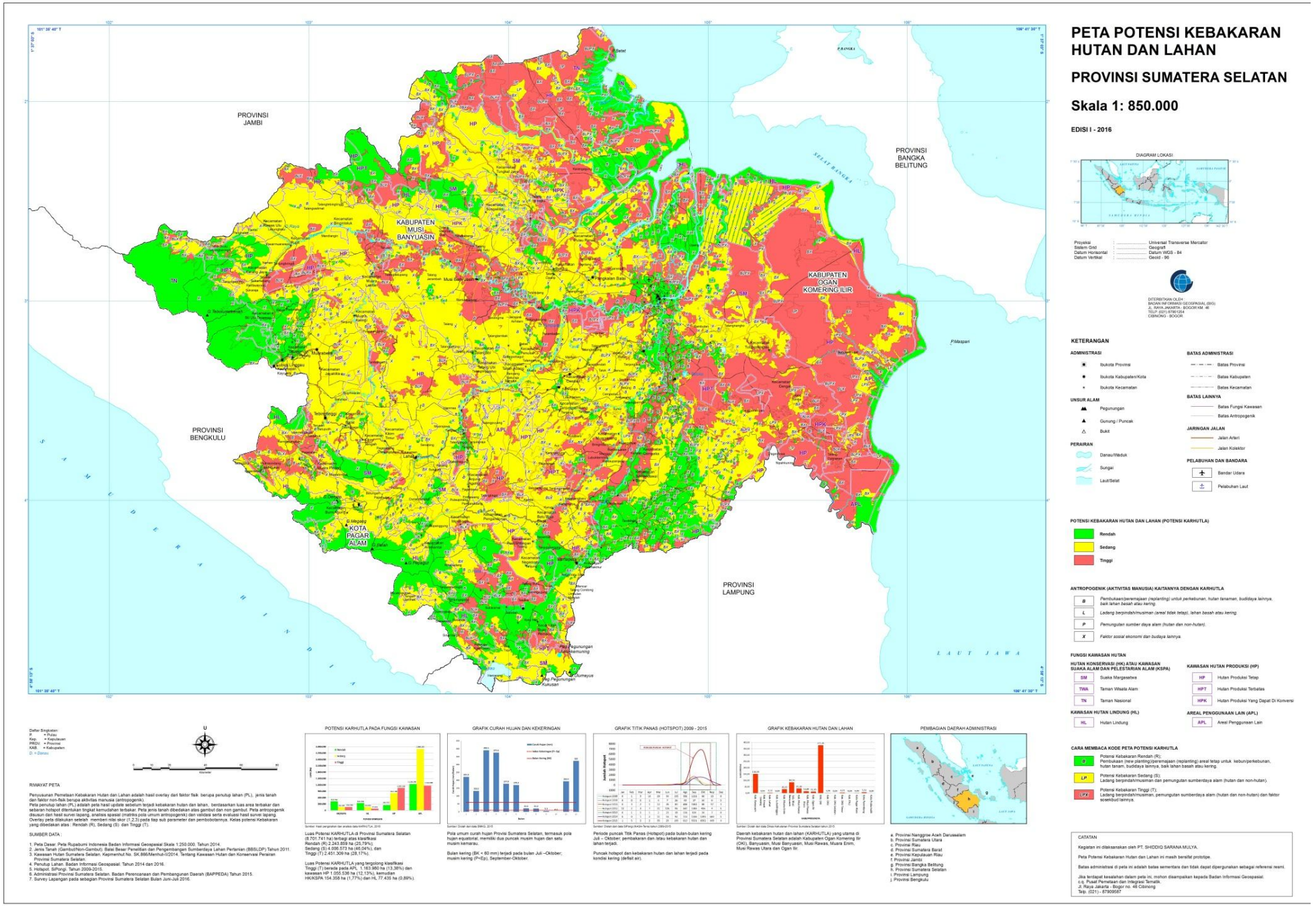


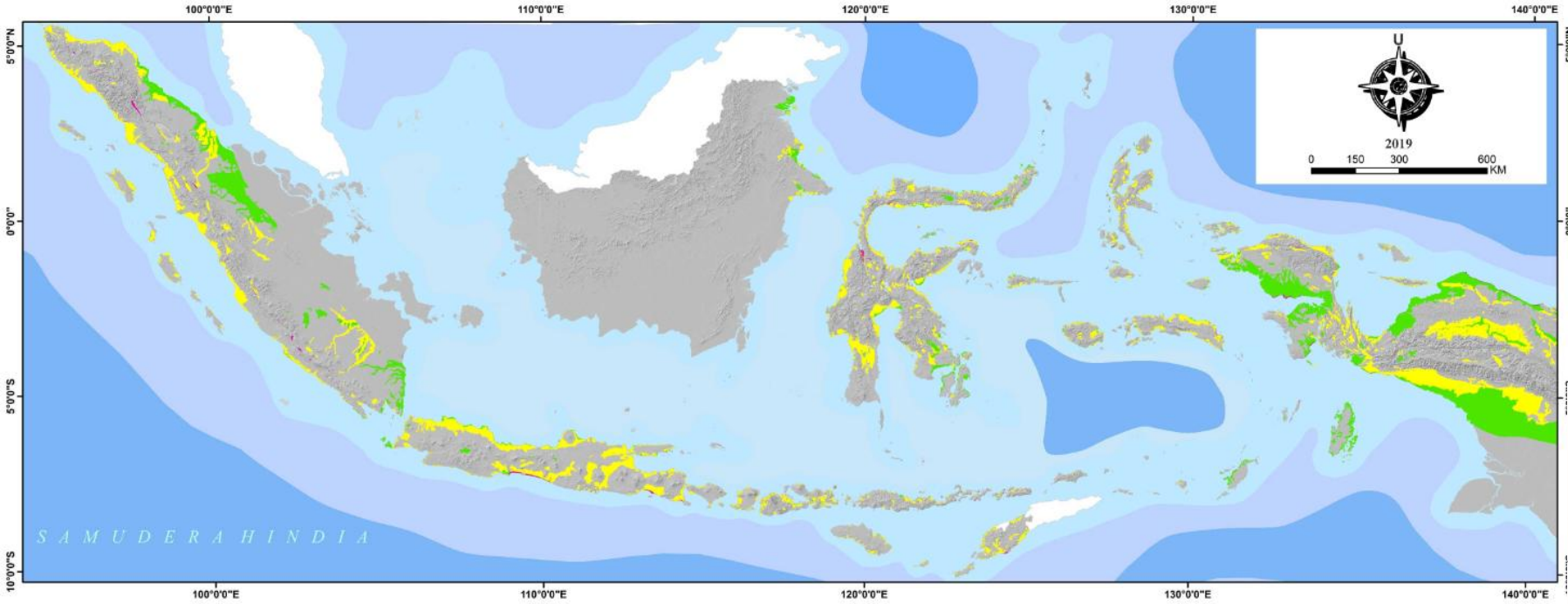

Example of

