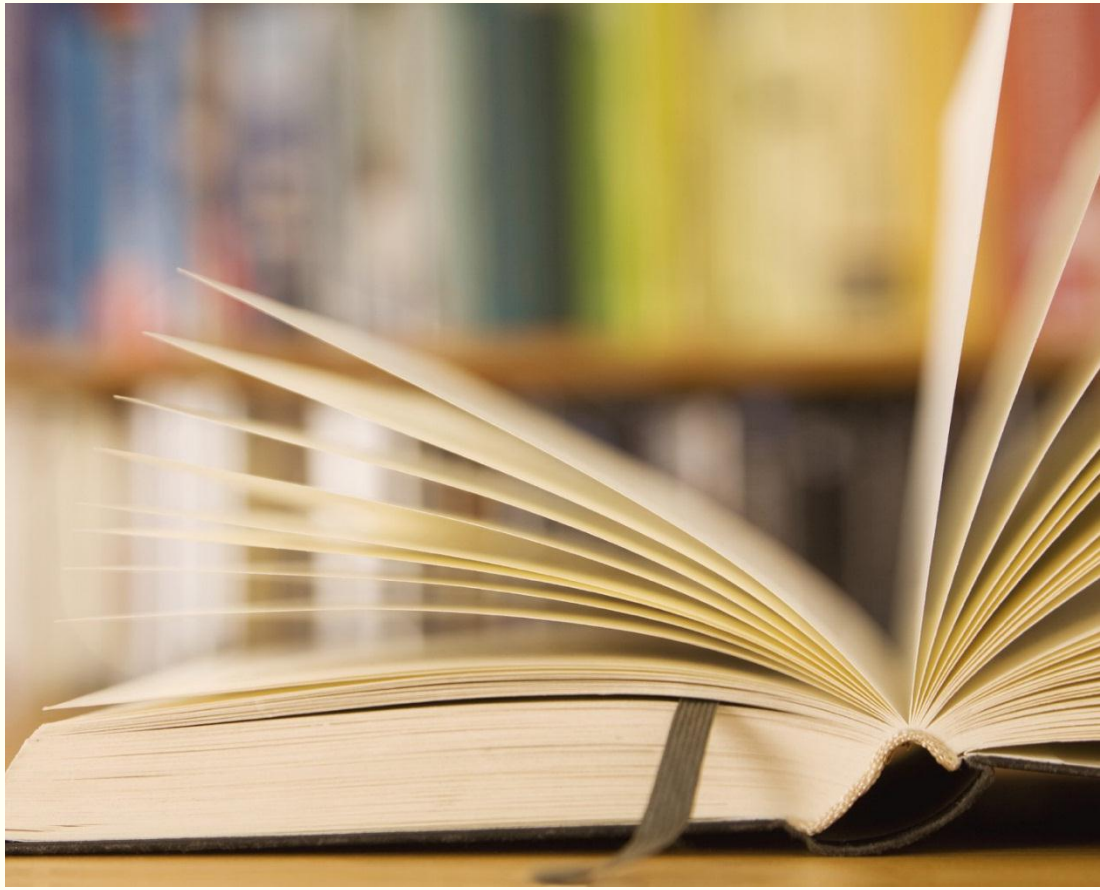
EARTHQUAKE CATALOG, STATISTICS, SEISMICITY SMOOTHING & PSHA

WAHYU TRIYOSO
GLOBAL GEOPHYSICS DIVISION
GEOPHYSICS ENGINEERING DEPARTMENT
BANDUNG INSTITUTE OF TECHNOLOGY

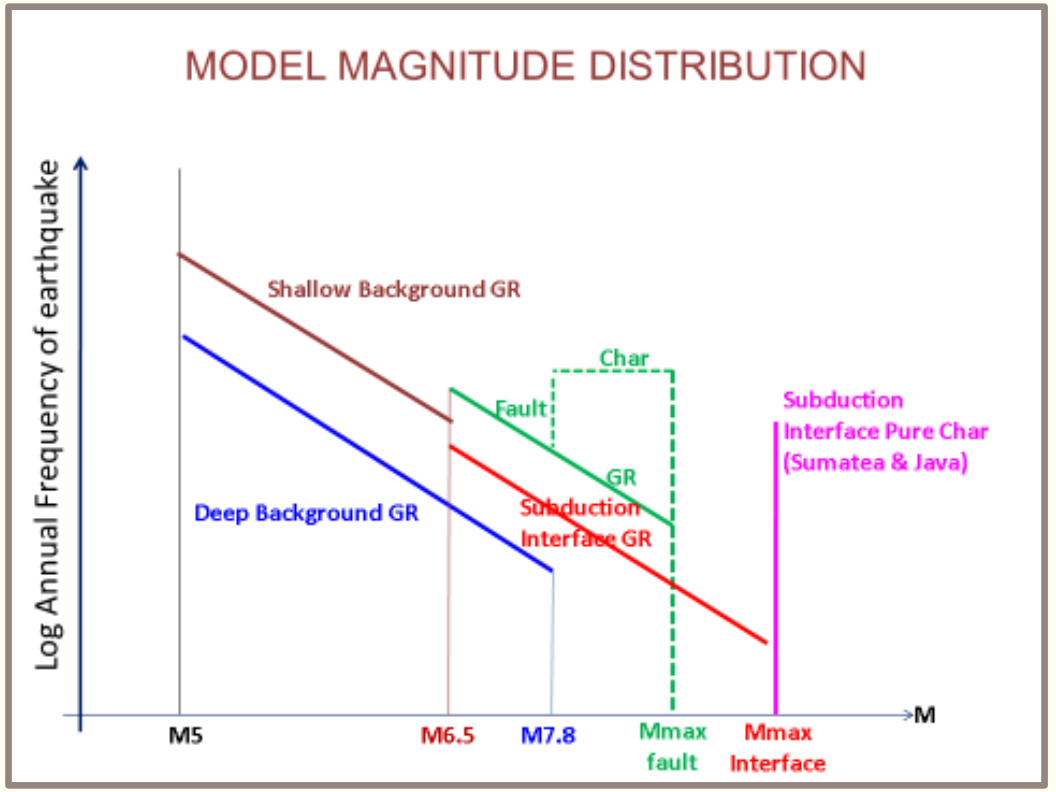
Some basic knowledge behind PSHA Revision Map of 2017



PSHA : An Overview ....

Schematic illustration of the basic five steps in probabilistic seismic hazard analysis.

- Identify earthquake sources.
- **Characterize the distribution of earthquake magnitudes from each source.**
- Characterize the distribution of source-to-site distances from each source.
- Predict the resulting distribution of ground motion intensity.
- Combine information from parts a-d to compute the annual rate of exceeding a given ground motion intensity.

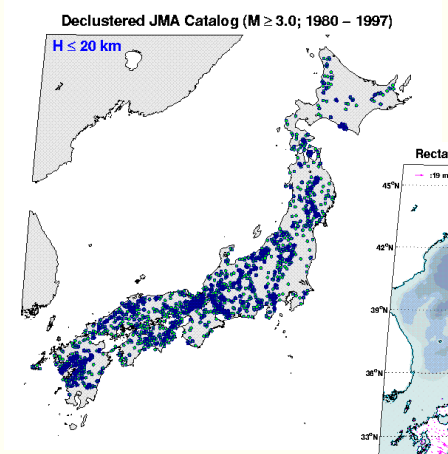


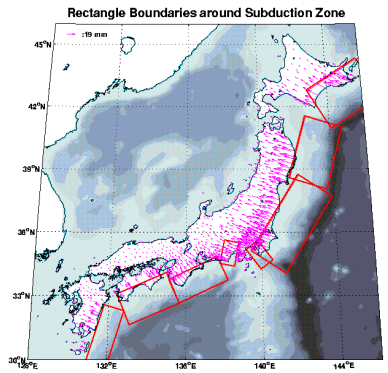
Probabilistic Seismic Hazard Analysis

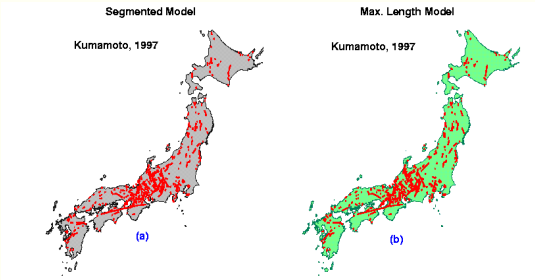
•One important factor in seismic hazard study is how reliable is the long-term earthquake potential model used to estimate seismic hazard.

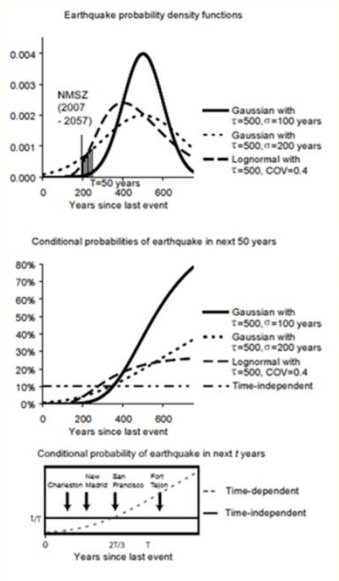
•To construct various long-term earthquake potential models, several different data sets could be used. They are small and moderate instrumentally recorded earthquake catalog, seismotectonic zoning, active fault research result, the GPS data or combining two models or more to construct a new model.

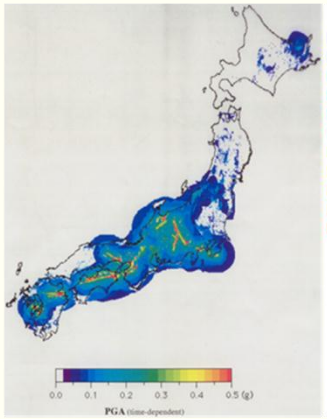
•A spatial smoothing technique proposed by Frankel in 1995, information on strain accumulation as was proposed by Ward in 1994, and a method based on estimated slip rate and other parameters of active faults (e.g. Wesnousky et al. in 1984) are usually used

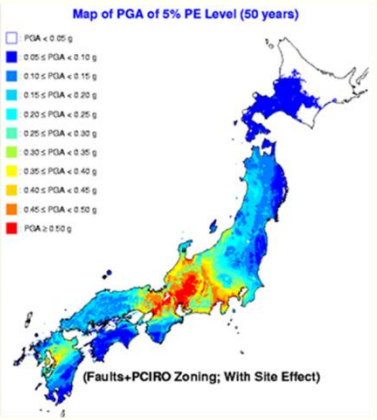












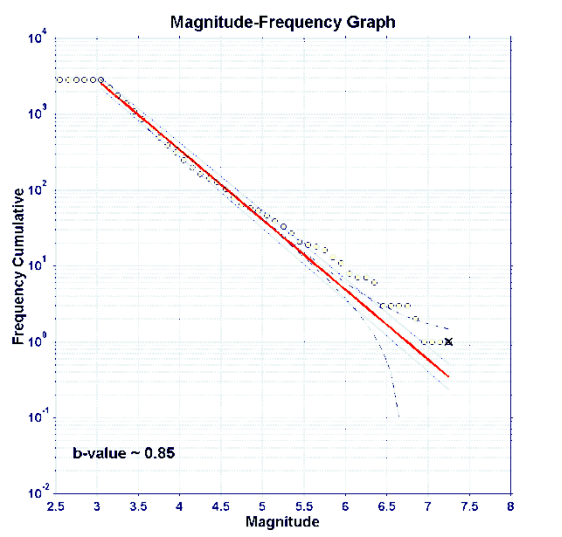
Various Long-term Earthquake Potential Models

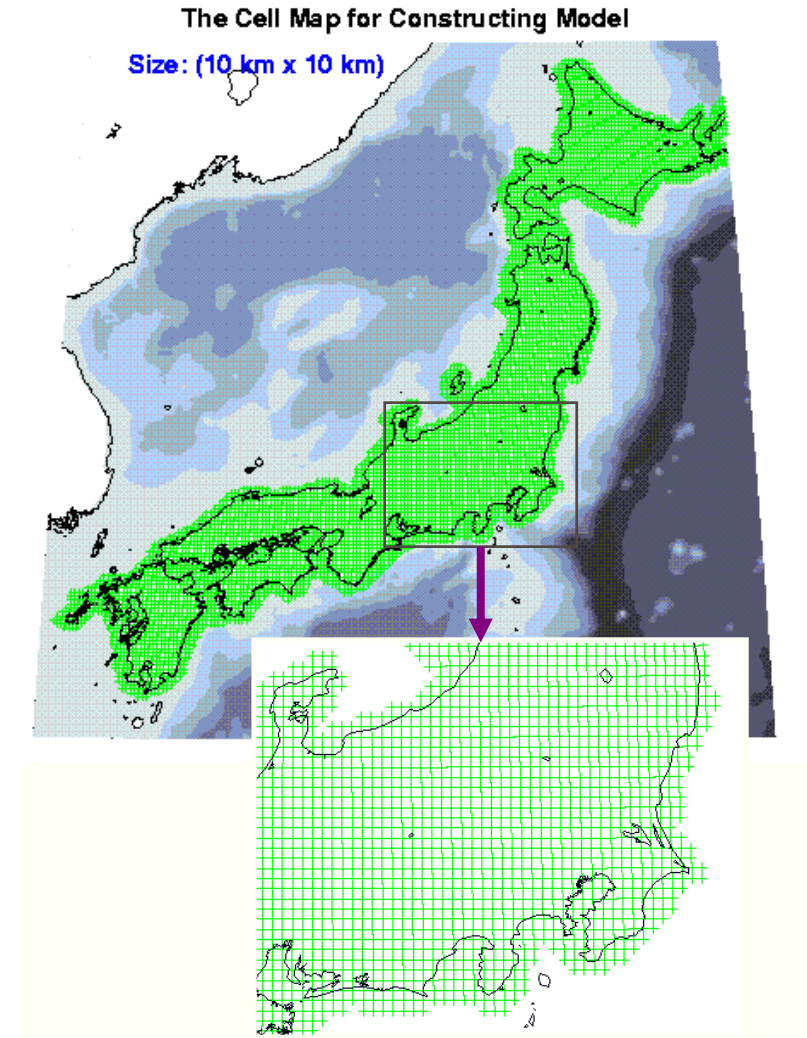
Models: It can be constructed based on:

1. Instrumentally Recorded Earthquake catalog
2. Slip-rate of Active Faults
3. GPS or Geodetic data
4. Seismic Zoning
5. Combinations of models

