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Challenges and issue in developing tsunami model in Indonesia

Dr. Sugeng Pribadi (BMKG)

Sub Division of Earthquake and Tsunami Survey,
Meteorological, Climatological, and Geophysical Agency, Indonesia)

Outlines

1. Background
    - Tectono-volcanic disasters in Indonesia
    - The task of producing tsunami map

1. The need of high resolution data
    - The use of tide correction

2. Existing condition and challenges
3. Summary and recommendation

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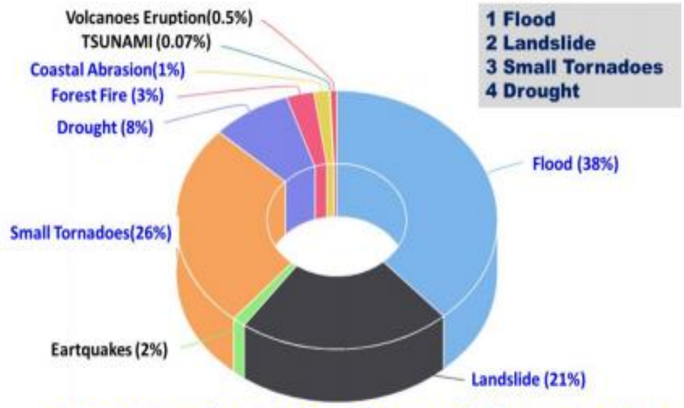
1. Background

Indonesia is a supermarket's dissasters

	LOMBOK EQ 07/2018	SULAWESI EQ & TSUNAMI 09/2018	SUNDA STRAIT EQ & TSUNAMI 12/2018	INDONESIA EL NINO 2015
deaths	564	2.101	429	~20
injuries	1.886	4.338	1.485	~100.000 (respiratory problem)
relocated	11.510	221.450	16.082	... (mills?)
loss & damages	1.3 Bn US$ (0.1% GDP)	1.21 Bn US$ (0.1% GDP)	surveyed	25 Bn US$ (2% GDP)

Source: BNPB, BMKG



Disaster related Weather and Climate: 96 %

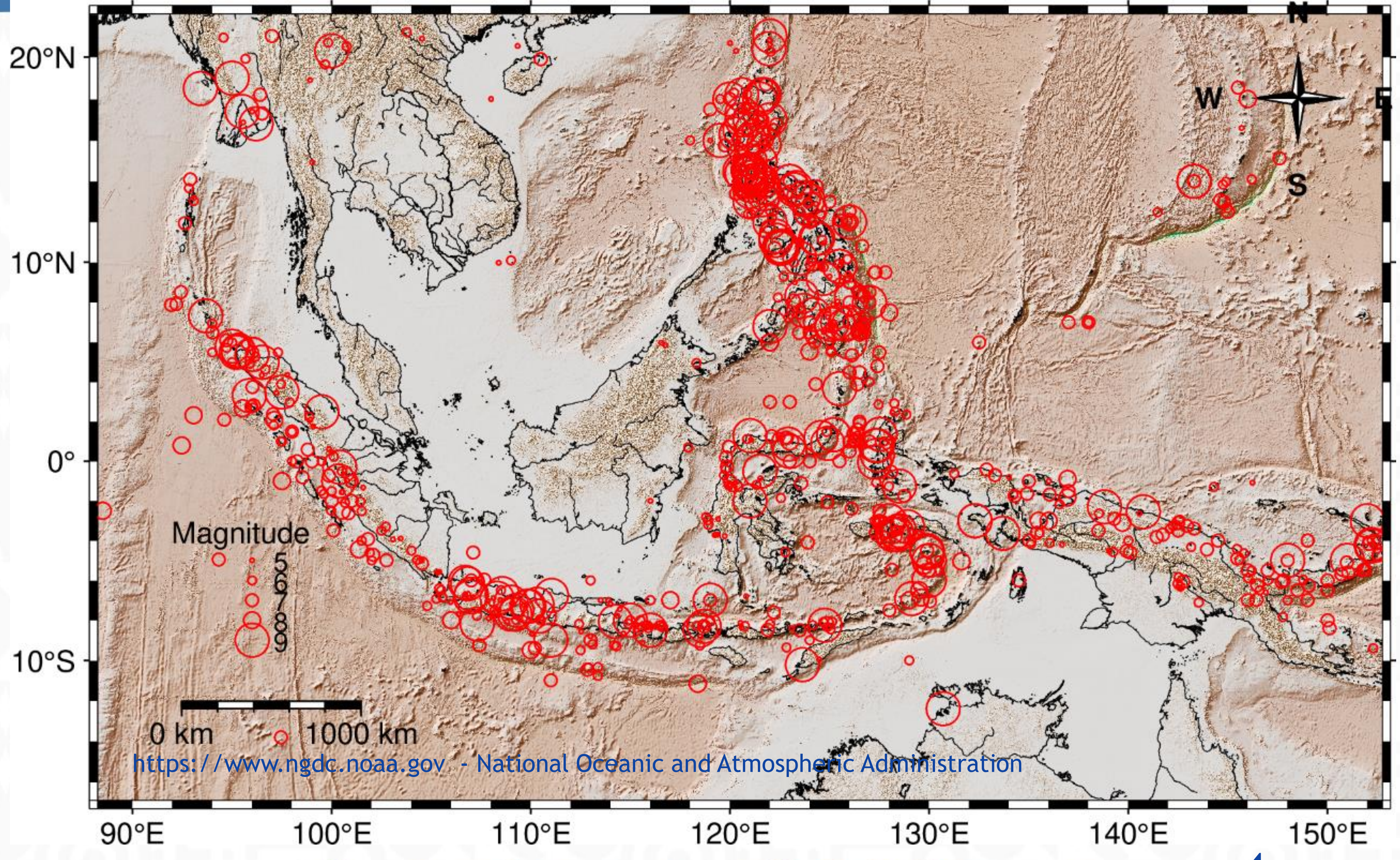
(Karnawati, BMKG)