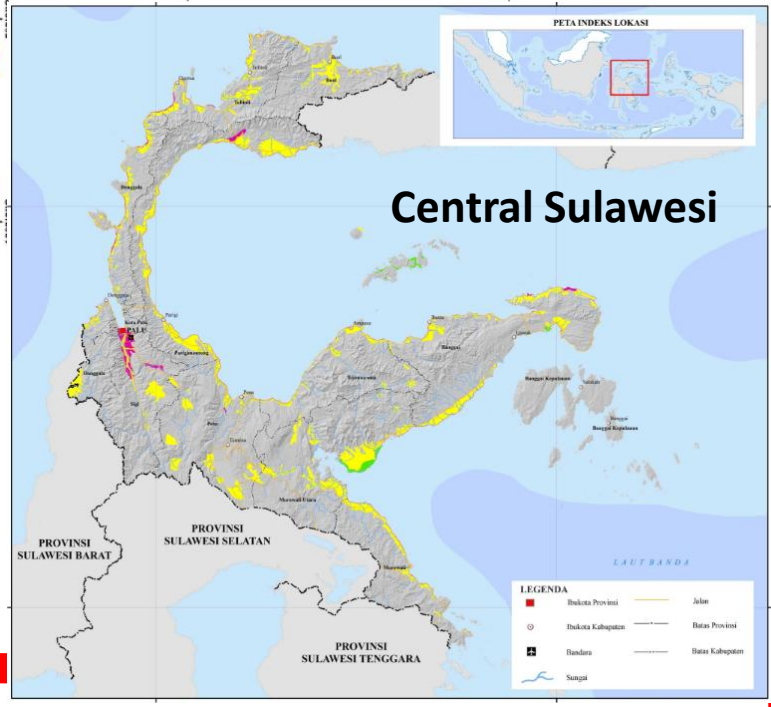
# Land and Forest Fire Hazard Map in South Sumatera