Assumptions

- Time independent
- G-R Law Works

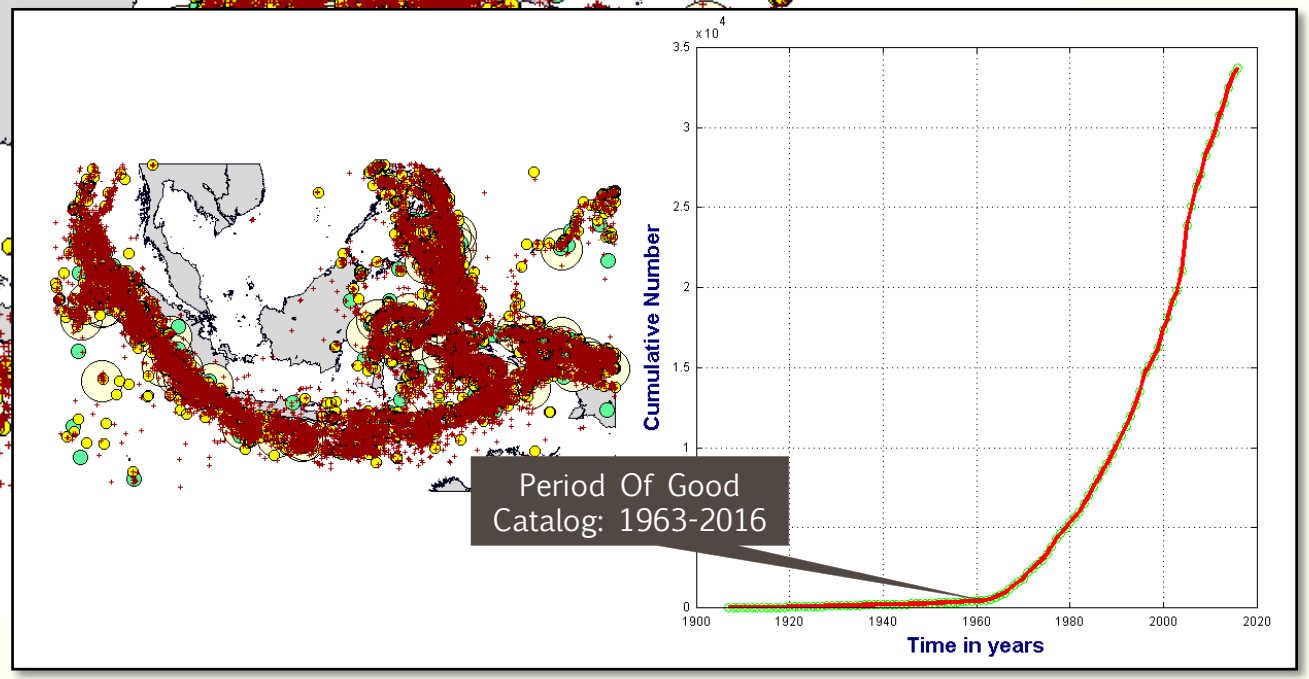




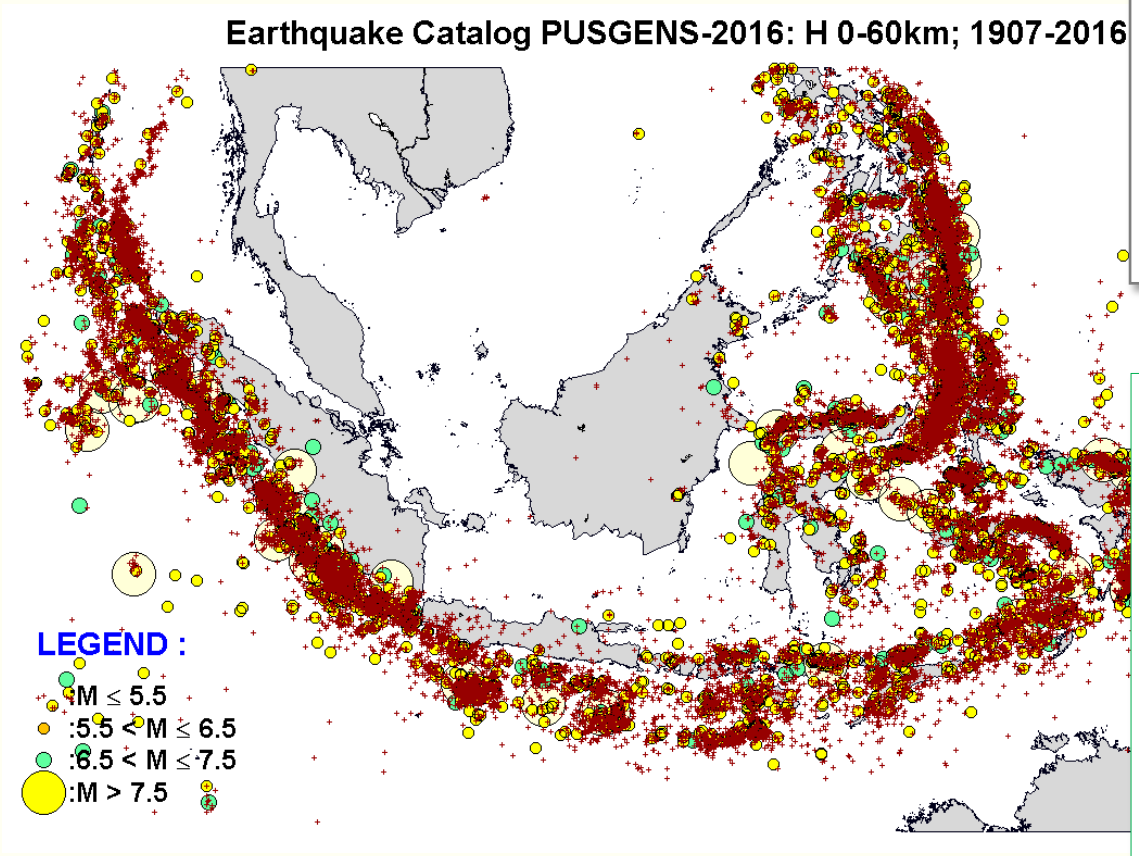
EARTHQUAKE CATALOG, STATISTIC & SEISMICITY

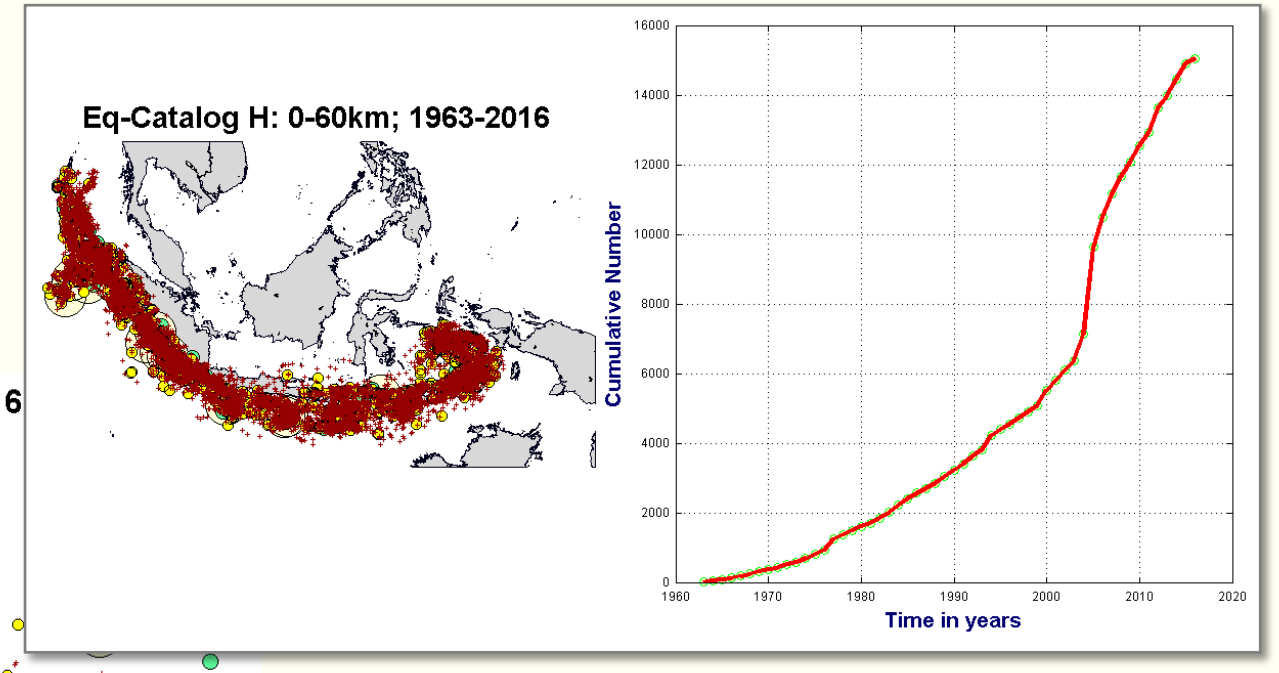
Understanding catalog for psha map revision of 2017

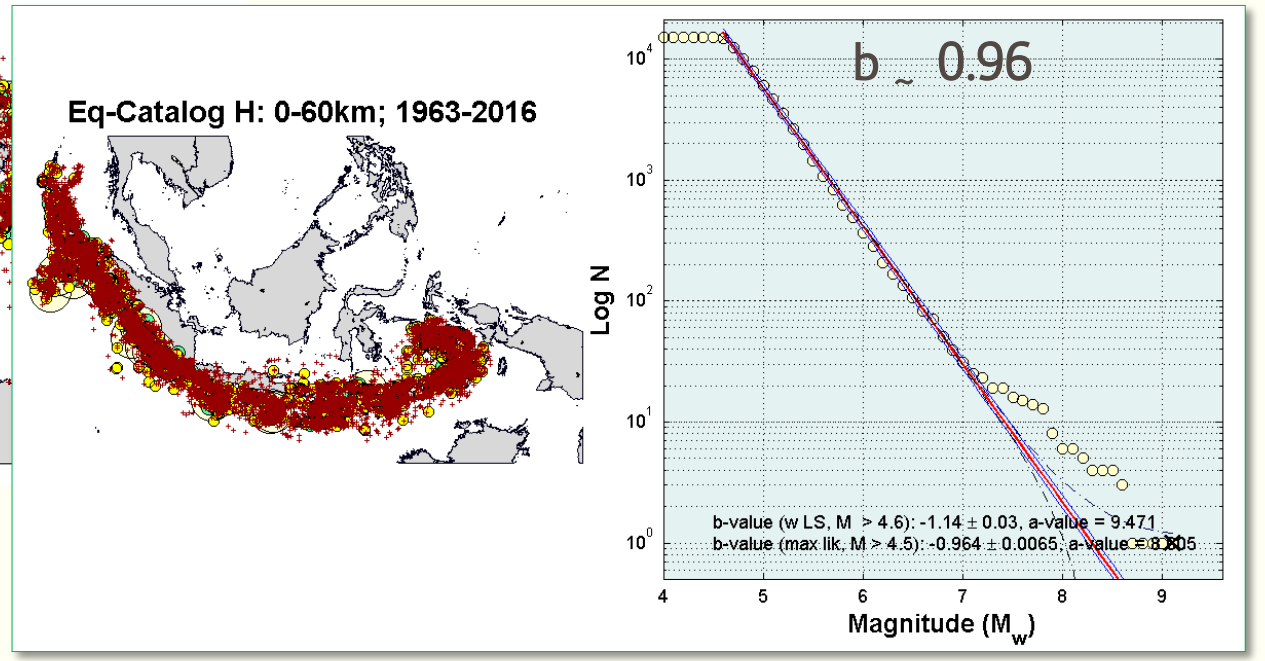
Earthquake Catalog PUSGENS-2016: All Depth; 1907-2016



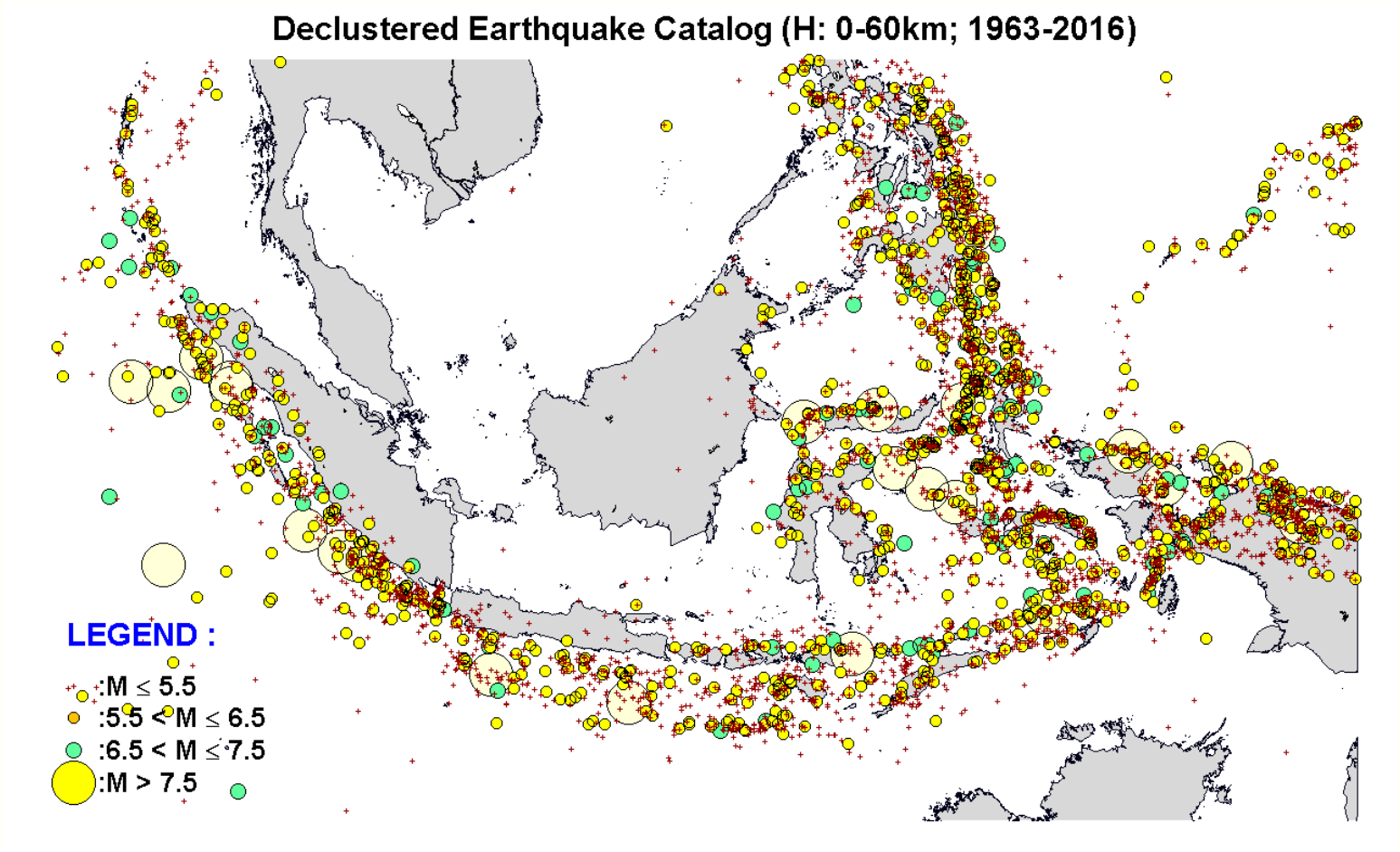
Selected Catalog
At The Depth: 0-60km

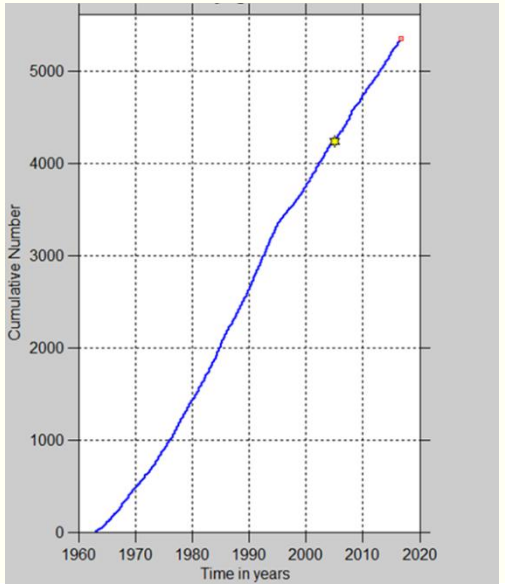


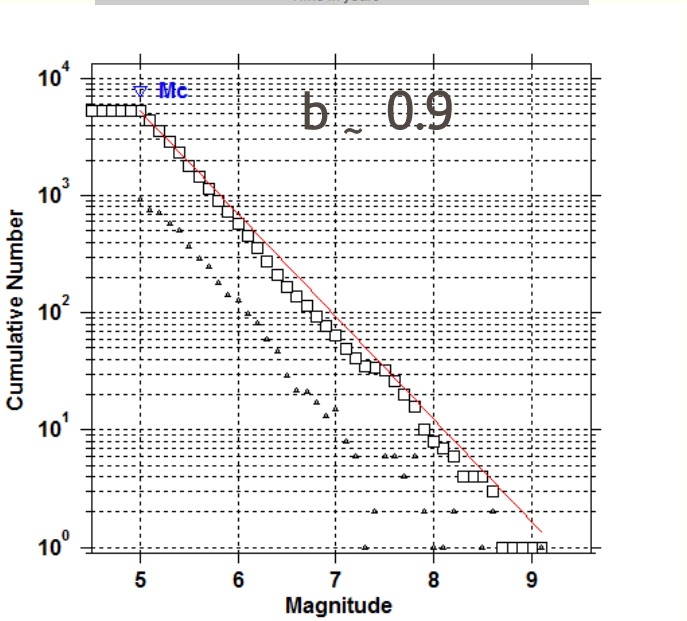




De-clustered Selected Catalog At The Depth: 0-60km







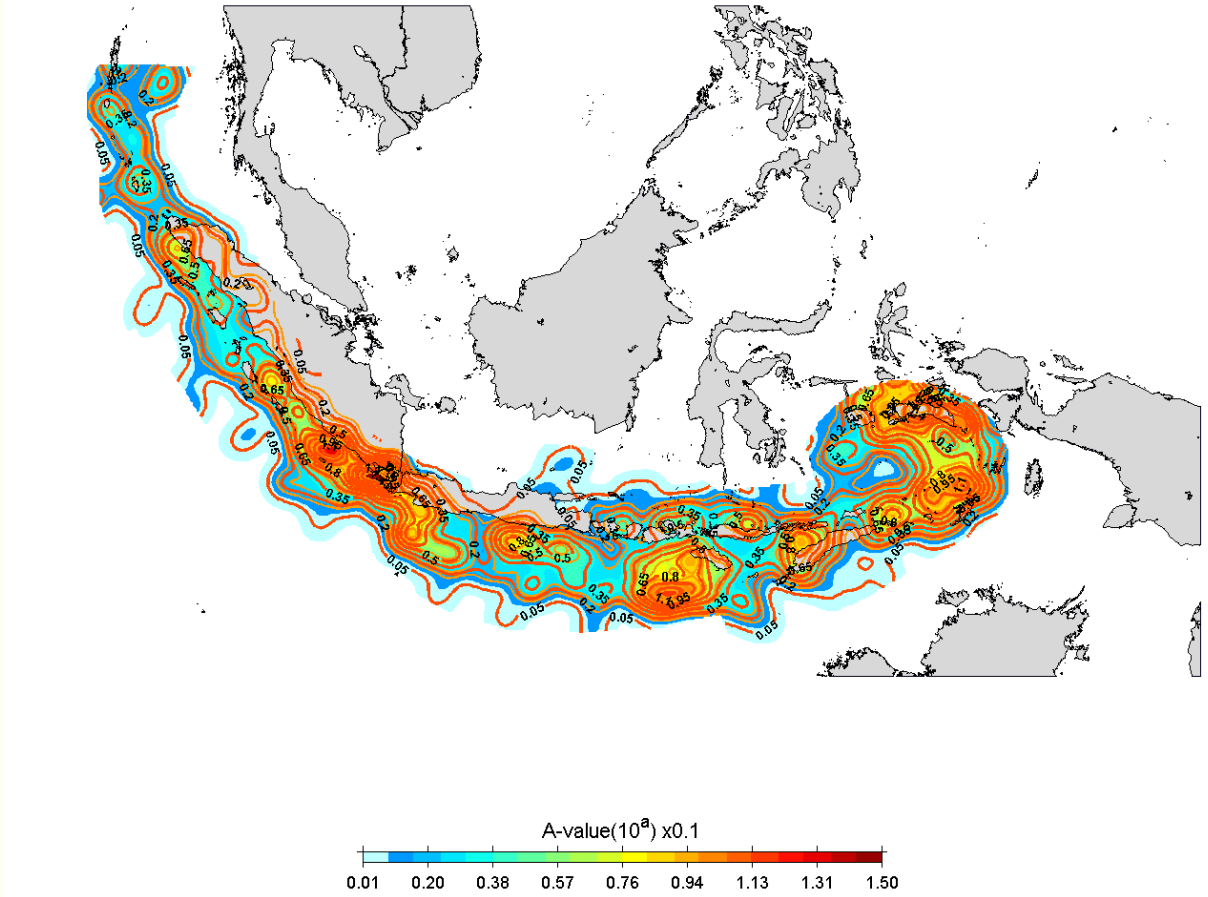
Maximum Likelihood Solution
b-value = 0.876 +/- 0.01, a value = 8.1, a value (annual) = 6.37
Magnitude of Completeness = 5

TESTING STABILITY SEISMICITY PATTERN UNDER ASSUMPTION OF POISONIAN DISTRIBUTION:

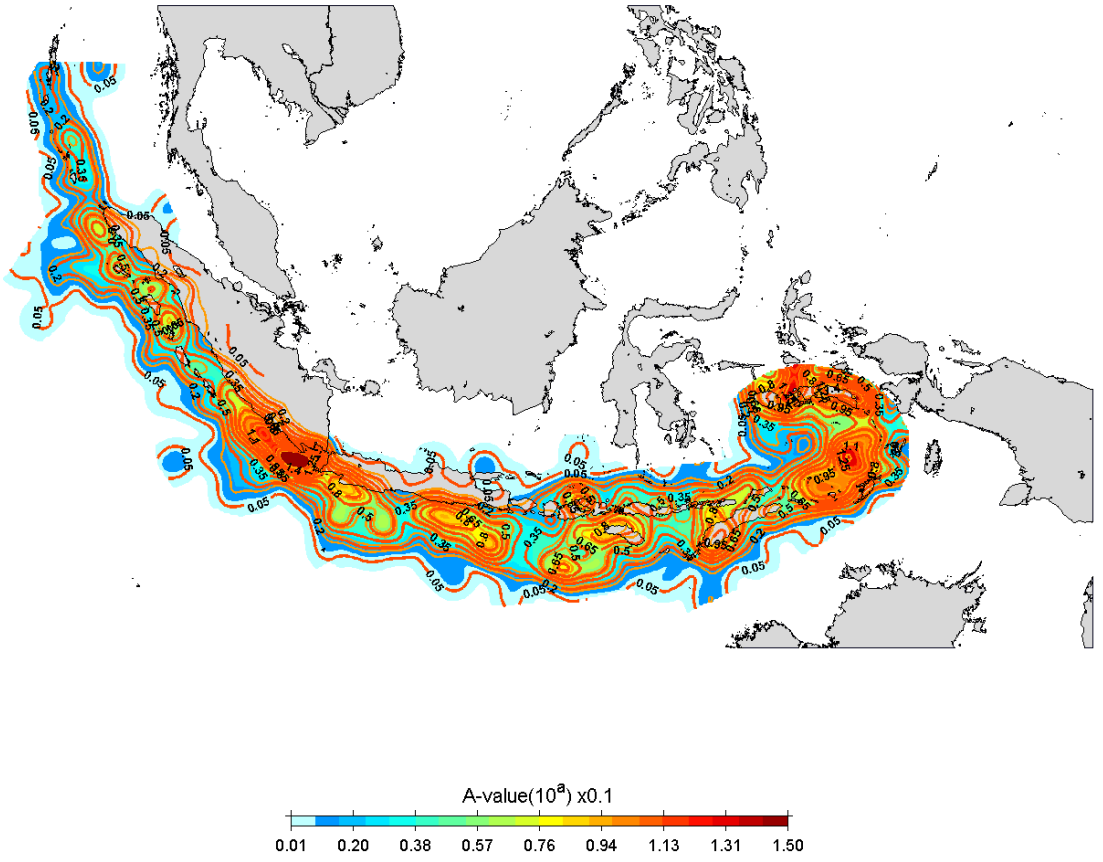
STUDY CASE FOR SUNDA ARC

We divide catalog of 1963-2016 of The De-clustered Earthquake Catalog to 1963-1990 & 1991-2016 by following Frankel's Hypothesis

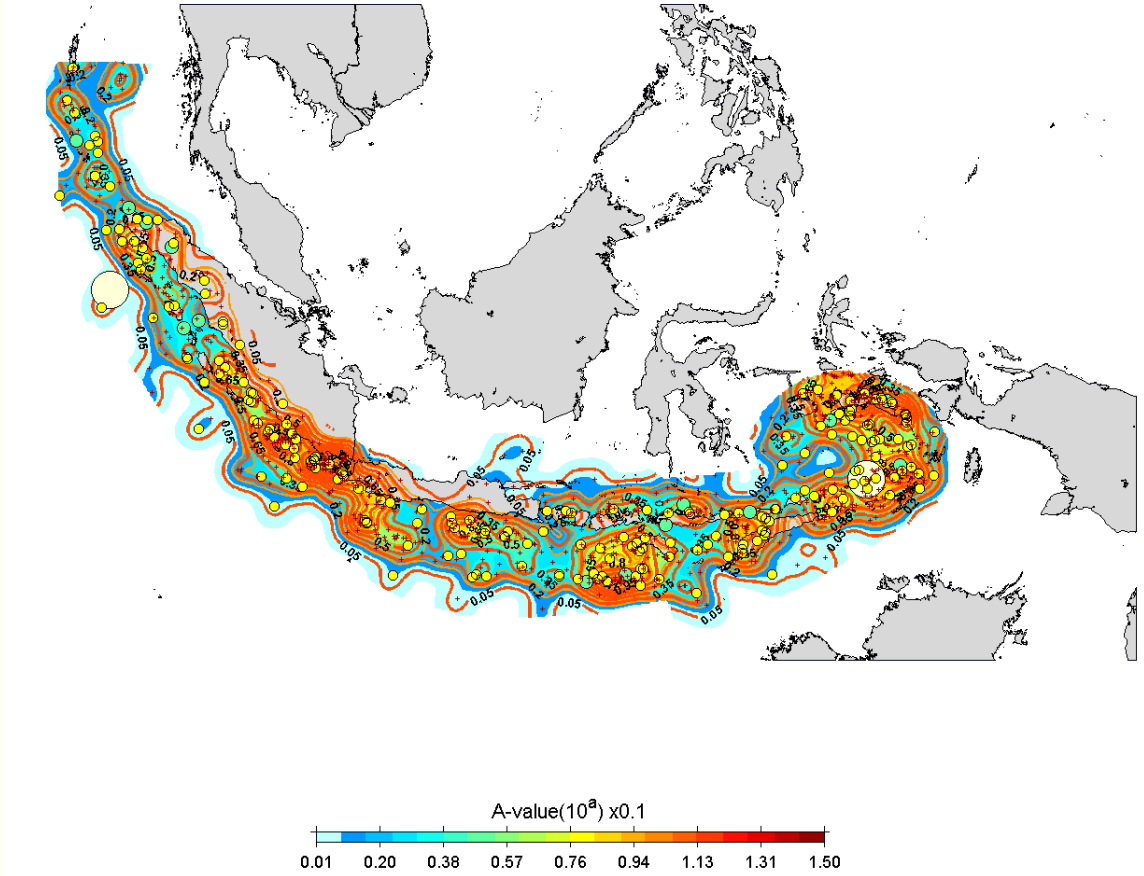
Map A-value (1963-1990; H: 0-60km)



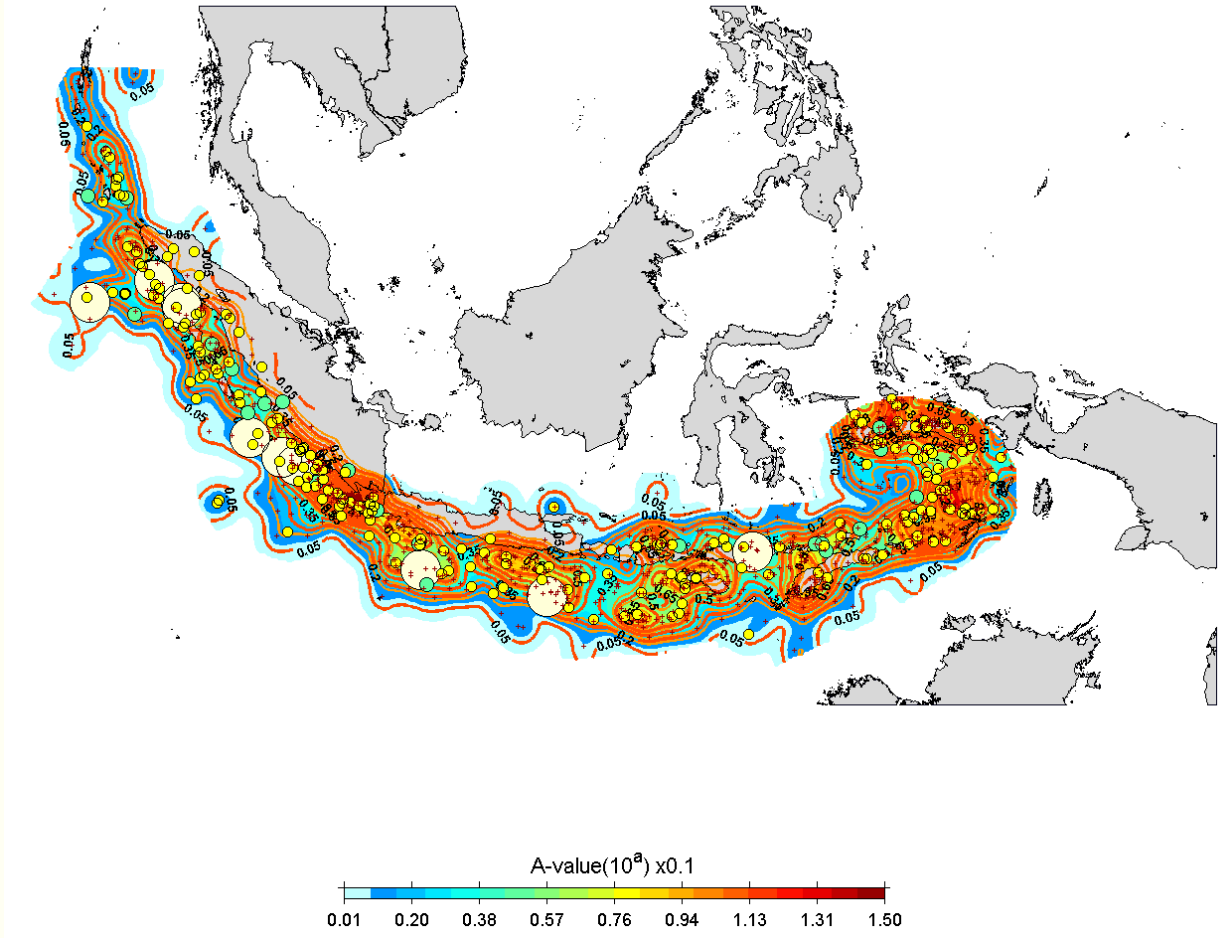
Map A-value (1991-2016; H: 0-60km)



Map A-value (1963-1990; H: 0-60km)



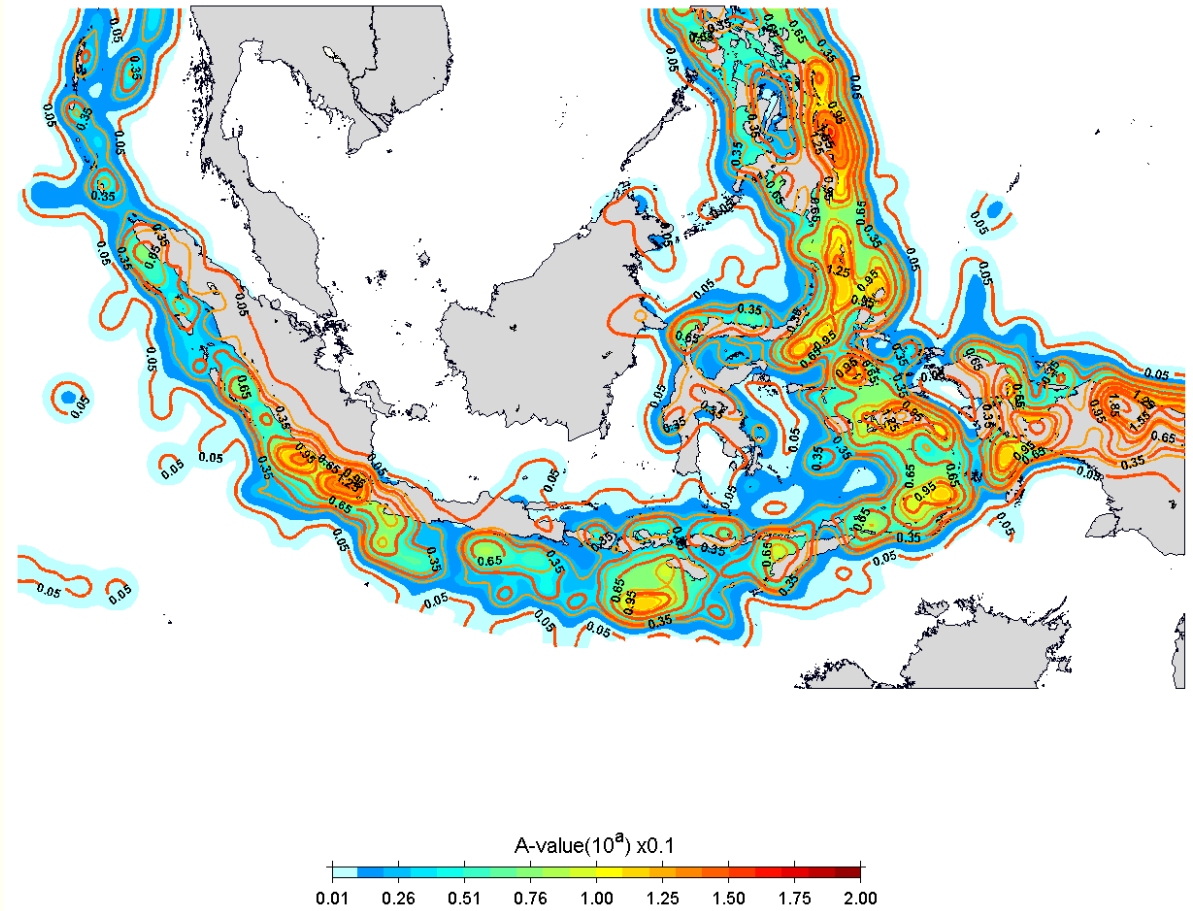
Map A-value (1991-2016; H: 0-60km)



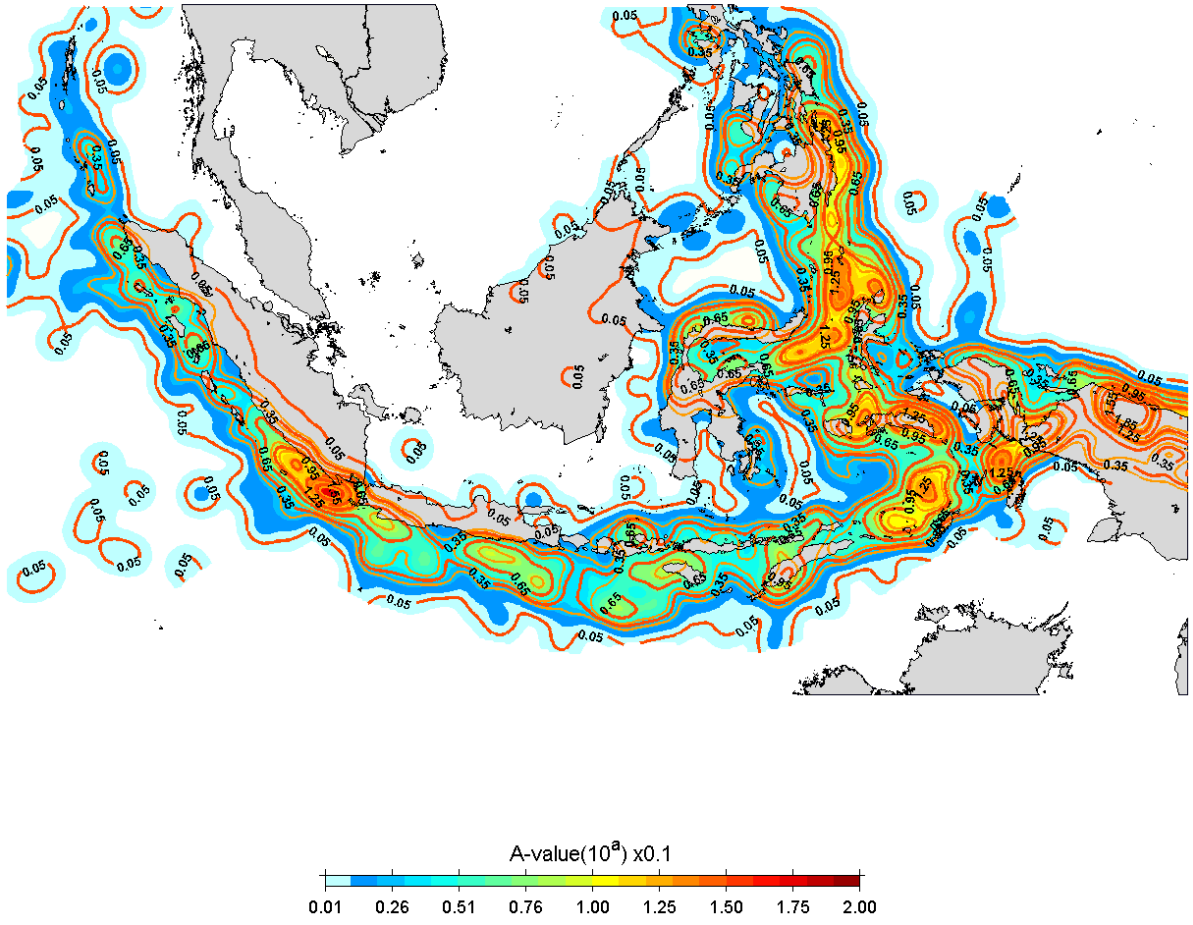
TESTING STABILITY SEISMICITY PATTERN UNDER ASSUMPTION OF POISONIAN DISTRIBUTION: INDONESIA REGION

We divide catalog of 1963-2016 of The De-clustered Earthquake Catalog to 1963-1990 & 1991-2016 by following Frankel's Hypothesis