Tectono-volcanic disasters are very rare (2%), but when they occur causing large losses of life and material.

Rough statistical calculations show a recurrence of

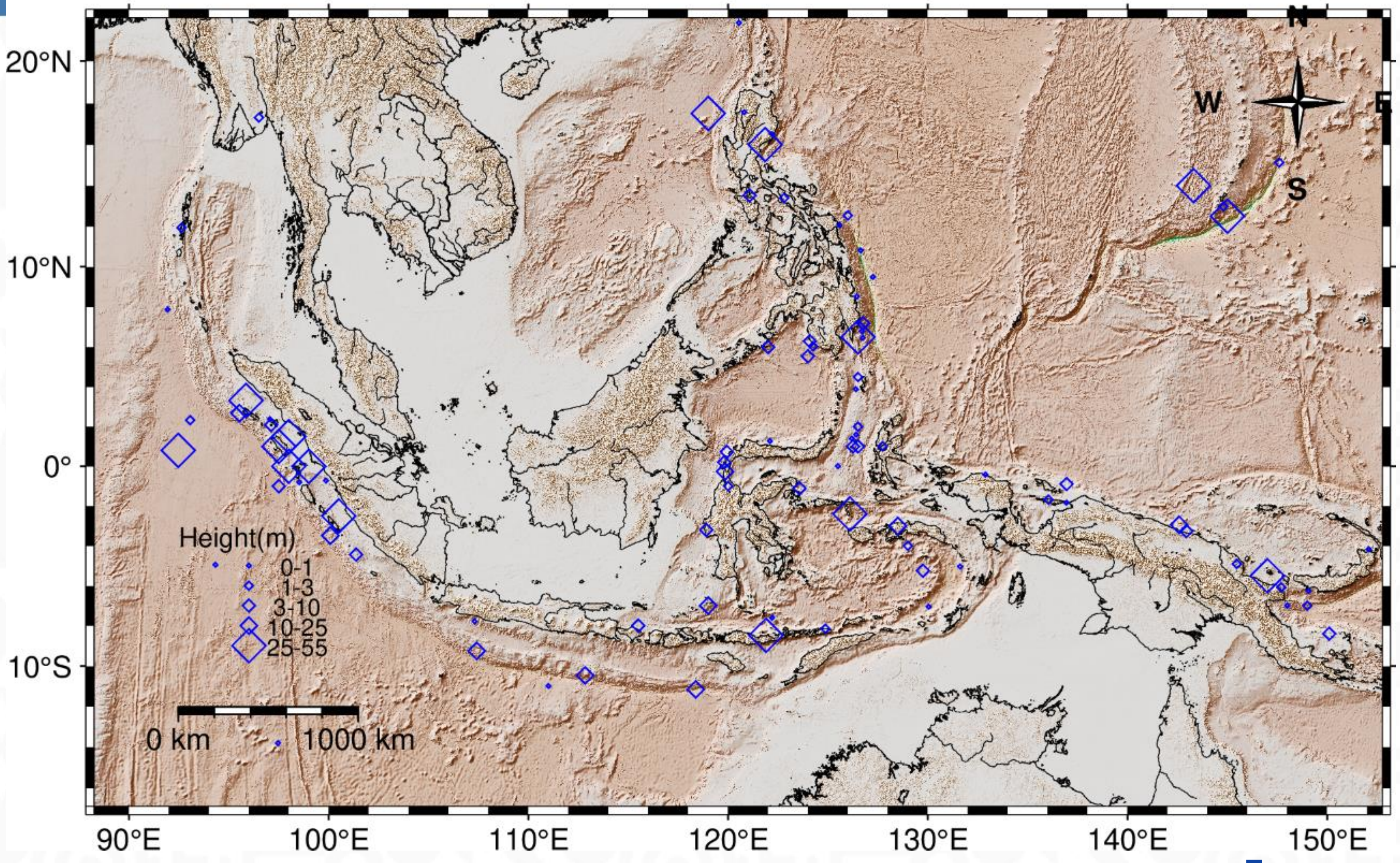
- BIG earthquakes ~ 3 years
- Destructive tsunami ~ 5 years