(Scale 1:250.000)

**Peatland and forest fires are usually caused by anthropogenic factors and supported by other local environment and physical factors.**

# Map of Liquefaction Vulnerability Zone






## KETERANGAN

**Zona Kerentanan Likuefaksi Tinggi**
zona kerentanan yang dapat mengalami likuefaksi secara merata dan struktur tanah umumnya menjadi rusak parah hingga hancur. Tipe kerusakan struktur tanah yang terjadi berupa likuefaksi aliran (*flow liquefaction*), pergeseran lateral (*lateral displacement*), penurunan tanah (*vertical displacement*) dan semburan pasir (*sand boil*).

**Zona Kerentanan Likuefaksi Sedang**
zona kerentanan yang dapat mengalami likuefaksi secara tidak merata dan struktur tanah umumnya rusak. Tipe kerusakan struktur tanah yang terjadi berupa pergeseran lateral, penurunan tanah dan semburan pasir.

**Zona Kerentanan Likuefaksi Rendah**
Zona kerentanan yang jarang mengalami likuefaksi. Pada umumnya likuefaksi yang terjadi berupa titik-titik semburan pasir dan sedikit menimbulkan kerusakan pada struktur tanah.

**Zona Tidak Rentan Likuefaksi**

## BATASAN DAN SARAN PENGGUNAAN PETA

Zona kerentanan yang termuat dalam peta ini memberikan indikasi awal kejadian likuefaksi dan merupakan informasi awal untuk perencanaan regional pada skala 1:100.000 atau lebih kecil bagi pemilihan lokasi untuk pengembangan kawasan/wilayah (misal penentuan kawasan industri, perkotaan, perdagangan/jasa). Untuk kebutuhan perencanaan detil pada skala 1:50.000 atau lebih besar diperlukan peta potensi likuefaksi guna mengarahkan pembangunan fisik (misal perencanaan jenis bangunan).

Sumber Data
Peta Sistem Lahan Indonesia, BIG
Peta Sumber dan Bahaya Gempa Indonesia, (Pusat Studi Gempa Nasional, 2017)
Peta Geologi Indonesia KSP Skala 1 : 100.000 (Badan Geologi, 2016)
Peta Geologi Indonesia Skala 1 : 100.000 dan 1 : 250.000, Badan Geologi
Peta Topografi KSP Skala 1 : 25.000 dan 1 : 50.000 (BIG, 2016)
Demnas, BIG

KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL
BADAN GEOLOGI
PUSAT AIR TANAH DAN GEOLOGI TATA LINGKUNGAN

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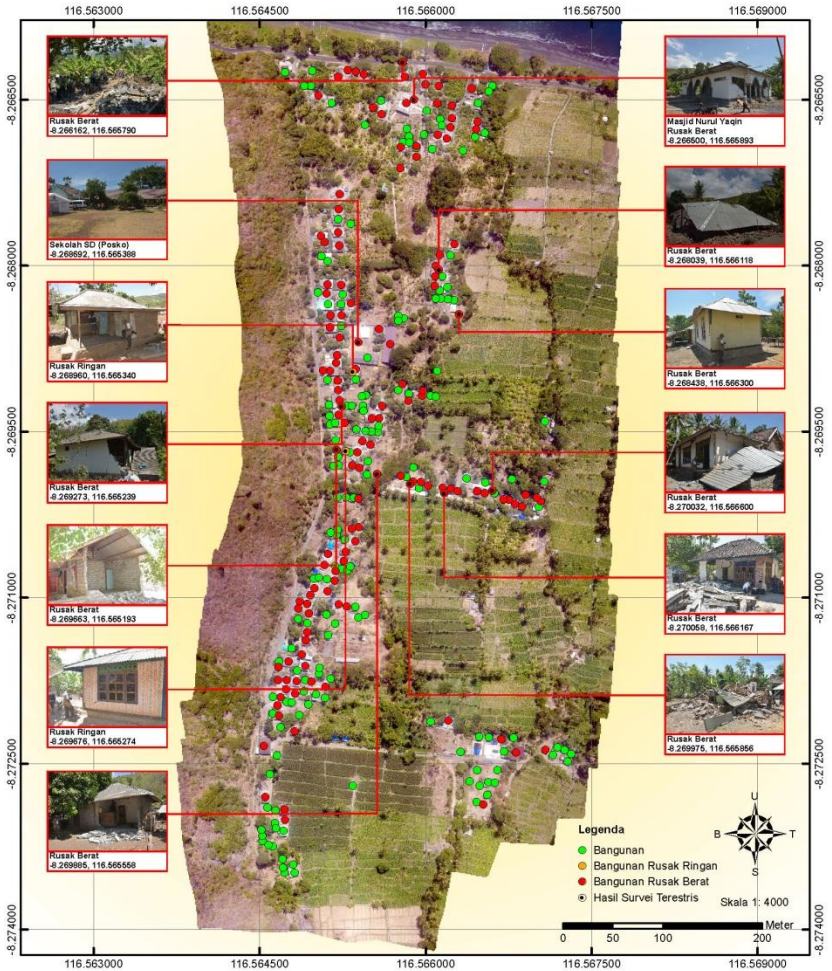
BADAN INFORMASI GEOSPASIAL