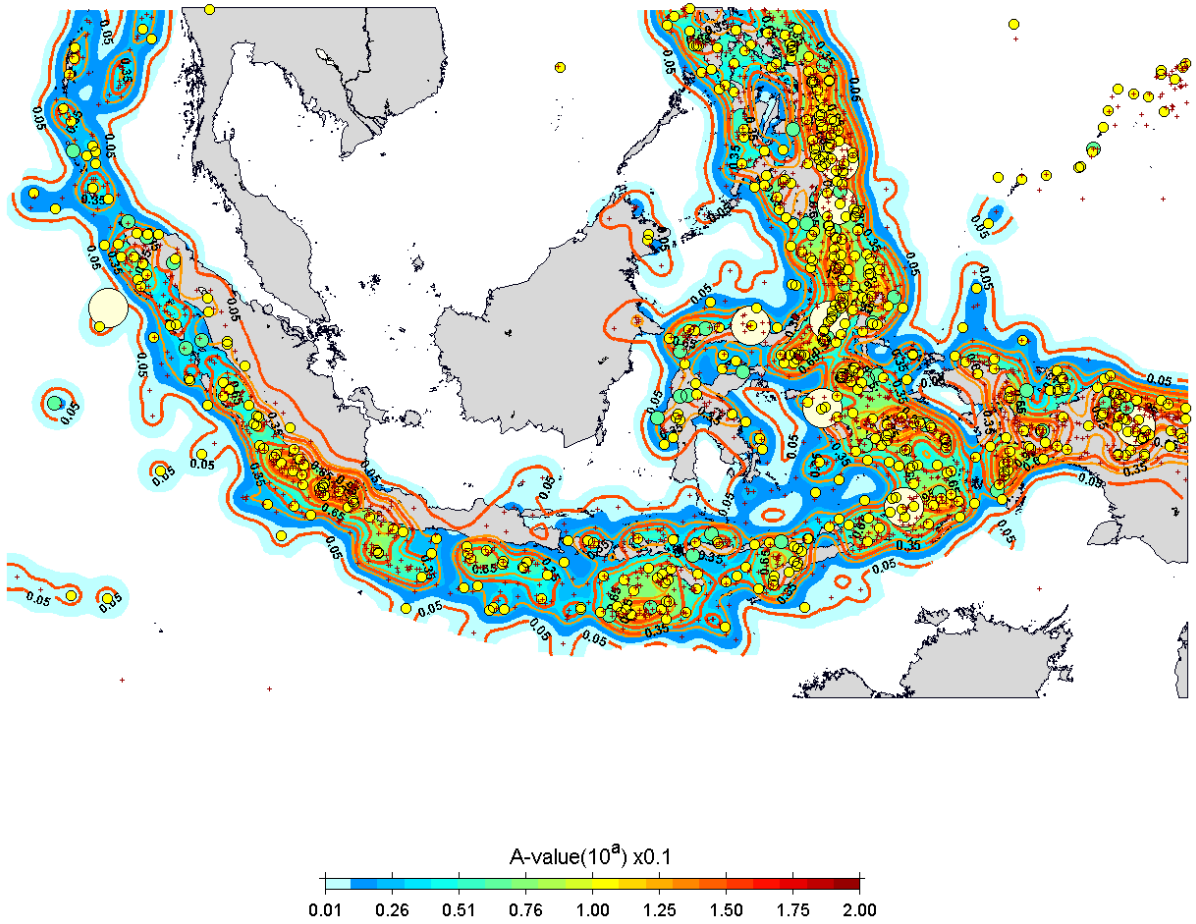
Map A-value (1963-1990; H:0-60km)



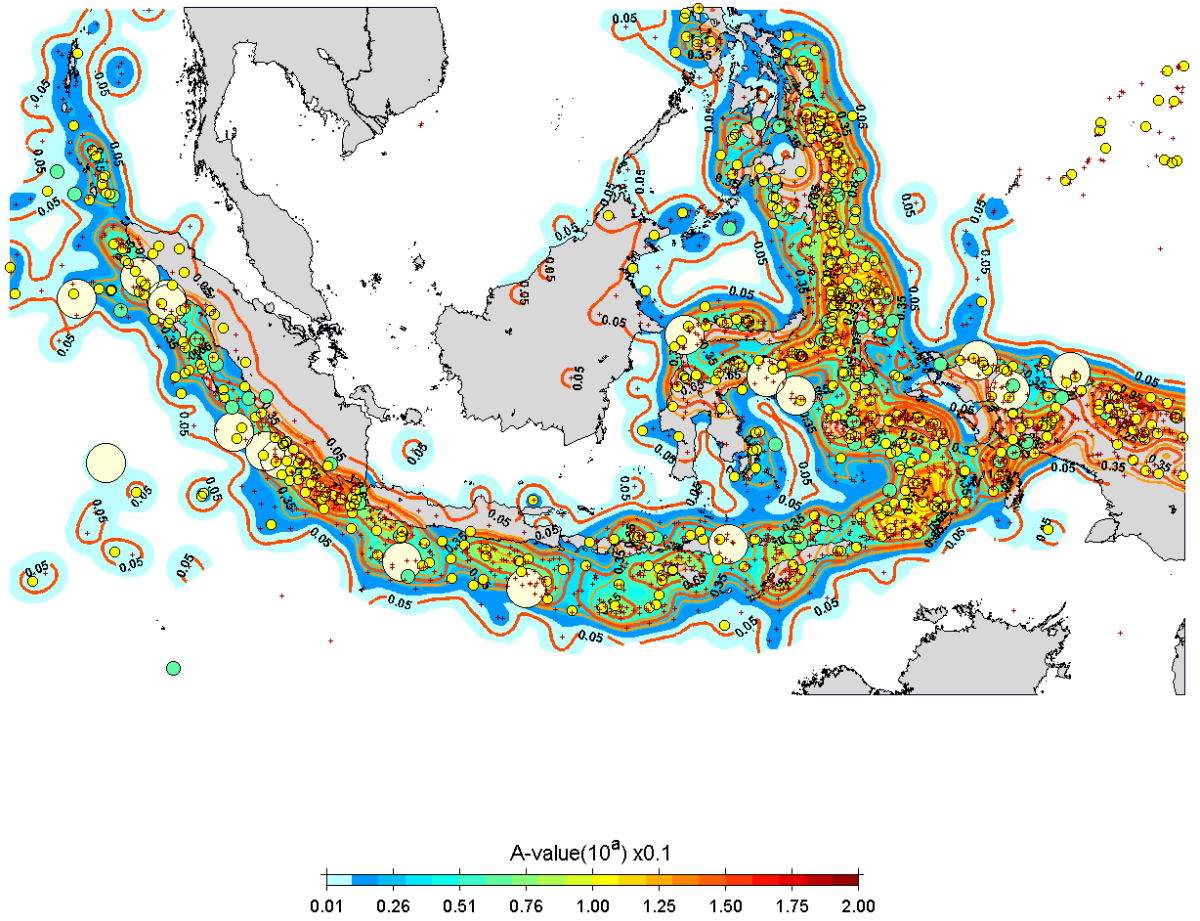
Map A-value (1991-2016; H:0-60km)

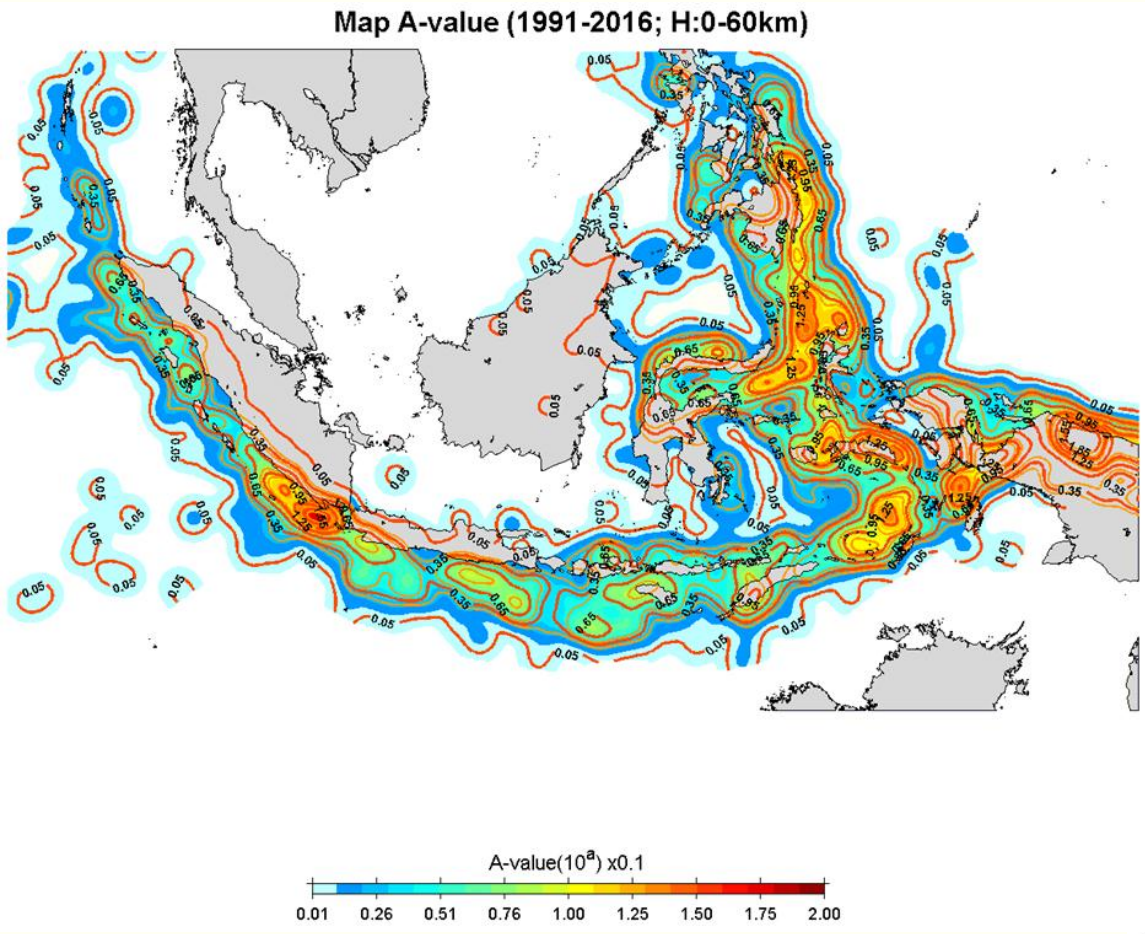


Map A-value (1963-1990; H:0-60km)

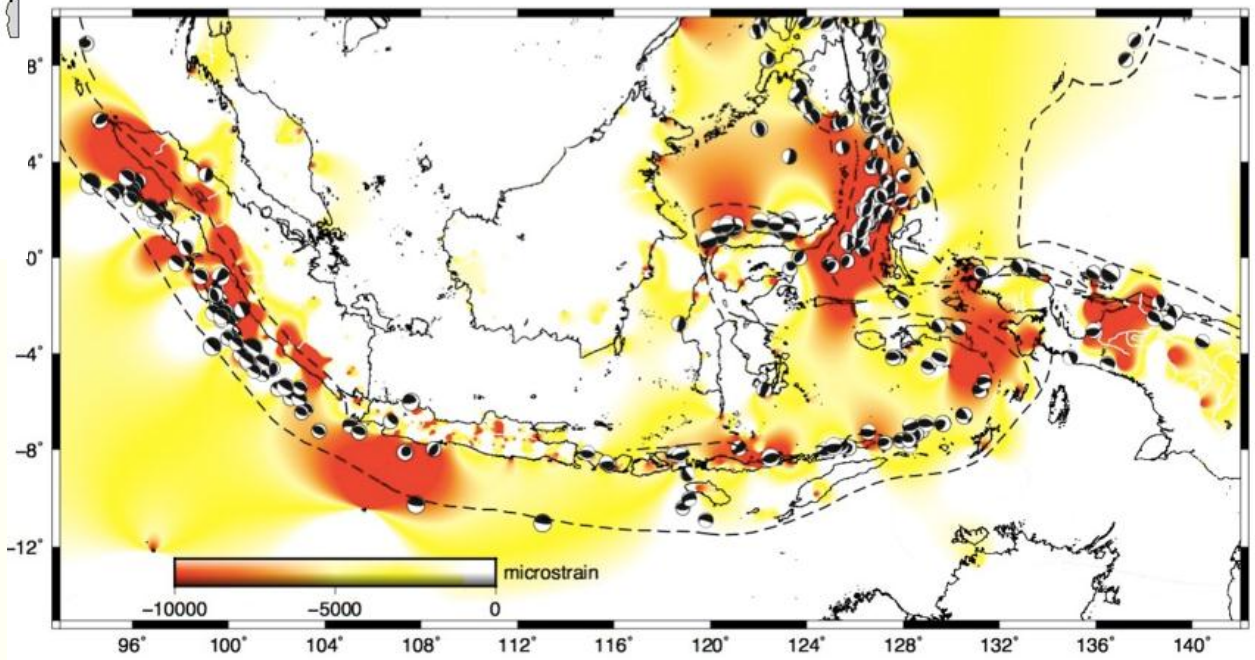


Map A-value (1991-2016; H:0-60km)





Areal Strain



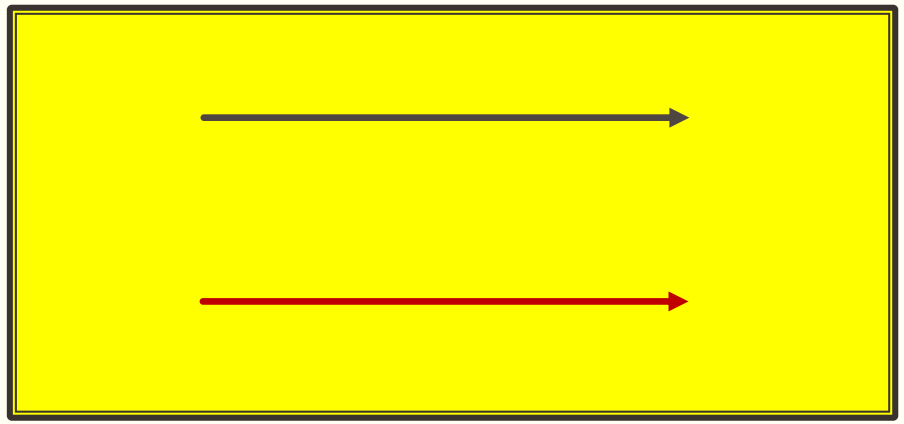
Some Notes

- Evaluation of The A-value by utilizing different windows observation of both Sunda Arc and The Whole Indonesia Region show stable seismicity pattern.
- The PUSGENS 2016 catalog seems to be reliable enough to be used for revising the seismic hazard maps.

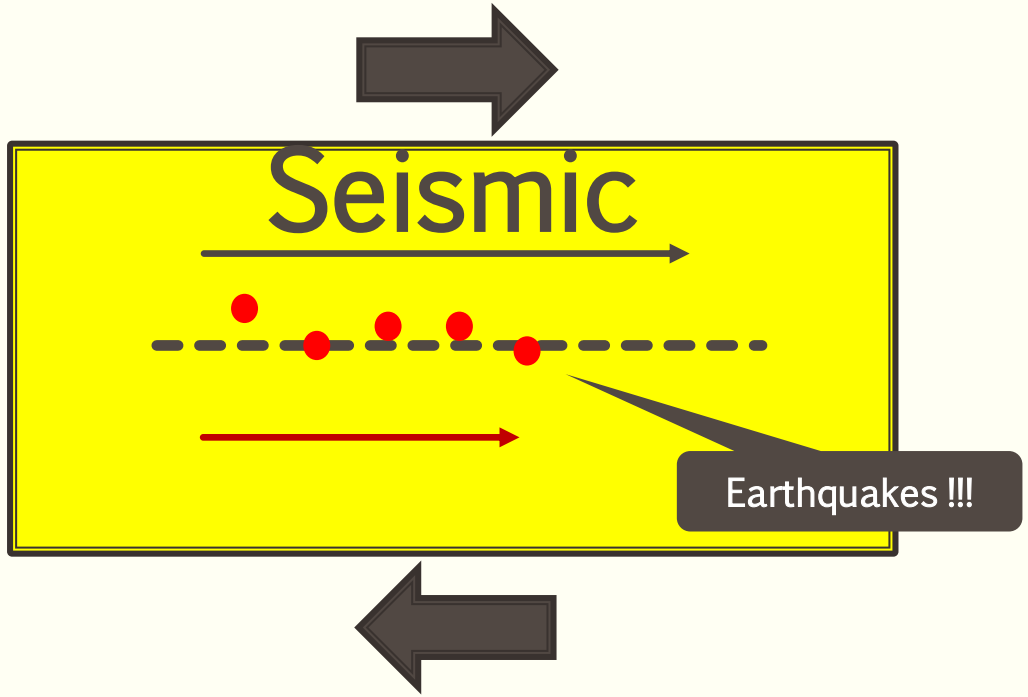
UNDERSTANDING SEISMO-GEODETIC BEHAVIOR OF BASIC TECTONIC ELEMENTS IN JAVA ISLAND FOR PSHA MAP REVISION OF 2017