Epicenter 460-2023 (NOAA) 287 events M>5



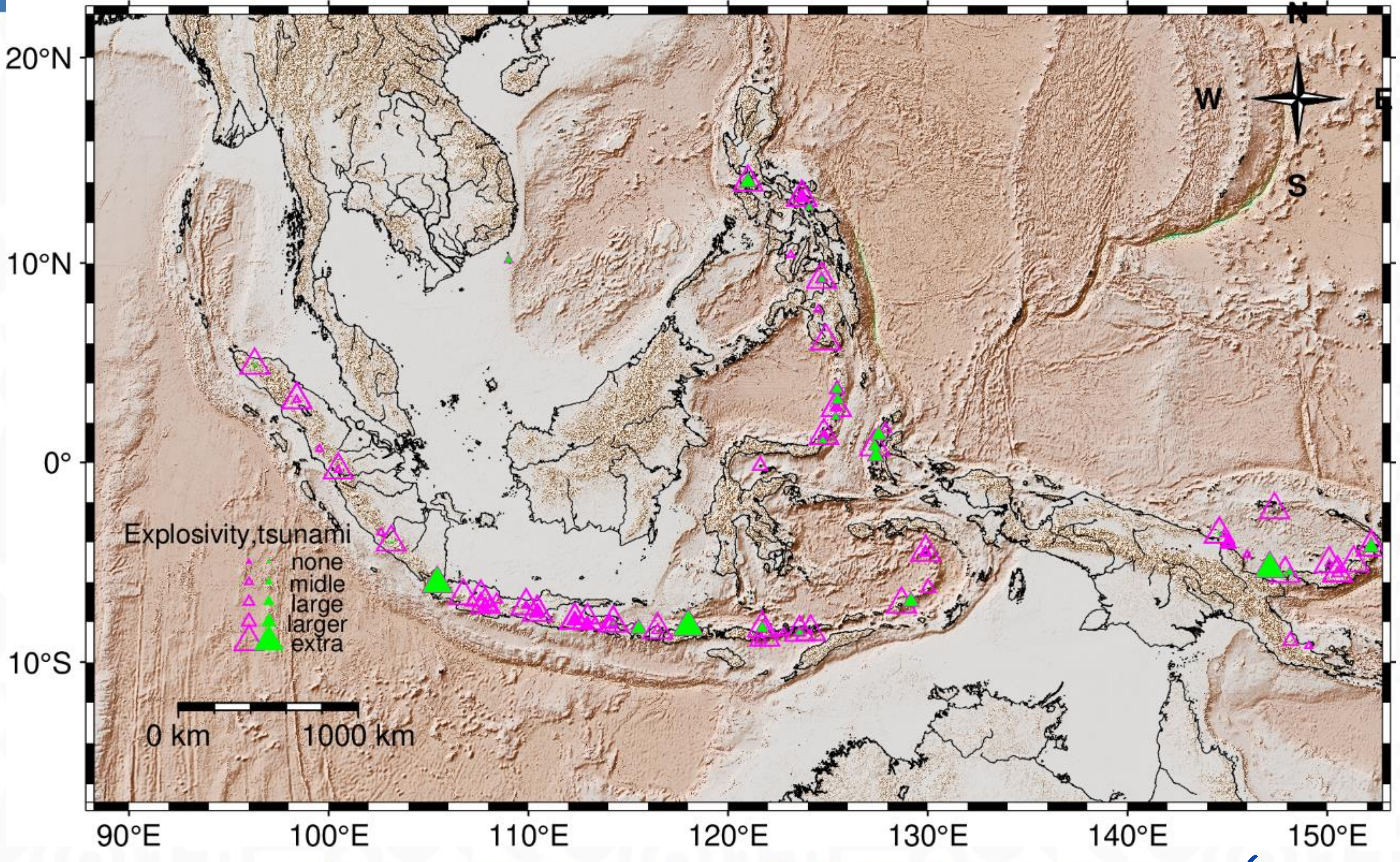
https://www.ngdc.noaa.gov - National Oceanic and Atmospheric Administration