**Lombok Earthquake August 2018**

# Post-Event Rapid Assessment Mapping

PETA WILAYAH TERDAMPAK BENCANA GEMPA BUMI NTB 2018
DUSUN MENTARENG, DESA OBEL-OBEL,
KECAMATAN SAMBALIA, KABUPATEN LOMBOK TIMUR




**Sumber Data:**
Pemotretan udara dilakukan pada ketinggian medan 125 meter dengan menggunakan pesawat udara nirawak jenis multirotor. Survei terestris dilakukan pada hari Kamis, 2 Agustus 2018, pukul 11.32 WITA.

**Hasil Survei Satuan Reaksi Cepat:**
Pola sebaran permukiman memanjang dengan jumlah bangunan sekitar 287 unit. Berdasarkan hasil interpretasi dan survei terestris, bangunan dengan tingkat kerusakan berat berjumlah 129 unit. Jarak permukiman dari episentrum sekitar 1.38 km ke arah timur-tenggara.

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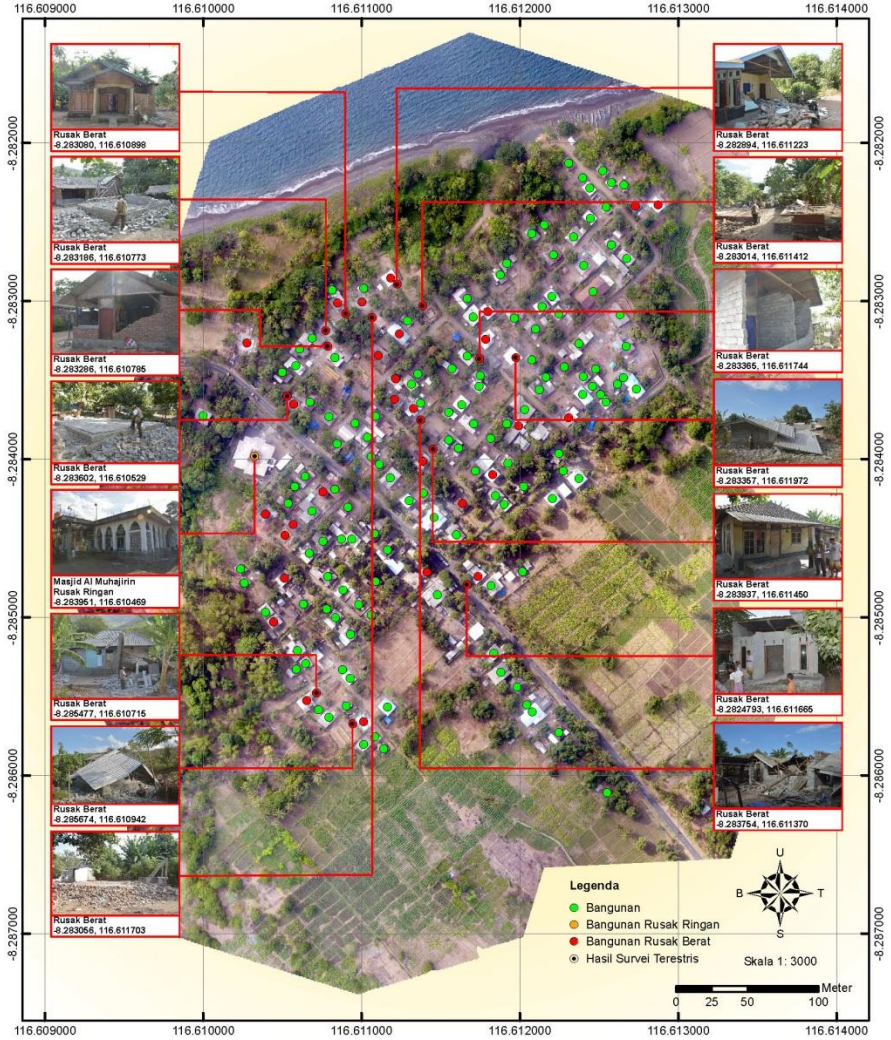
PETA WILAYAH TERDAMPAK BENCANA GEMPA BUMI NTB 2018
DUSUN PEMADEKAN DESA OBEL-OBEL,
KECAMATAN SAMBALIA, KABUPATEN LOMBOK TIMUR