The Main Idea

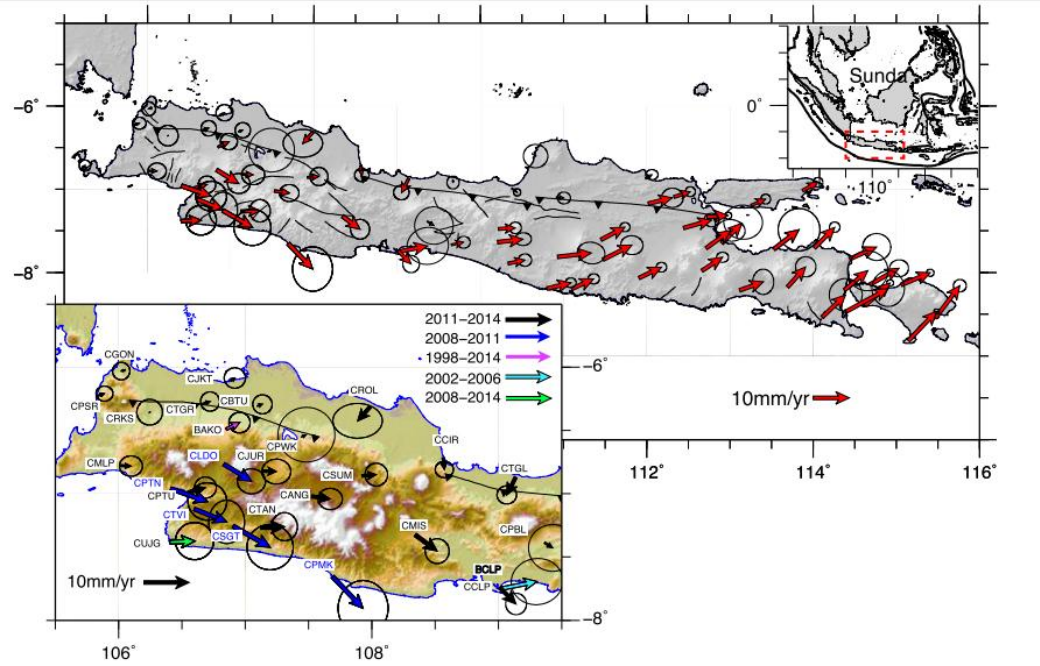
Understanding Displacement Gradient



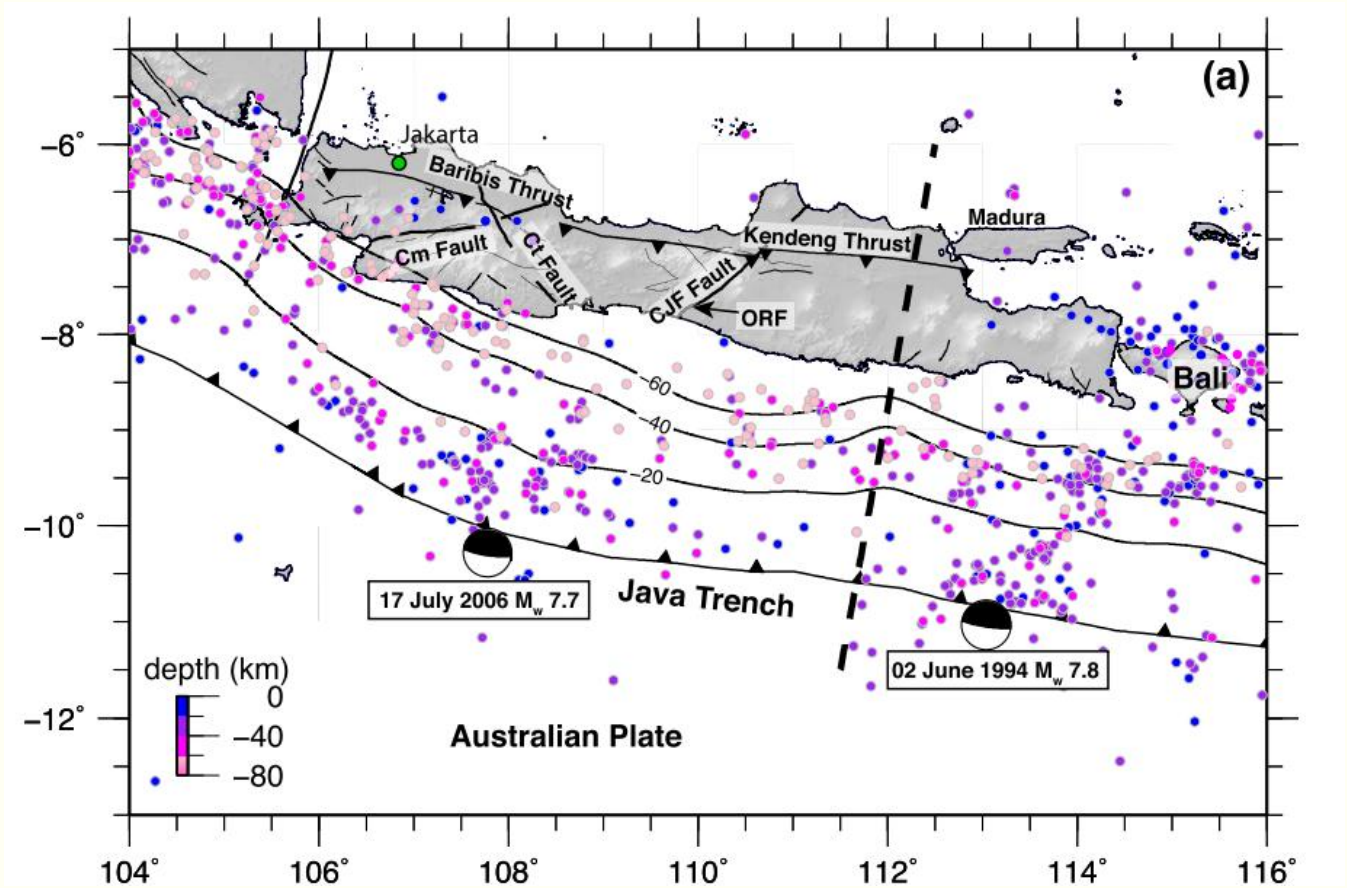
Aseismic



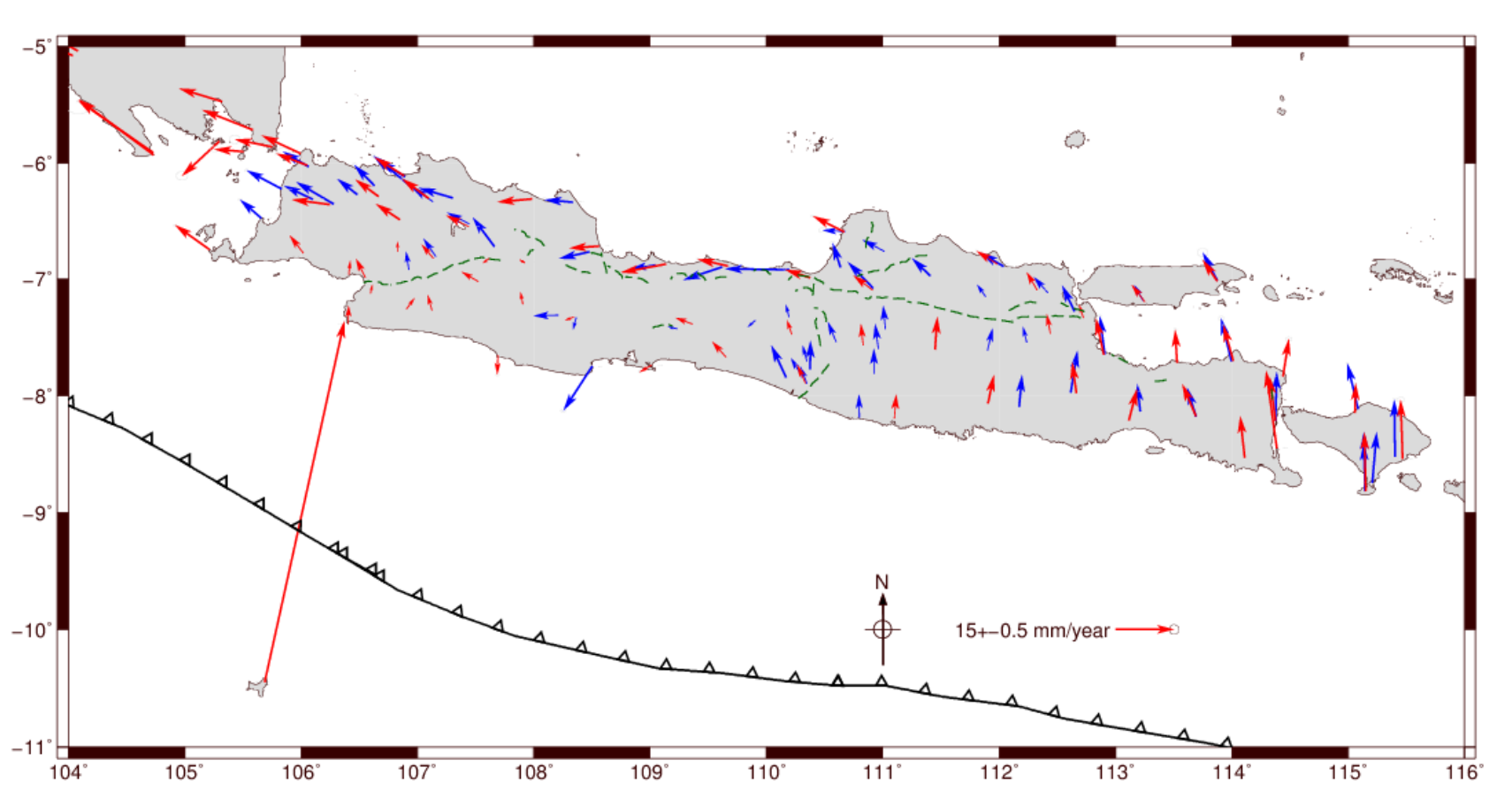
Tectonic Implication



Persebaran titik GPS yang digunakan dalam perhitungan model blok Sesar Baribis dan Kendeng (Koulali dkk, 2016b)

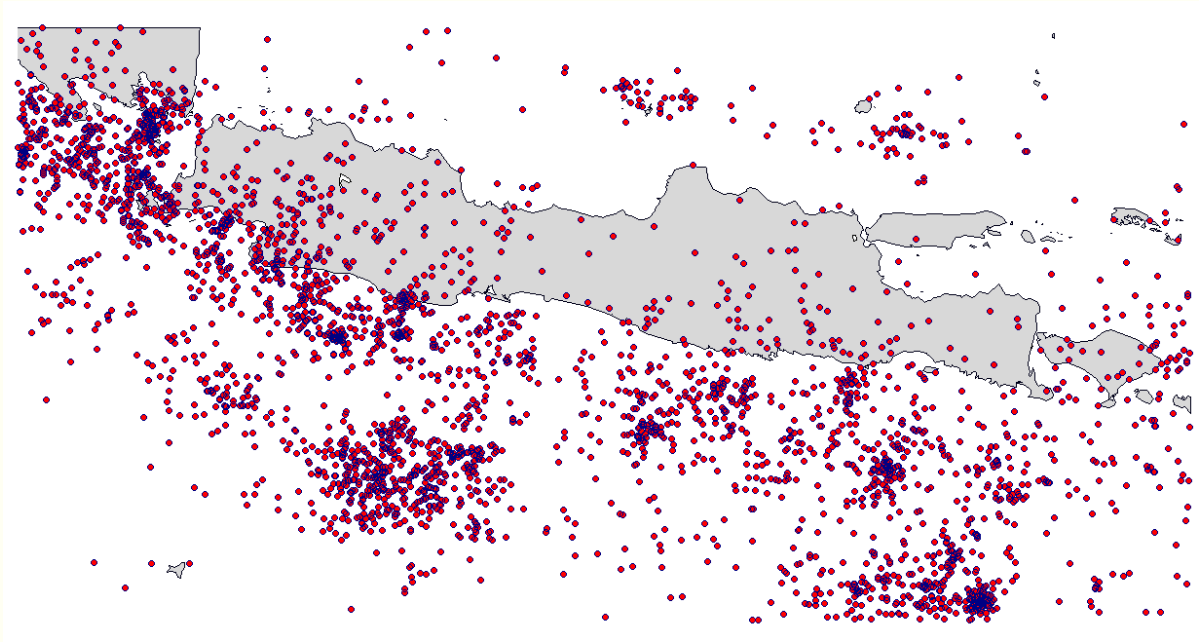


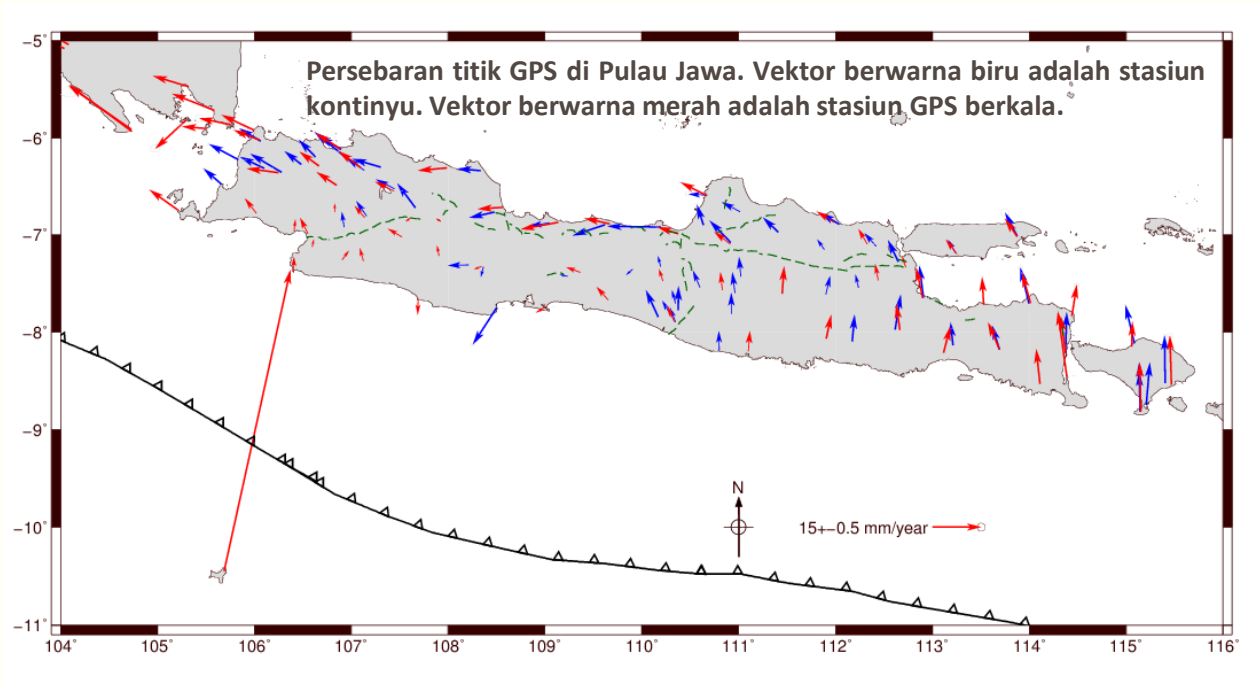
Sesar Kendeng yang terletak memanjang sepanjang Jawa Timur dan Jawa Tengah menurut Koulali dkk (2016)



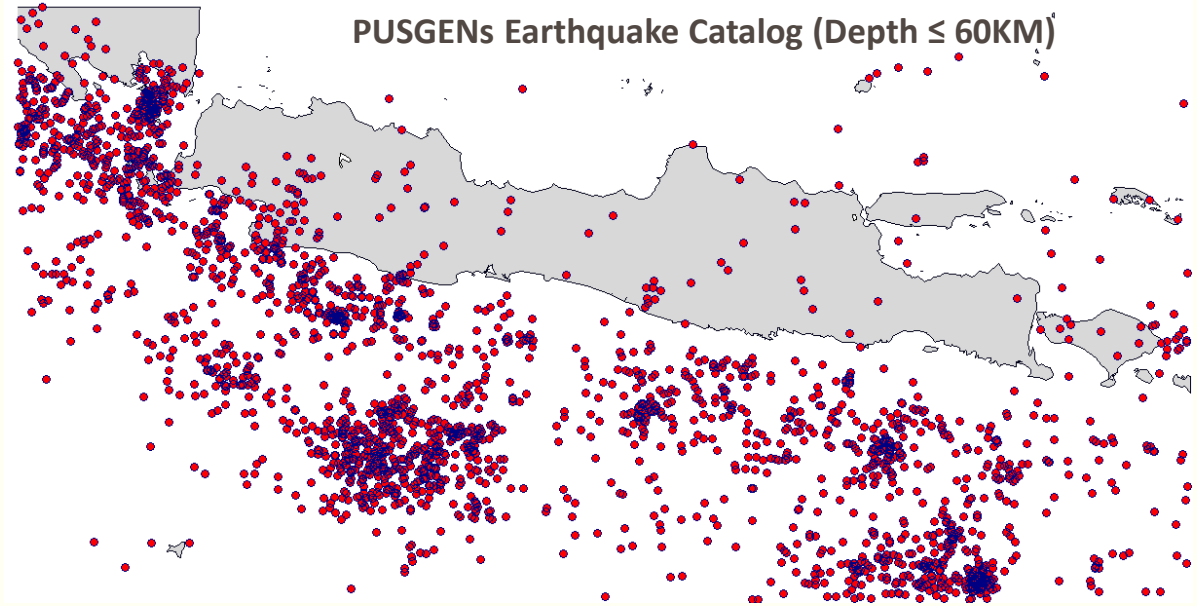
Persebaran titik GPS di Pulau Jawa. Vektor berwarna biru adalah stasiun kontinyu. Vektor berwarna merah adalah stasiun GPS berkala.