Tsunami 1711-2023 (NOAA) 91 events



Volcanic -4000-2023 (NOAA)

291 mountains, 52 tsunamis



Potential volcanic tsunami:
(1) Anak Krakatau Lampung
(2) Rokatenda, NTT
(3) Ruang, Sulut
(4) Awu, Sulut

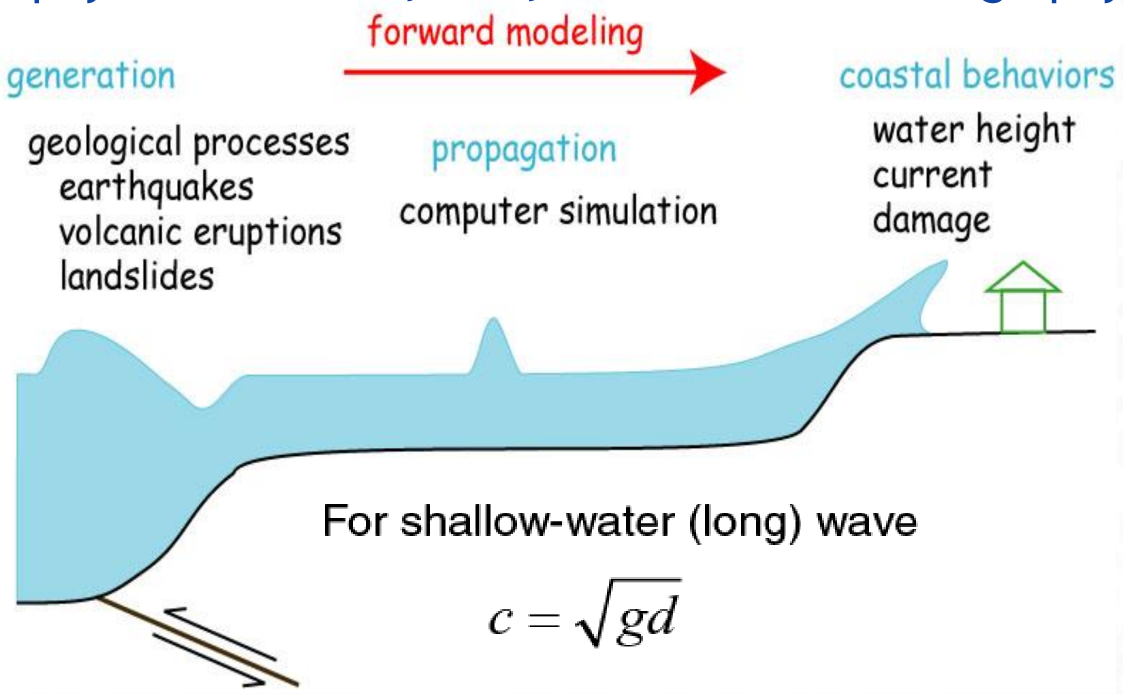
(5) Iliwerung-Hobal
(6) Banuawuhu
(7) Gamalama
(8) Kie Besi
(9) Gamkonora
(10) Rokatenda
(11) Rinjani-Samalas
(12) Tambora
(13) Teon

(Magma, ESDM)

Tsunami Generation and Propagation

Tsunami =harbor wave 津波

Geophysics | Hydrodynamics | Geography, GIS



$$c = \sqrt{gd}$$

(Kenji Satake)

Characteristics of tsunami in Indonesia

- *tsunamigenic* far field
- *tsunamigenic* near field
- *tsunami earthquake*
- *non seismic tsunami*
- *meteo tsunami*

- Tohuku 2011, Aceh 2004
- Nias 2005
- Java 2006, Java 1994, Mentawai 2010
- Palu 2018, Anak Krakatau 2018
- Hunga Tonga 2022

Tsunami model work progress

- Non seismic tsunami: Palu 2018 & Krakatau 2018
- TOAST model

2021

Find model

- COMCOT & Tunami-N2
- Digitazion, interpolation contour

2022

Confirmation

- Evacuation maps
- Shelter

2023

Multi layer

- Integration Batnas & Demnas

2024

Field data

- Field survey GPS geodetic, LIDAR, UAV
- Small region

2025

Scale up

- HPC-GPU & Merah Putih system pcocessing
- Paralel to operational model (TOAST)