**Sumber Data:**
Pemotretan udara dilakukan pada ketinggian medan 150 meter dengan menggunakan pesawat udara nirawak jenis multirotor. Survei terestris dilakukan pada hari Kamis, 2 Agustus 2018, pukul 15.35 WITA.

**Hasil Survei Satuan Reaksi Cepat:**
Pola sebaran permukiman mengelompok dengan jumlah bangunan sekitar 165 unit. Berdasarkan hasil interpretasi dan survei terestris, bangunan dengan tingkat kerusakan berat berjumlah 34 unit. Jarak permukiman dari episentrum sekitar 4,38 km ke arah timur-tenggara.

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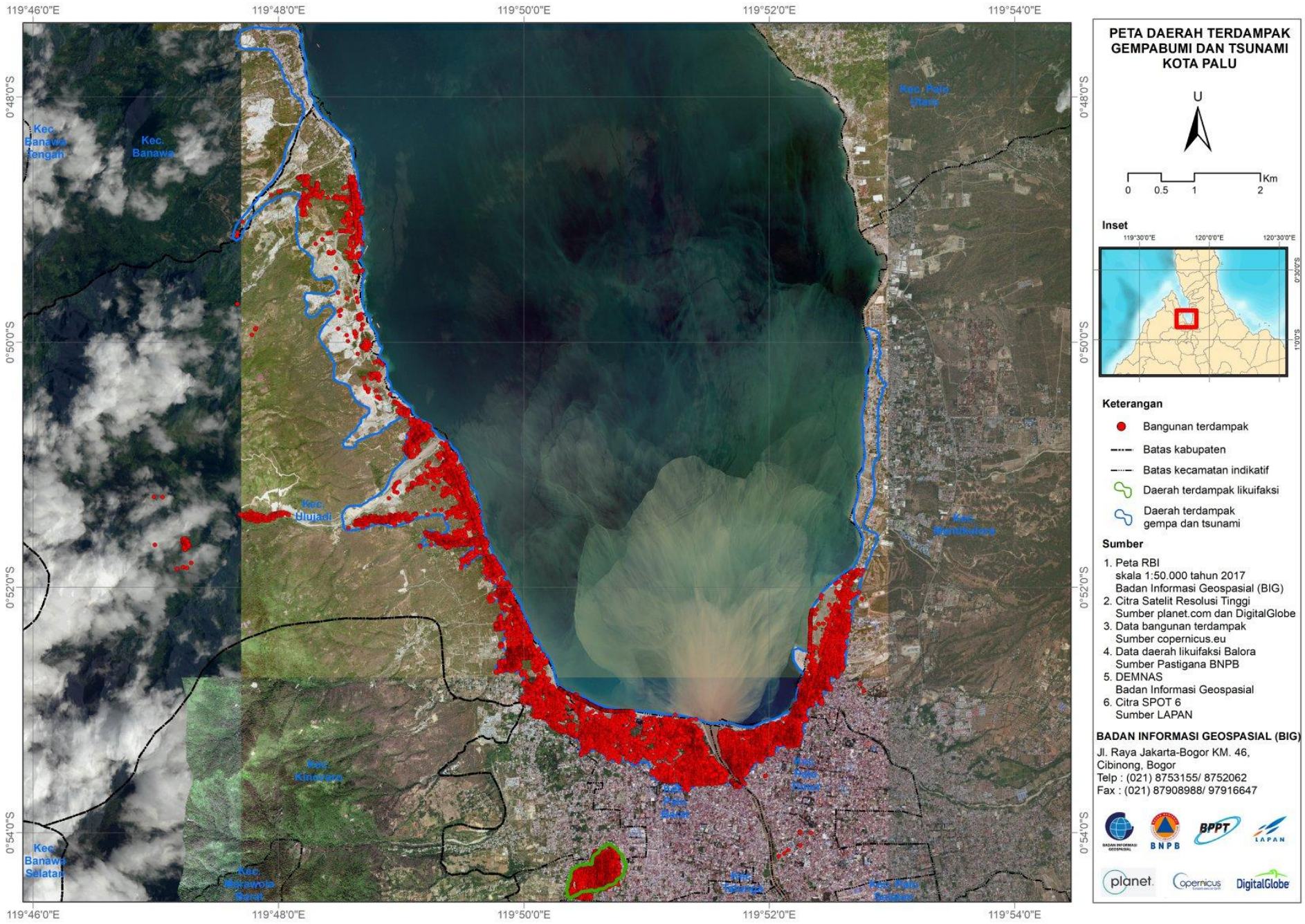
**Rapid mapping uses UAV and Field Survey to identify the distribution of settlement and infrastructure damage.**