PUSGENs Earthquake Catalog (All Depth)

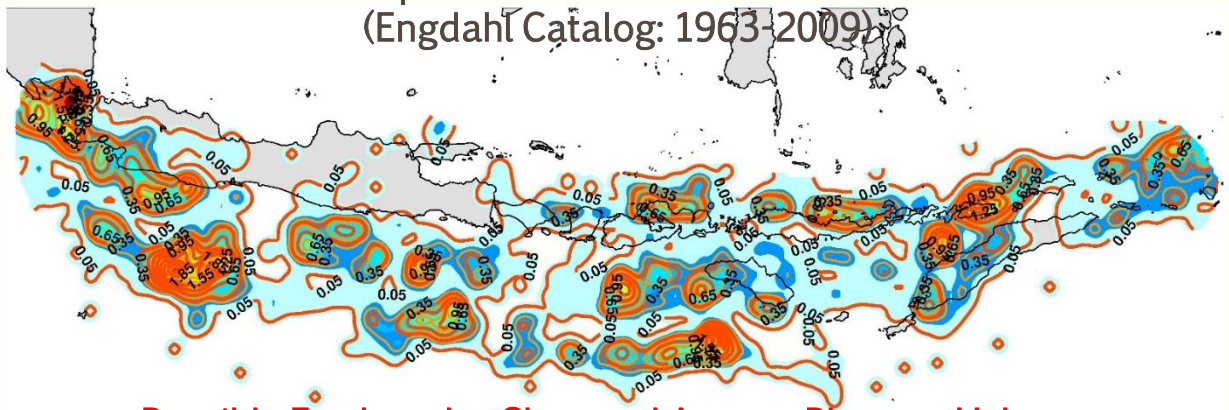




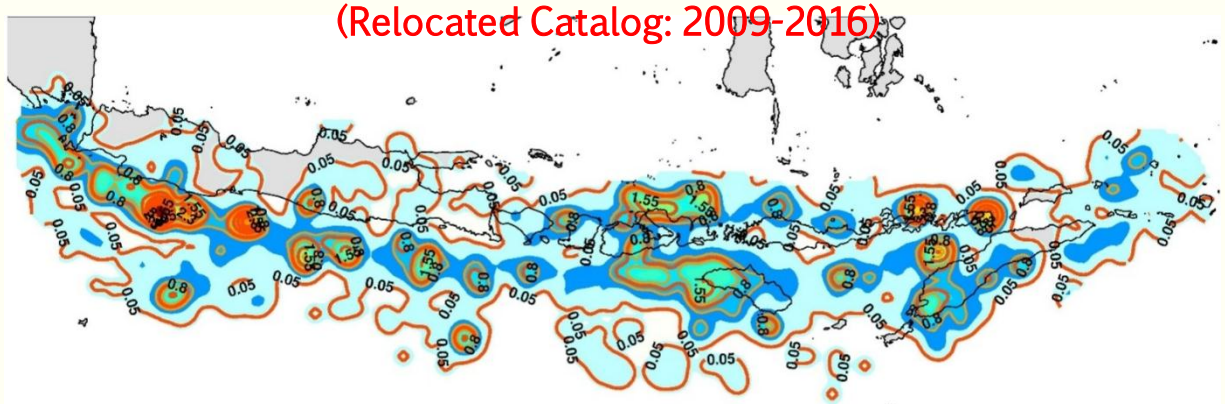
PUSGENs Earthquake Catalog (Depth ≤ 60KM)



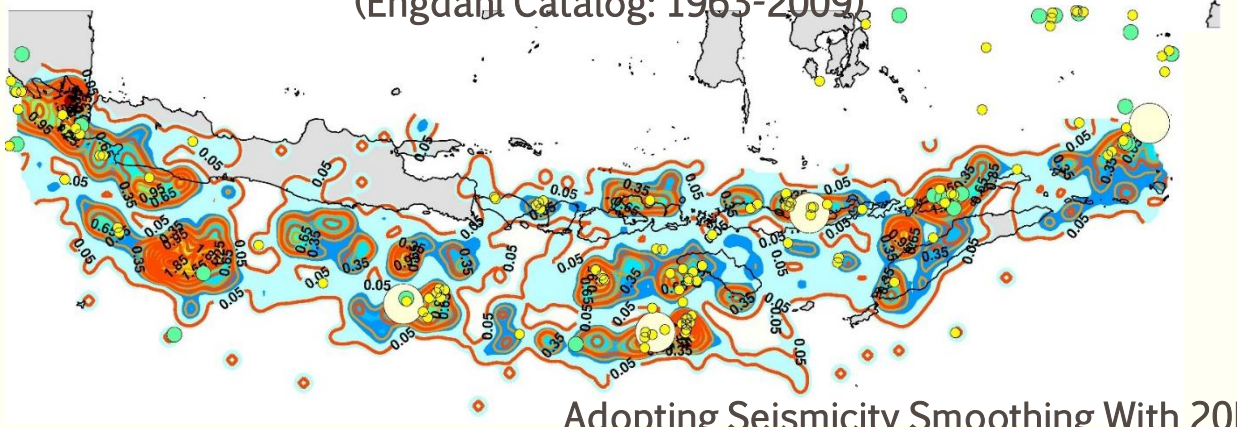
Possible Earthquake-Clustered Area or Plane or Volume
(Engdahl Catalog: 1963-2009)



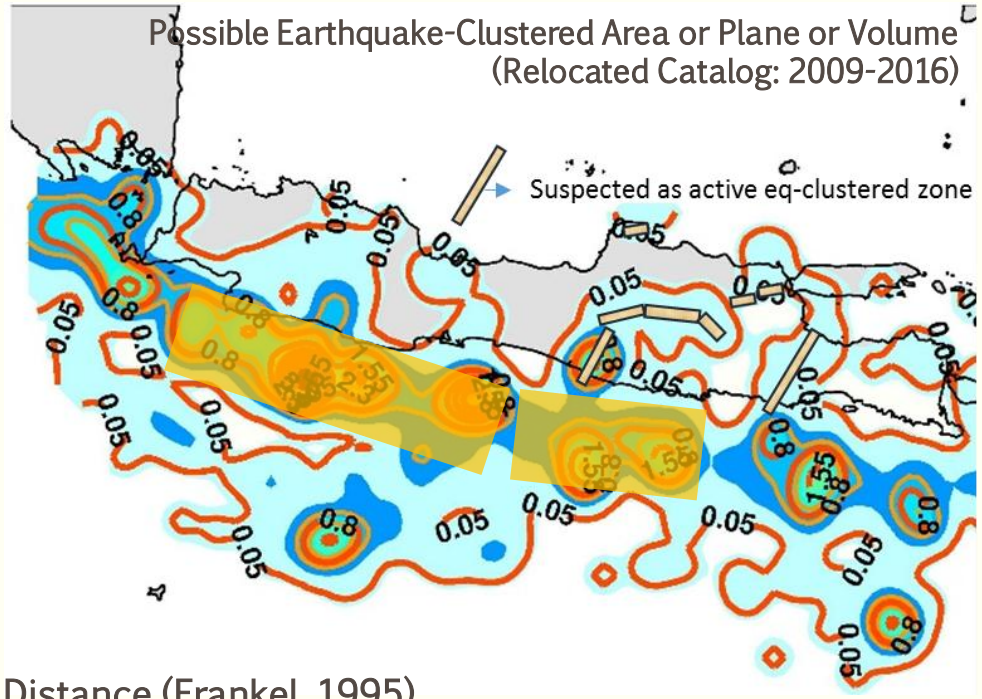
Possible Earthquake-Clustered Area or Plane or Volume
(Relocated Catalog: 2009-2016)



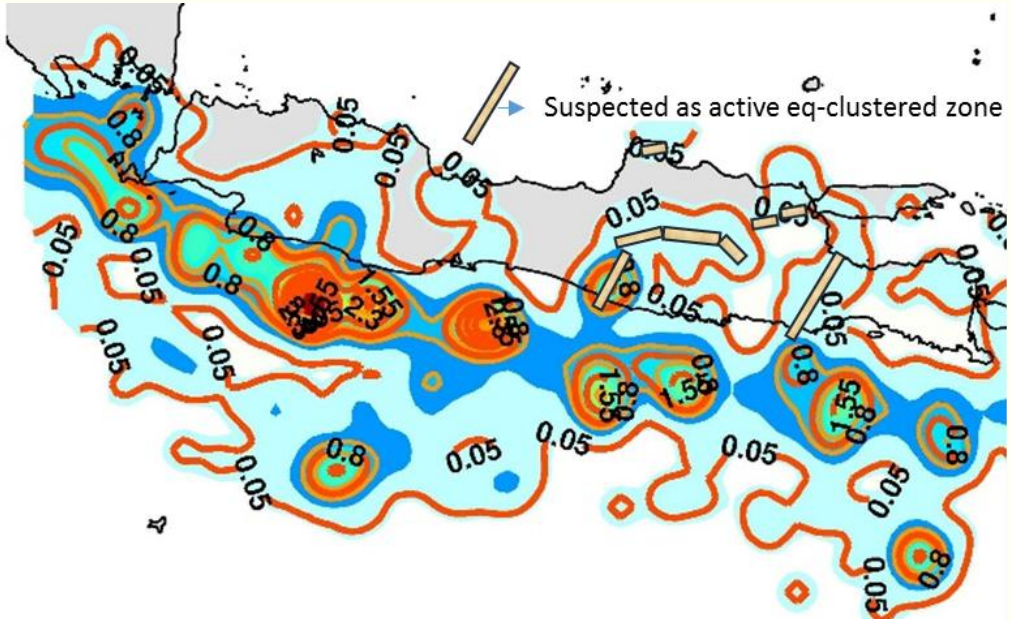
Possible Earthquake-Clustered Area or Plane or Volume
(Engdahl Catalog: 1963-2009)

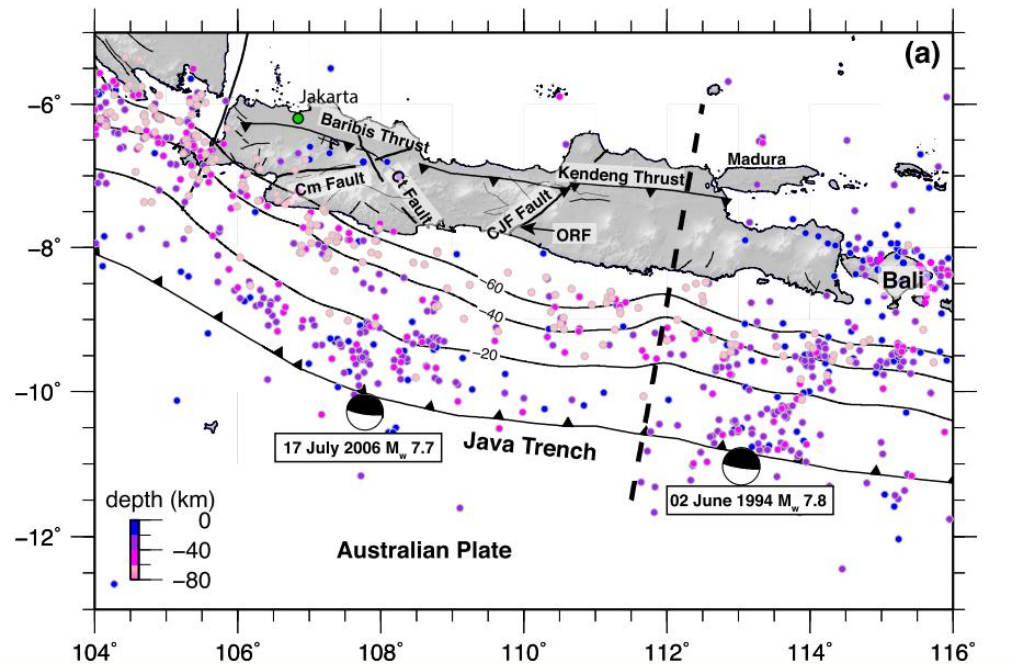


Possible Earthquake-Clustered Area or Plane or Volume
(Relocated Catalog: 2009-2016)

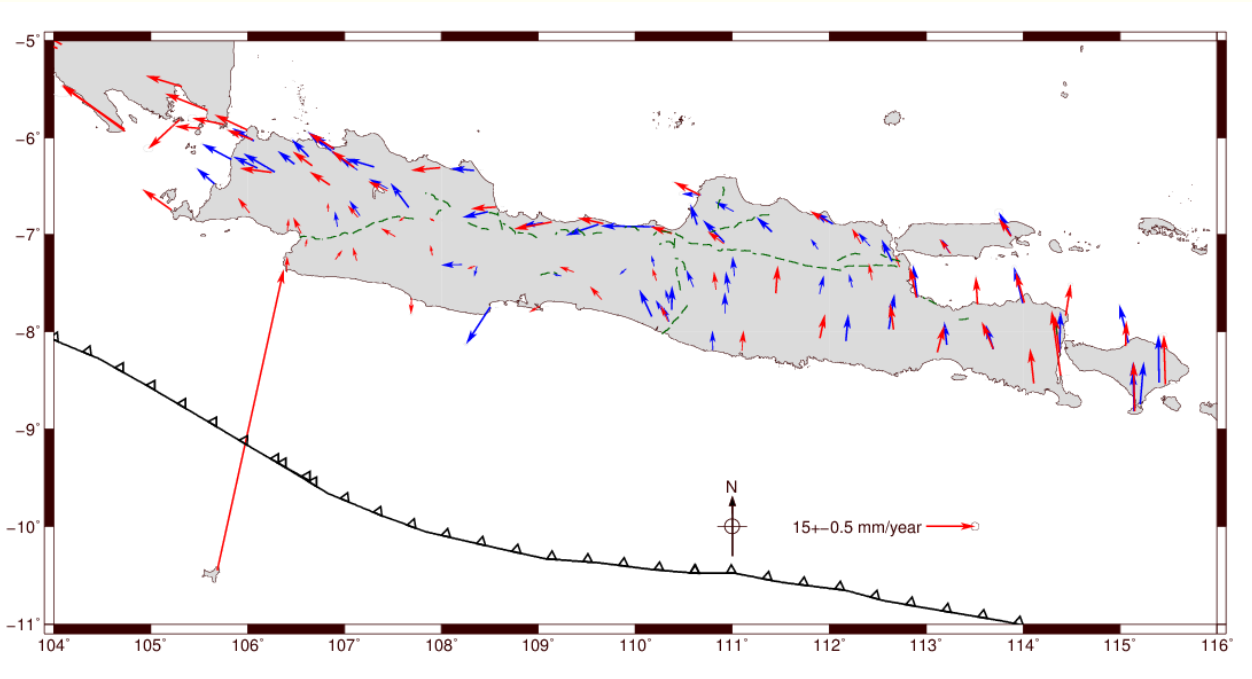


Adopting Seismicity Smoothing With 20km Correlation Distance (Frankel, 1995)

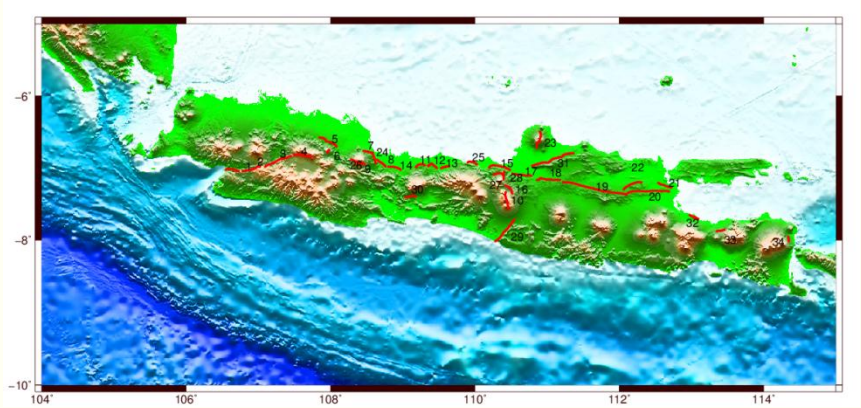


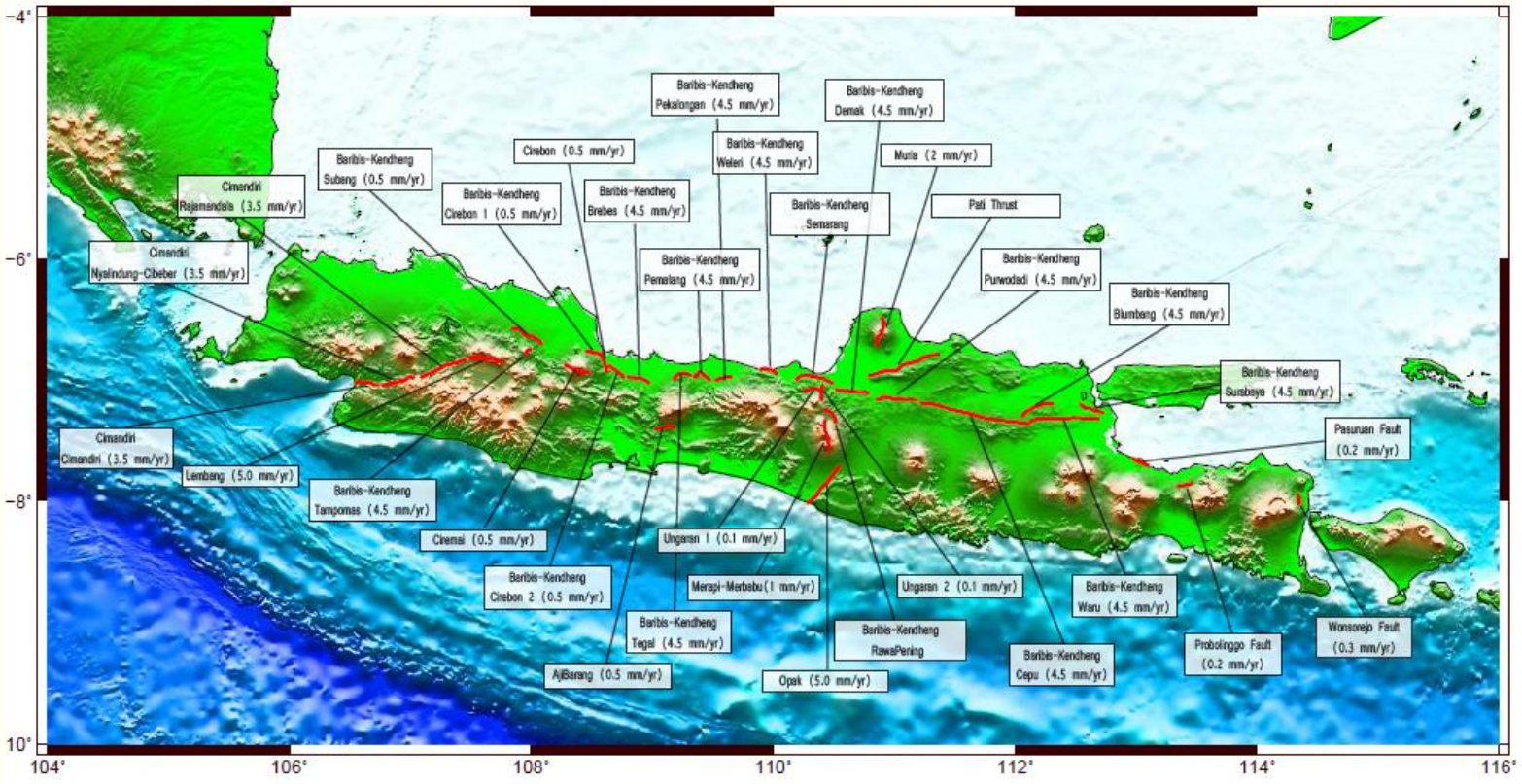


Sesar Kendeng yang terletak memanjang sepanjang Jawa Timur dan Jawa Tengah menurut Koulali dkk (2016)



Persebaran titik GPS di Pulau Jawa. Vektor berwarna biru adalah stasiun kontinyu. Vektor berwarna merah adalah stasiun GPS berkala.