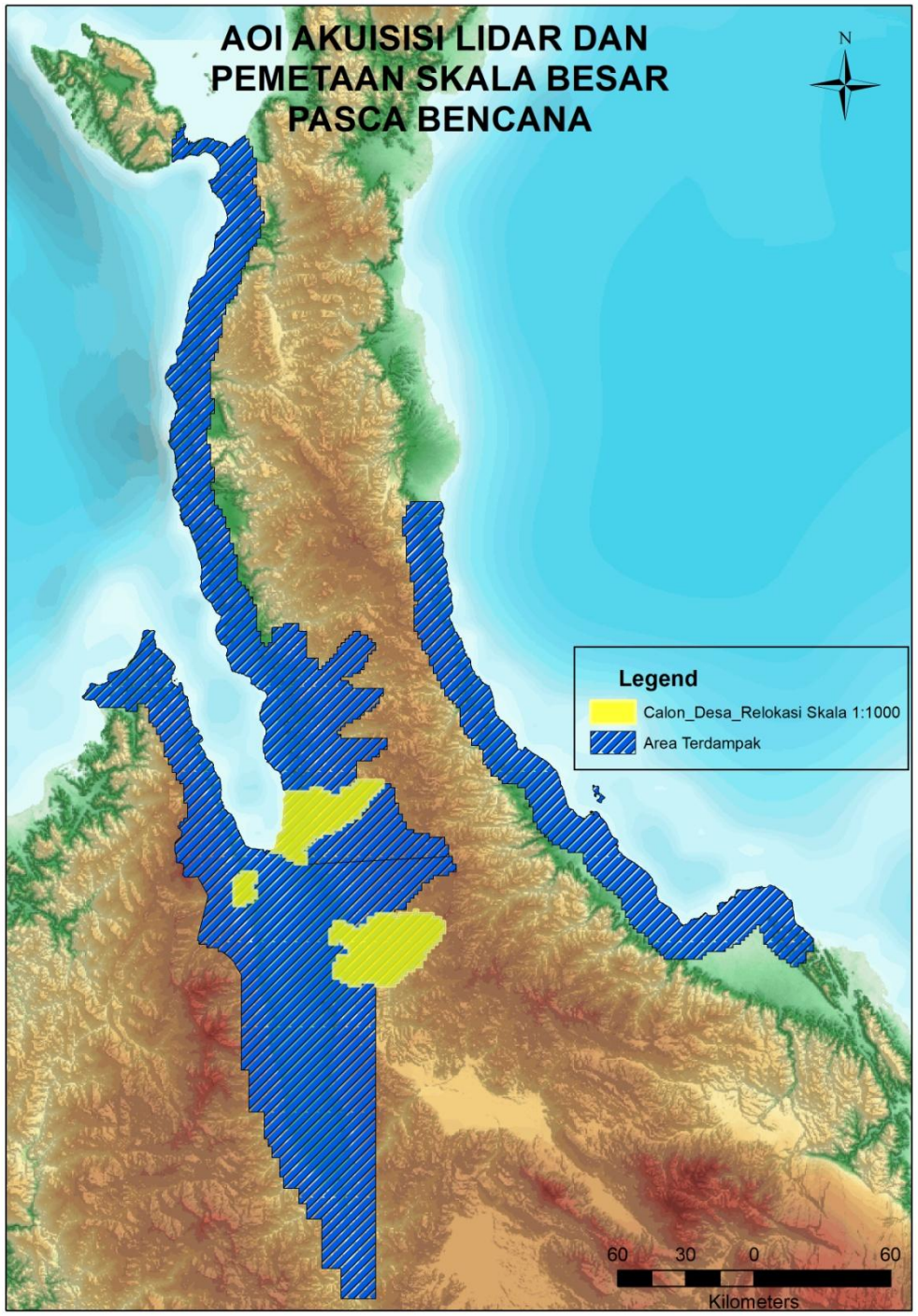
# Post-Event Rapid Assessment Mapping

## of affected houses/buildings

**Palu-Donggala Earthquake**
**28 September 2018**

Based on
Topographic Map,
National DEM,
Satellite Images,
and Ground Survey






**Example from Palu-Donggala Earthquake 28 September 2018**

# Geospatial Data for Rehabilitation and Reconstruction (RR) Programs:

- New Spatial Planning.
- New Housing Development.
- Relocation of Affected Inhabitants.
- RR of Roads and Infrastructures.
- RR of Drainage and Sewerage System.
- RR of Irrigation System.
- RR of Dam and **Reservoir, etc.**

**Require Basemaps of 1:1000 and 1:5000 Scales**

**Mapping based on Digital Photogrammetry and LIDAR was conducted by BIG; and the digital maps have been used by related Ministries, Agencies and Local Governments for various Rehabilitation and Reconstruction activities.**

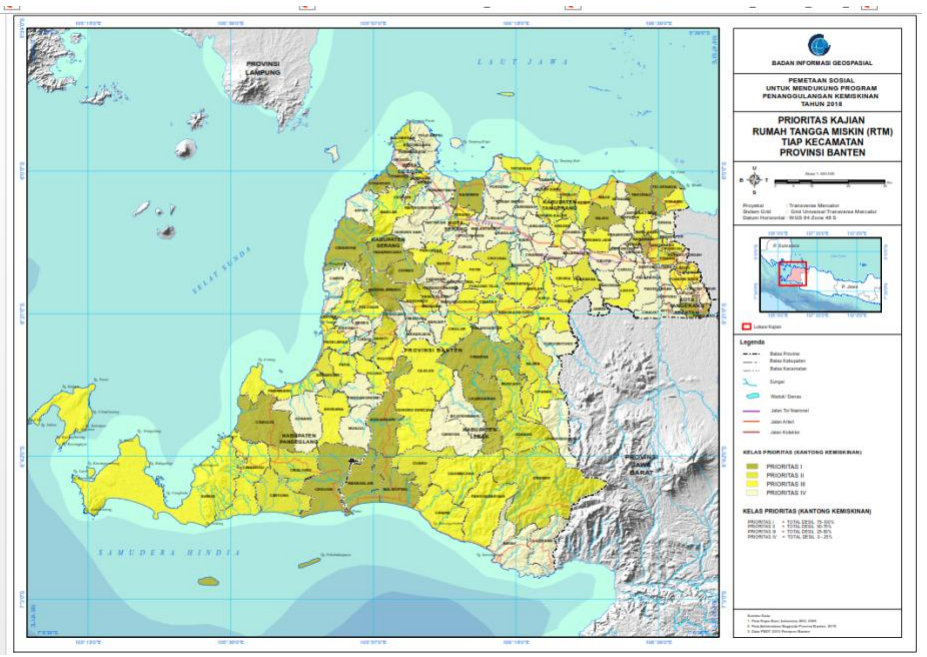
**Cost for RR Programs is estimated by BNPB to be about 12,6 Trillion IDR or about 865 Million USD.**