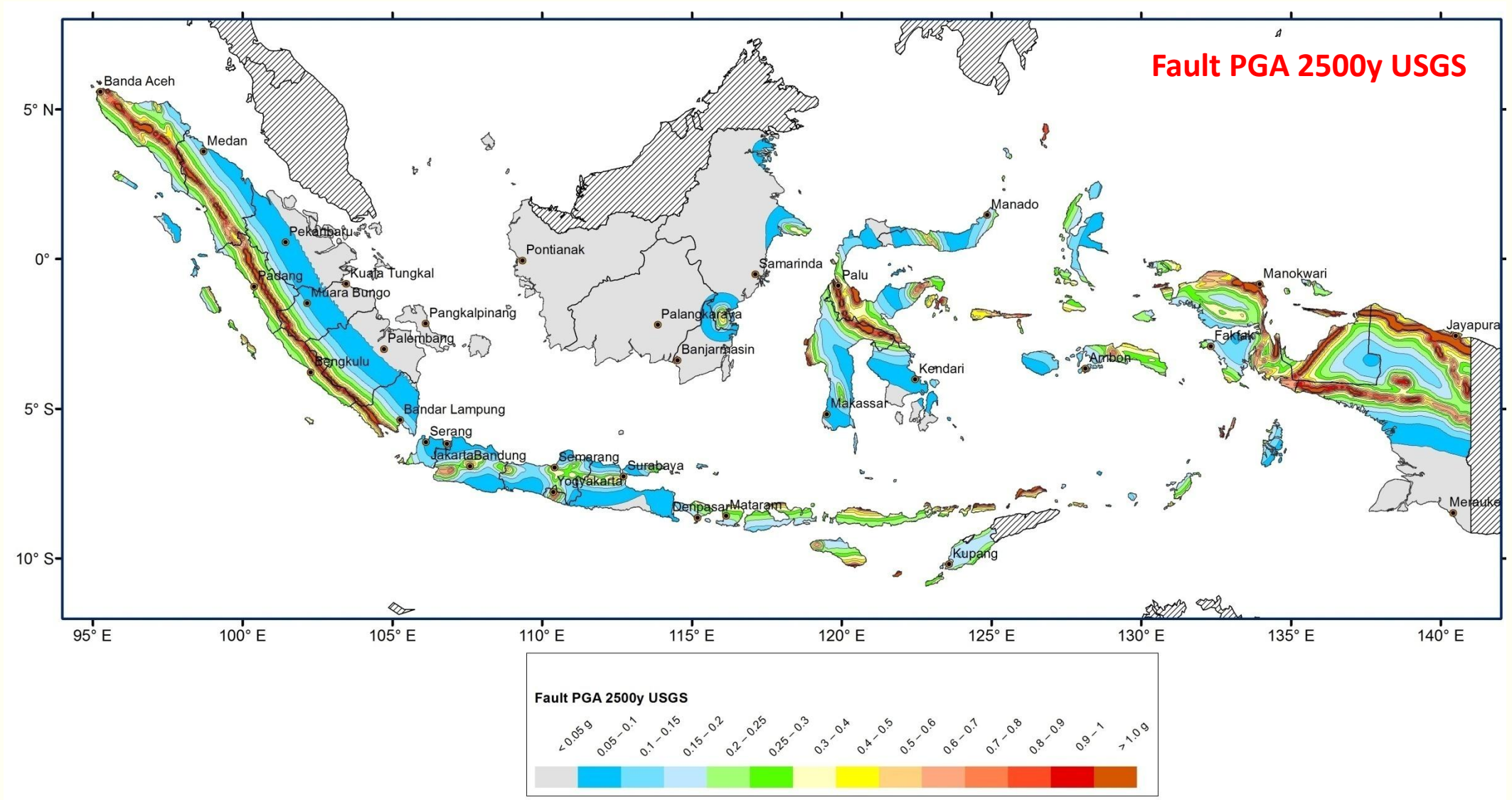




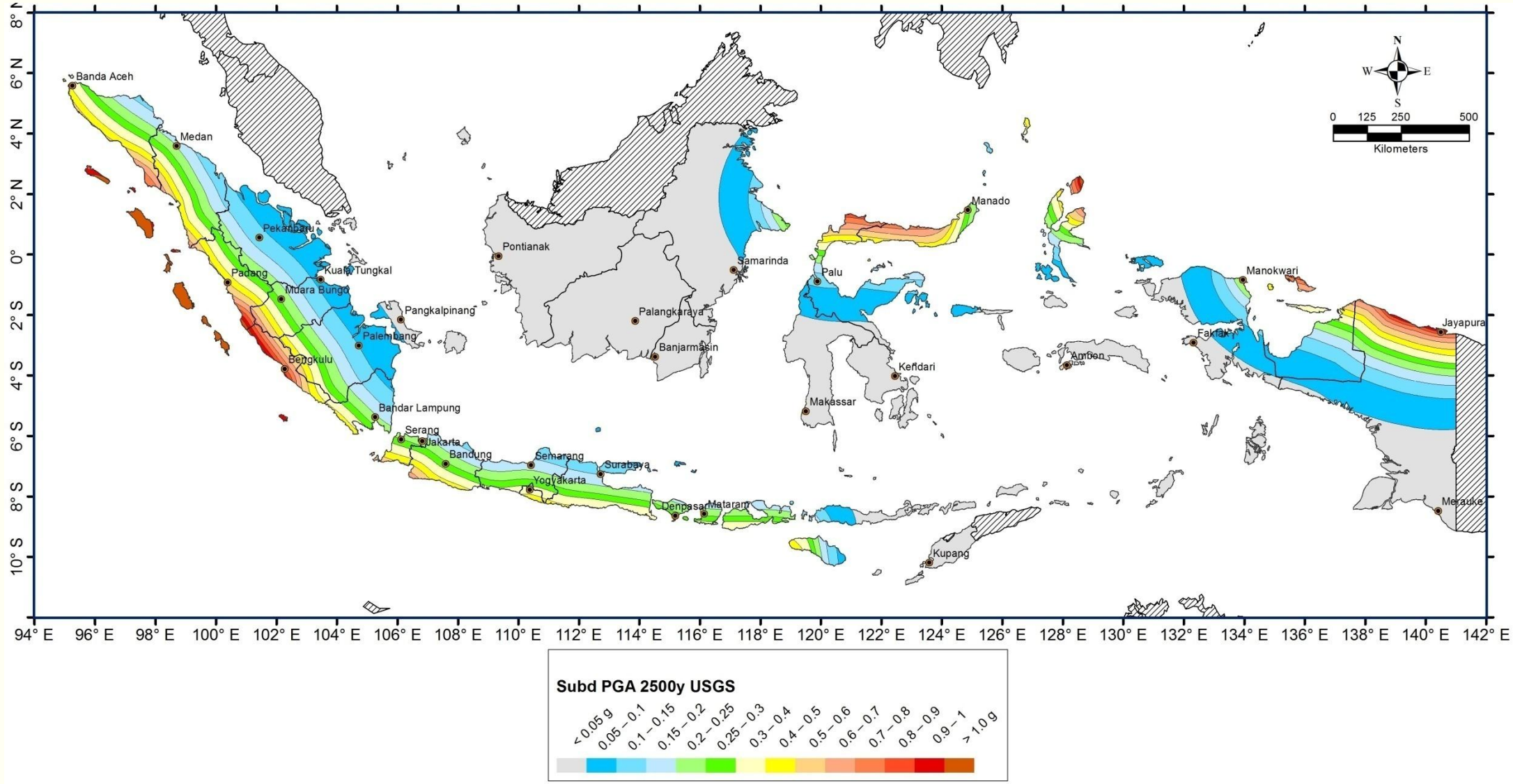
Peta Segmentasi Jawa

Our Basic & Main Data for PSHA Input are Updated

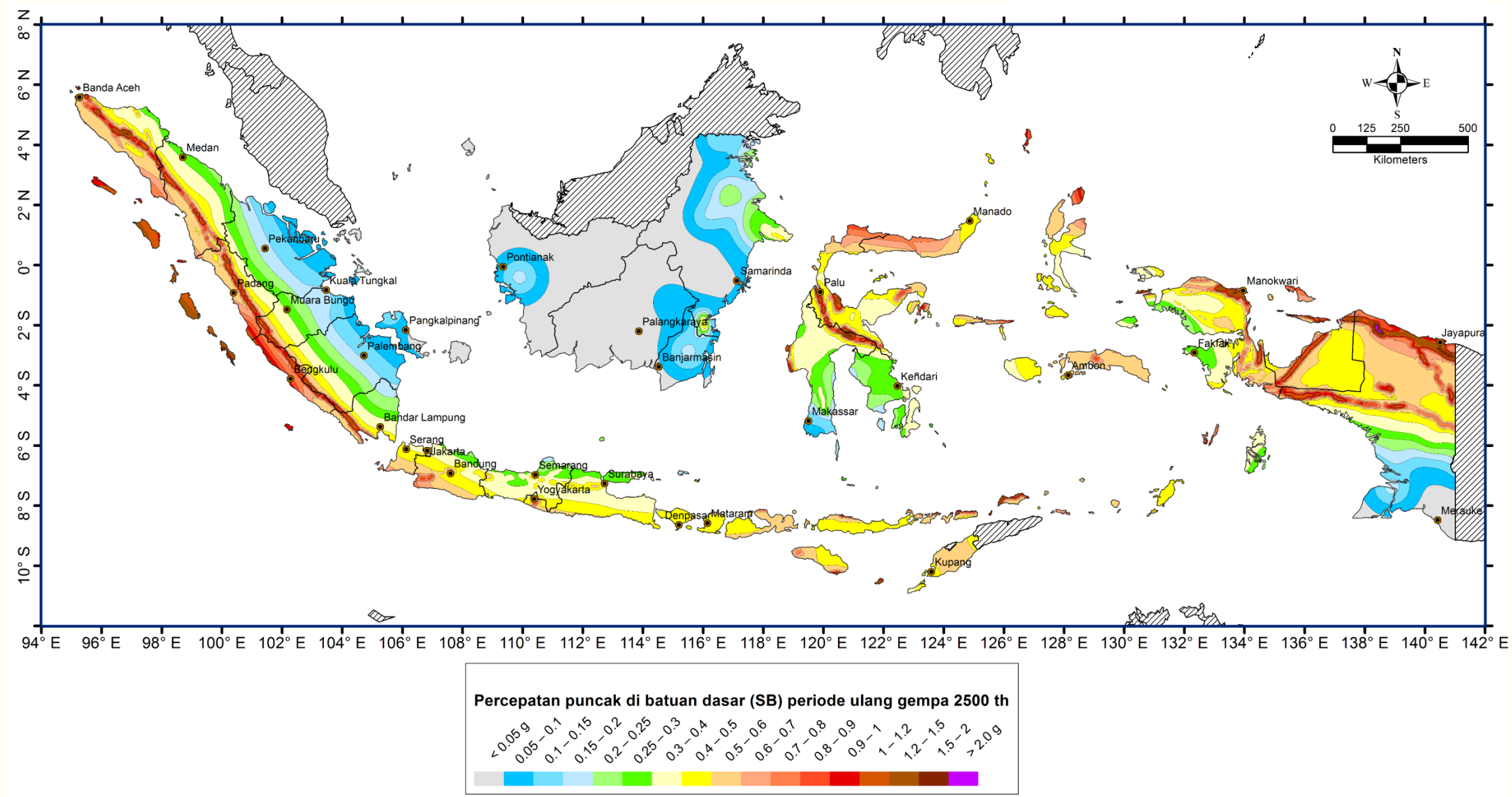
Thus ....
We really Need to Update Our PSHA Map


Fault PGA 2500y USGS
Banda Aceh
Medan
Pekanbaru
Padang
Kuala Tungkal
Muara Bungo
Pangkalpinang
Palembang
Bengkulu
Bandar Lampung
Serang
Jakarta
Bandung
Semarang
Surabaya
Yogyakarta
Denpasar
Mataram
Kupang
Pontianak
Samarinda
Palangkaraya
Banjarmasin
Manado
Palu
Kendari
Makassar
Ambon
Manokwari
Fakfak
Jayapura
Merauke
5° N
0°
5° S
10° S
95° E
100° E
105° E
110° E
115° E
120° E
125° E
130° E
135° E
140° E
Fault PGA 2500y USGS
< 0.05 g
0.05 – 0.1
0.1 – 0.15
0.15 – 0.2
0.2 – 0.25
0.25 – 0.3
0.3 – 0.4
0.4 – 0.5
0.5 – 0.6
0.6 – 0.7
0.7 – 0.8
0.8 – 0.9
0.9 – 1
> 1.0 g