# Social Mapping in Disaster Prone Areas

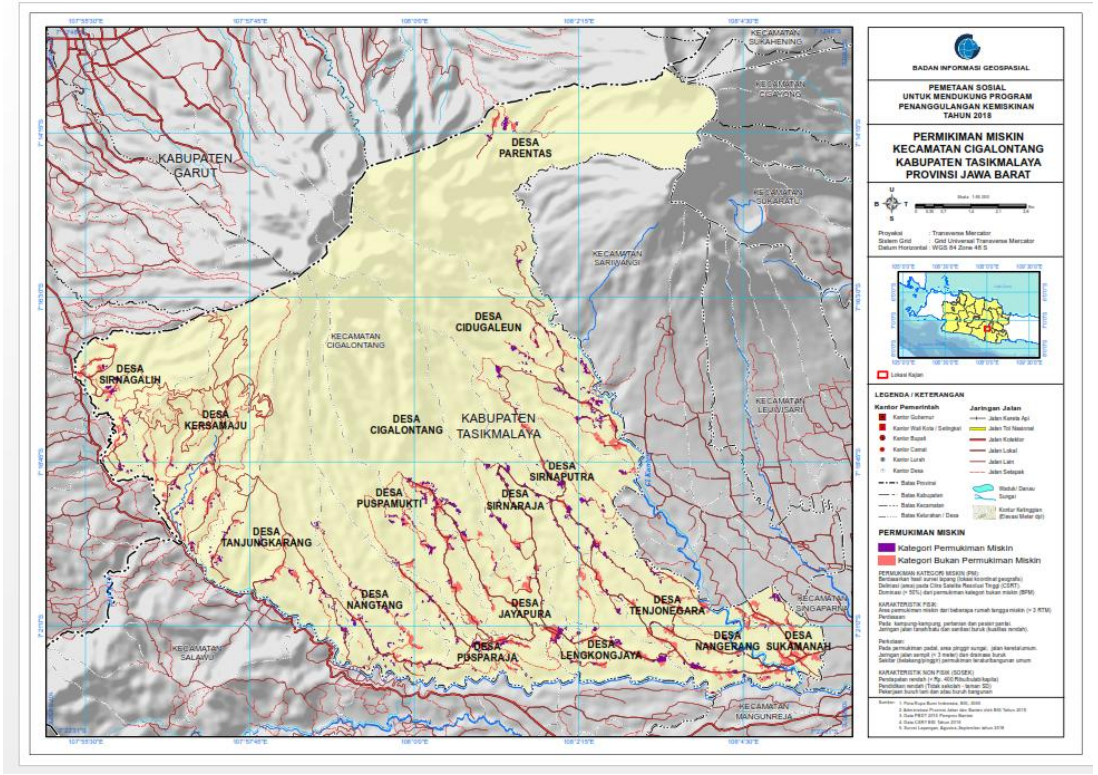
## Social Mapping to Support Poverty Reduction Programs:

**The results of this activity provide information related to poverty in the Provinces of West Java and Banten, which includes sample data by name by address in poverty areas. Thematic geospatial information generated in this social mapping is also complemented by the characteristics of settlements, for example settlements of the poor and non-poor categories.**

Map of Poor Households in Each District of West Java Province.




Map of Poor Households in Each District of Banten Province.




Map of Poor Settlements, Cigalontang, Tasikmalaya District, Prov. West Java.

# Closing Remarks

***Geospatial Data and Information are important and needed at every stage of Disaster Risk Reduction Management.***

***Participatory mapping is very helpful.***

**Lessons from previous Natural Disasters, the following are necessary:**

- ✓ Systematic Disaster related Research.
- ✓ Detailed and accurate geospatial information.
- ✓ Hazard-based Spatial Planning.
- ✓ Earthquake-resistance Building Codes.
- ✓ Public Education and Awareness.
- ✓ Reliable Early Warning System.
- ✓ Rapid Geospatial Data Sharing.
- ✓ Regular Exercise for Dealing with Disasters.
- ✓ Mapping of Liquefaction prone Areas.
- ✓ Disaster-related Insurance and Compensation.

# Thank you very much