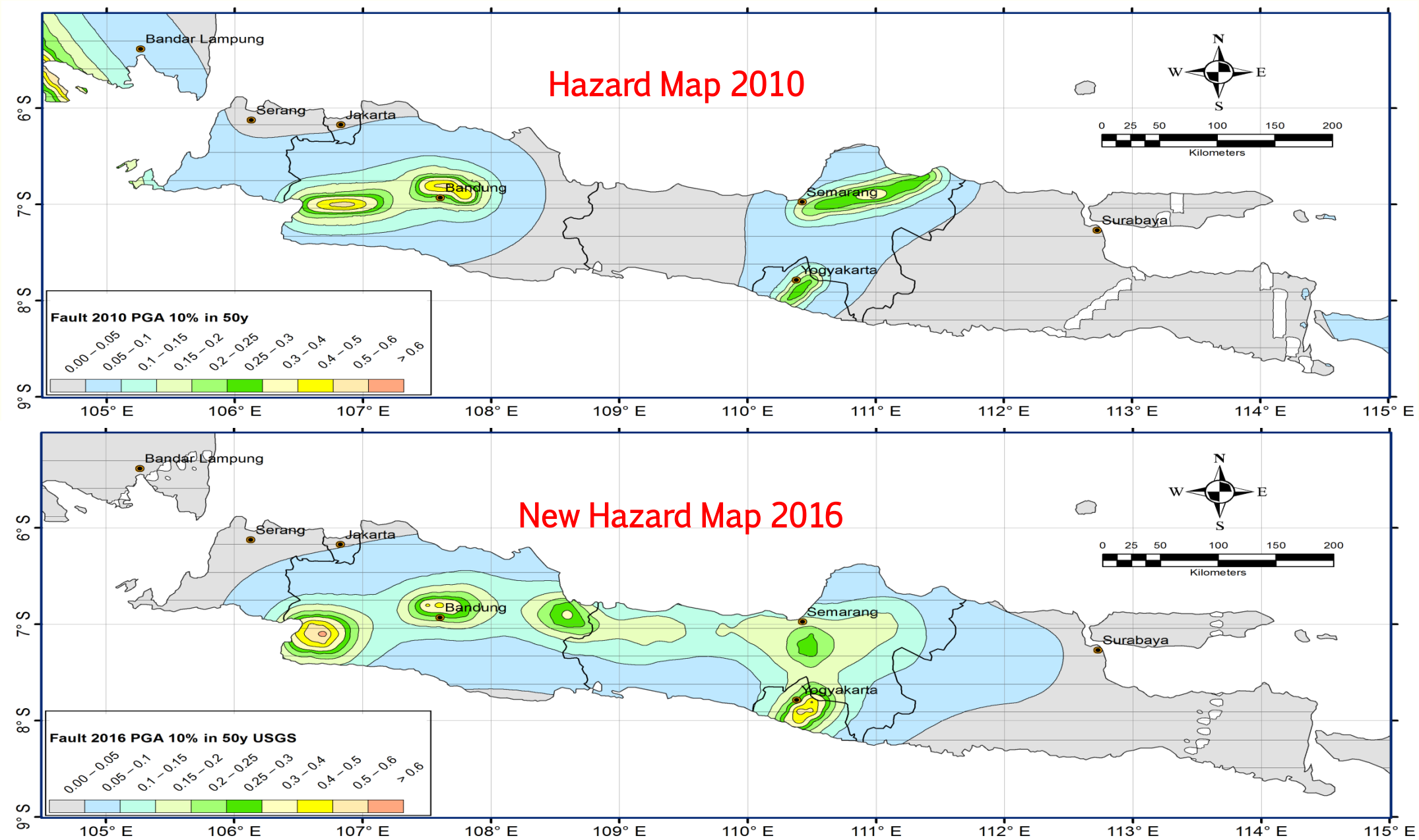
Subduction PGA 2500 year USGS



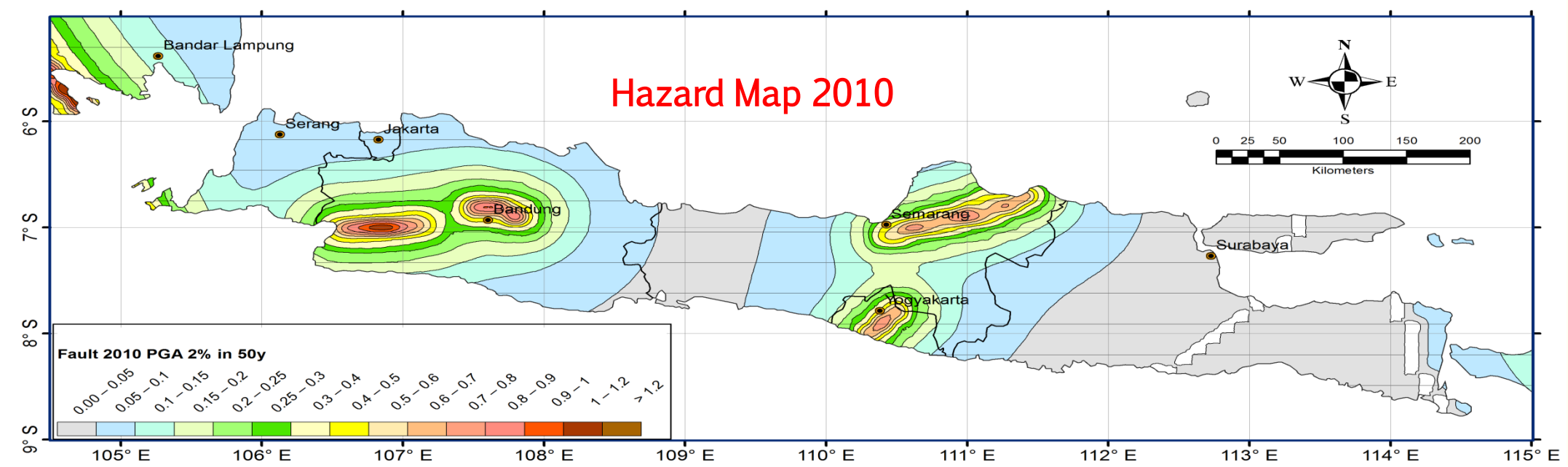
All Sources PGA 2500 years USGS

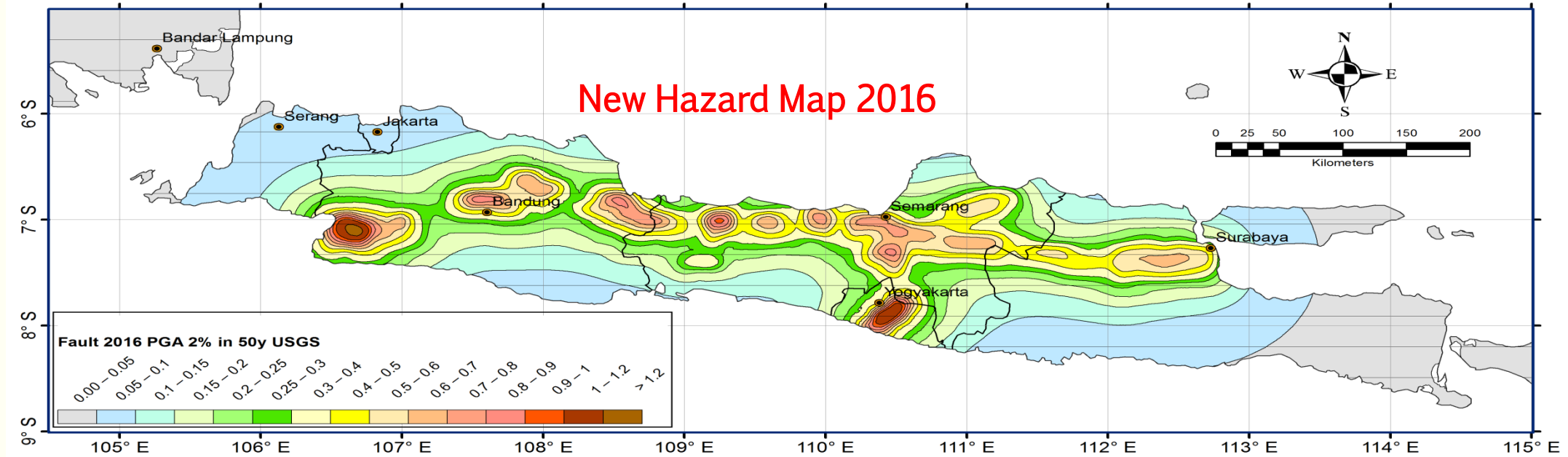


Hazard map PGA 10% in 50y (Fault Sources)
2010 Vs 2016

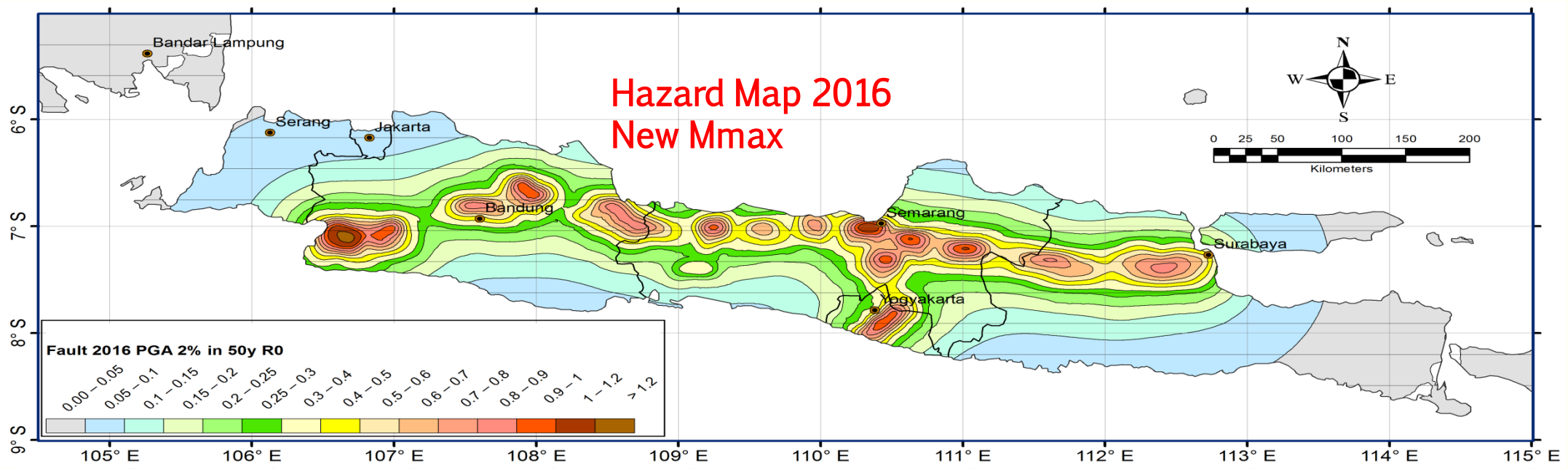


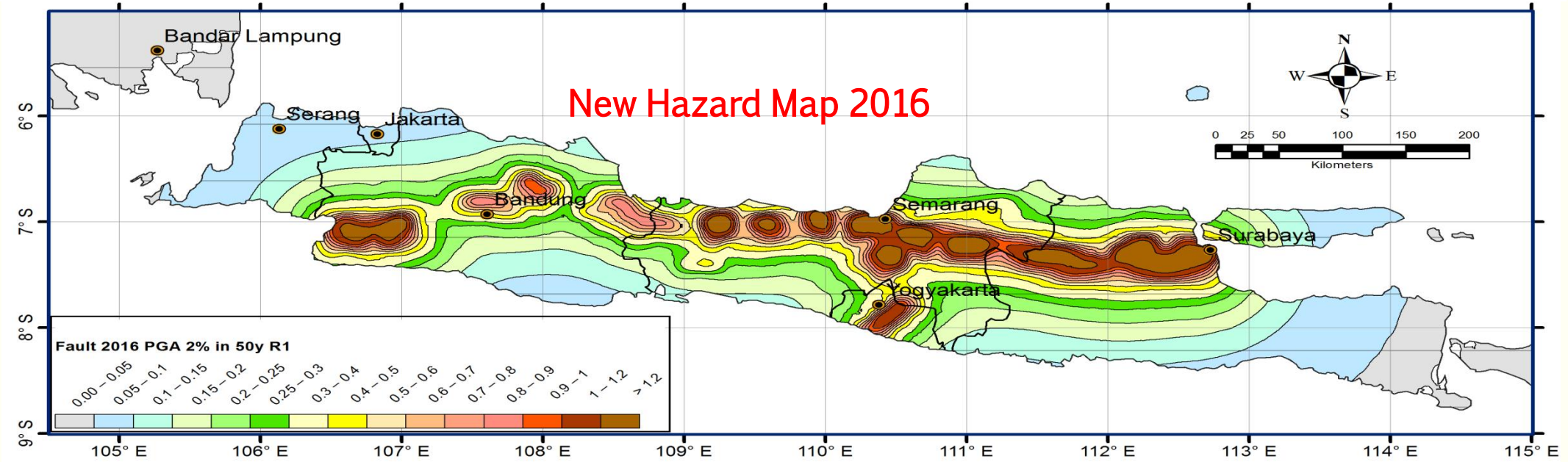
Hazard map PGA 2% in 50y (Fault Sources)
2010 Vs 2016



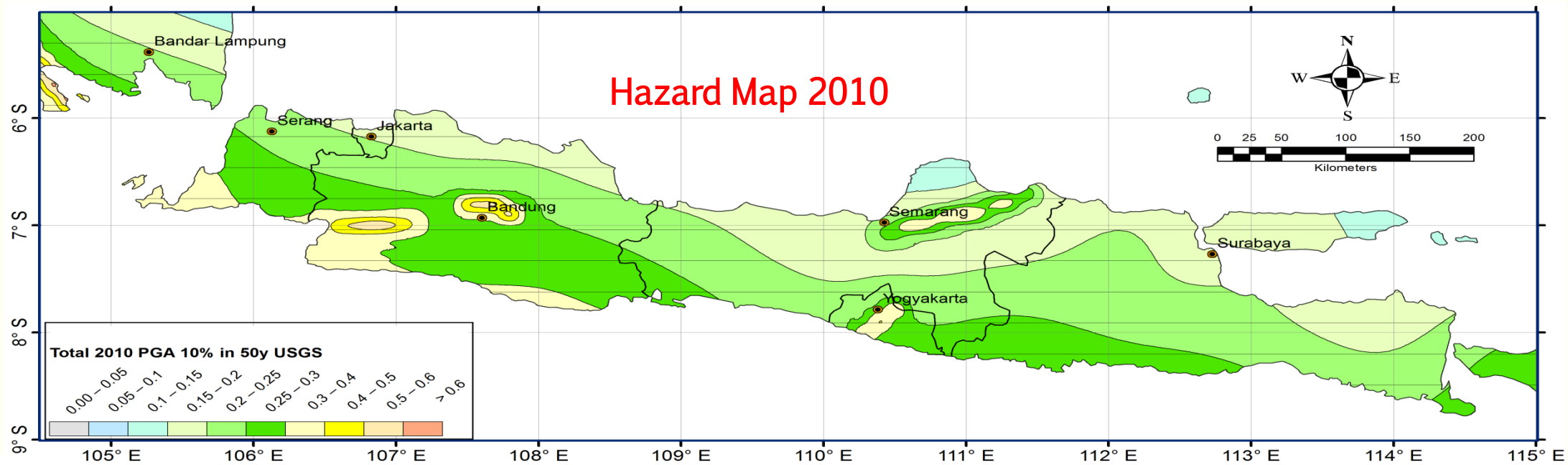


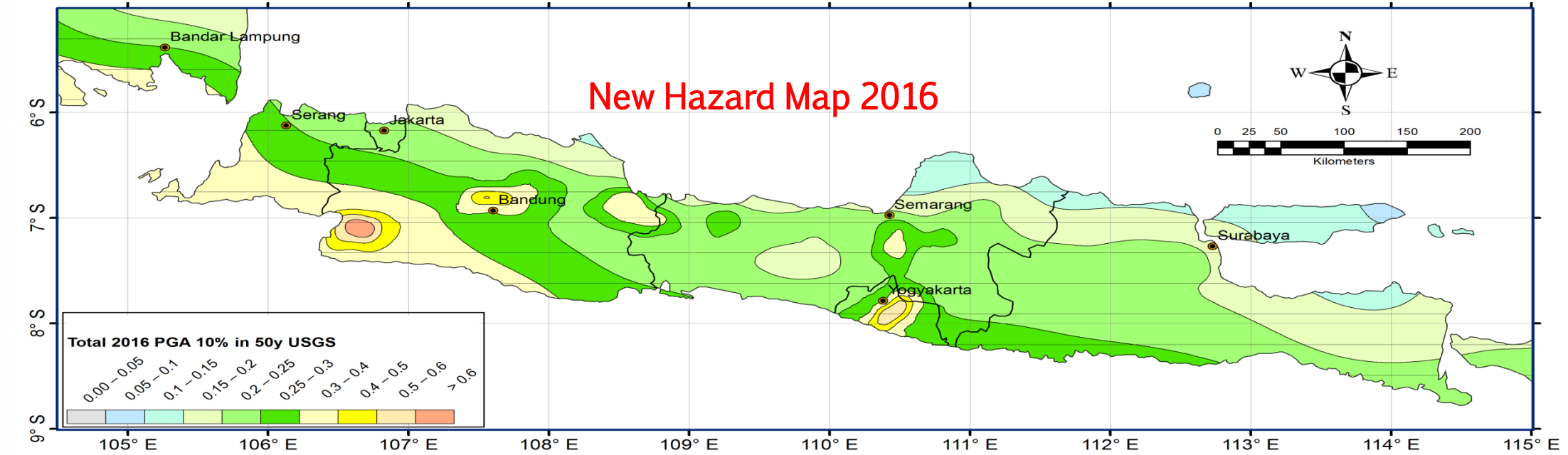
Hazard map PGA 2% in 50y (Fault Sources)
2010 Vs 2016



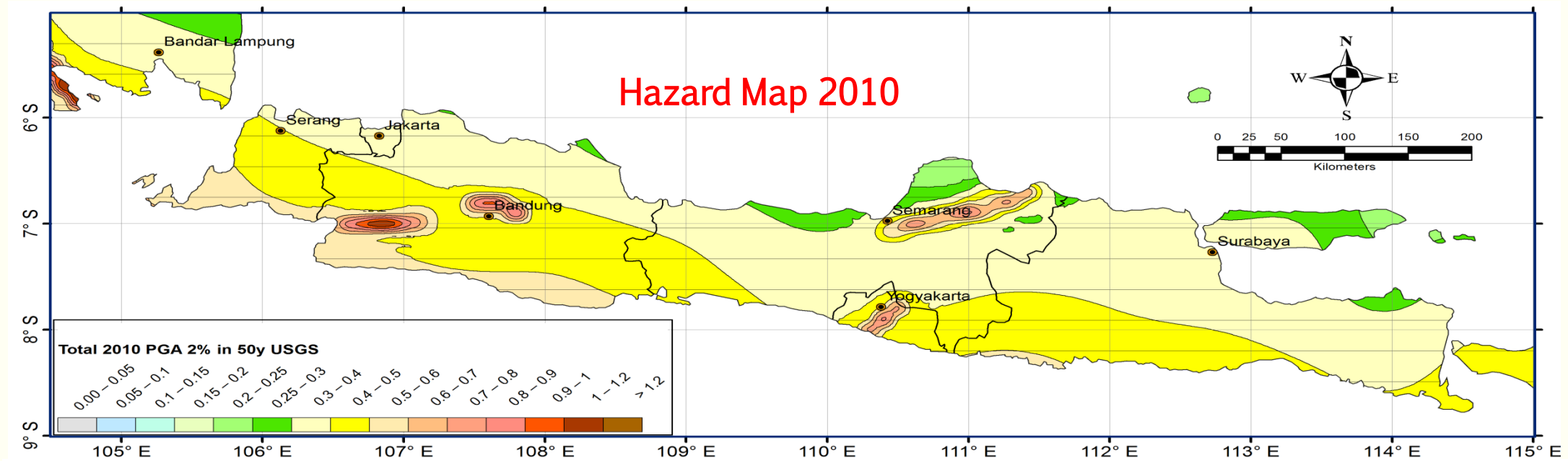


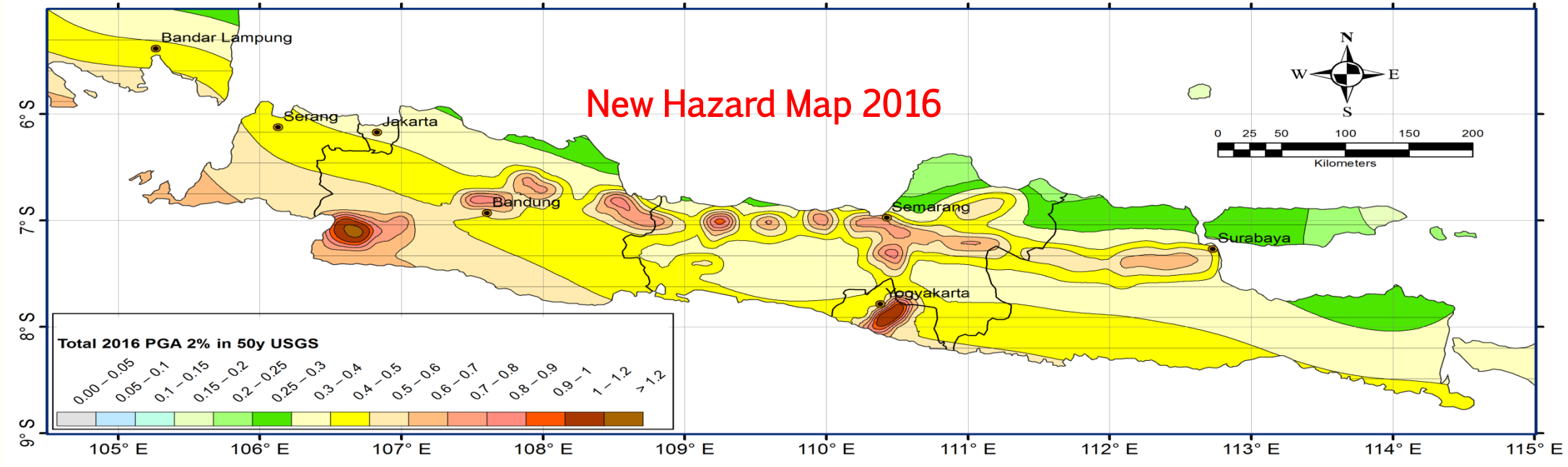
Hazard map PGA 10% in 50y (Total Sources)
2010 Vs 2016





Hazard map PGA 2% in 50y (Total Sources)
2010 Vs 2016



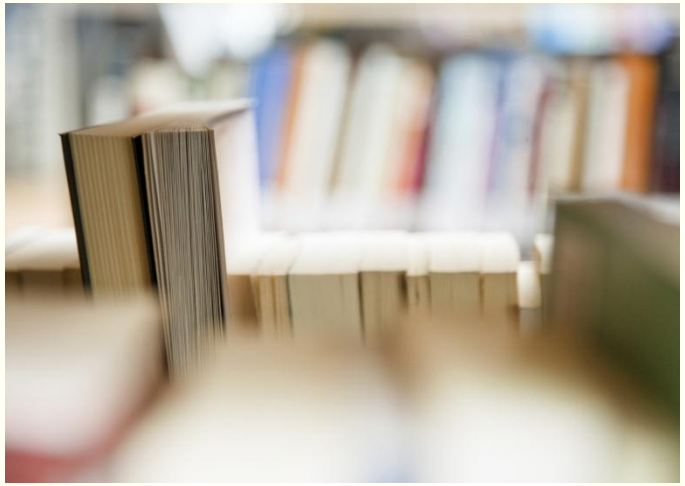


What We Really Need to Care In The Near Future ....

Our Concern is to understand better <u>the Most Plausible & Reliable Seismic Moment Rate</u> to PSHA Updating, Thus .....

- The Precise Segmentation is really Needed to be investigated more detail in the future research
- The Most reliable slip-rate is really Needed to be investigated in the near future
- Small Earthquake Monitoring is Really Needed to Done very soon

My Note ...



Better Resolution

In basic Static & Dynamic Data

is Something What We really Need

“IT WASN’T RAINING, WHEN NOAH BUILT THE ARK”

- Howard Ruff

MAKA, TAK PERLU MENUNGGU BENCANA KEMBALI TIBA UNTUK MEWUJUDKAN KESIAPSIAGAAN BENCANA, SEPERTI YANG TENGAH KITA USAHAKAN BERSAMA ☺

THANK YOU .....