The task of producing tsunami maps

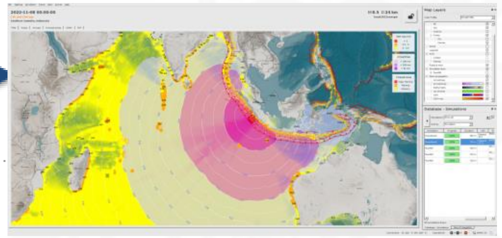
1 - Tsunami early warning has 24 operational hours /7 days

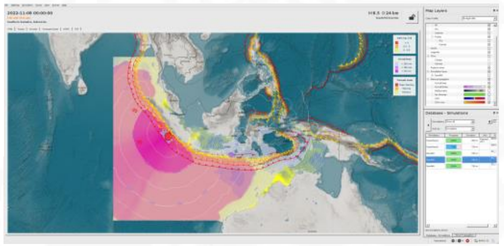
Choose model domain → GEBCO_08 (2 Minutes ~ 3.6 km rectangular grid) → Run EasyWave

Earthquake detection

Choose Initial Source → EQ Parameter SEISCOMP or Focal Mechanism → Run EasyWave

Tsunami Configuration File → Run EasyWave



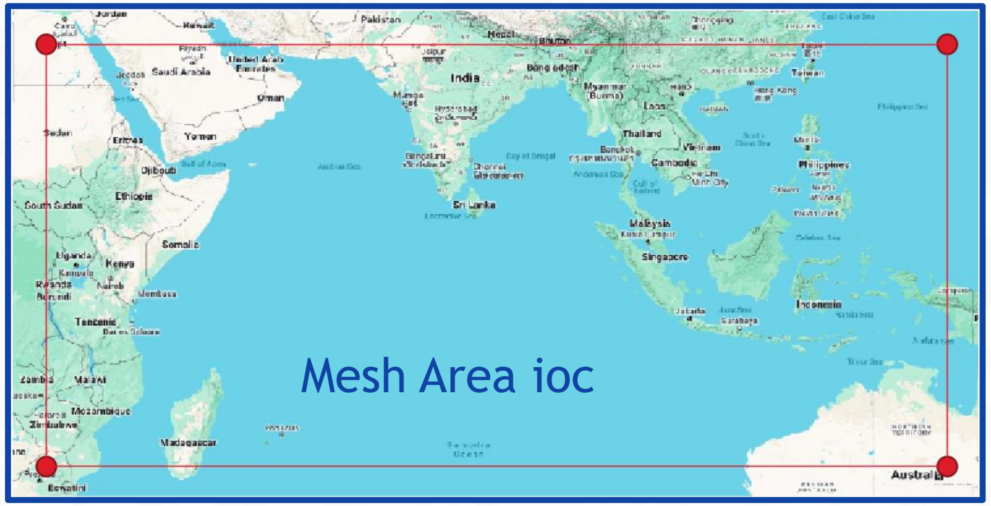


Operational model:
Tsunami Observation And Simulation Terminal (TOAST),GEBCO-08, ETH, EWH, warning zone

Easy wave
- On fly simulation
- South-East Asian and Indian Ocean Basin (RTSP)
- Finite different
- Linier long wave

Tsunawi
- Database 22.000 scenario
- National region
- SRTM90
- Finite element
- Triangular mesh
- Inundation

ELAPSE TIME TSUNAWI PROCESSING FOR INDIAN OCEAN



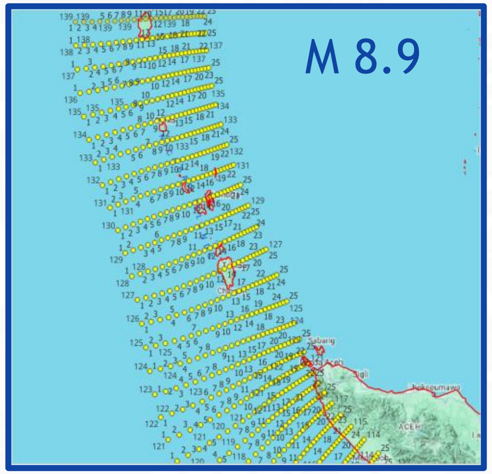
No	Mesh Node Number	Coarse / Finest	Elapse Time (seconds)	Elapse Time (minutes)
1	1,191,872	20.000 km / 500 m	1.147.4	19
2	2,667,689	10.000 km / 100 m	2.642.6	44
3	11,108,009	10.000 km / 50 m	11.706.2	195.1

Hardware:
- VM HPC
- 2 Nodes (88 Cores)
- RAM 754 GB
- Storage 8.7 TB

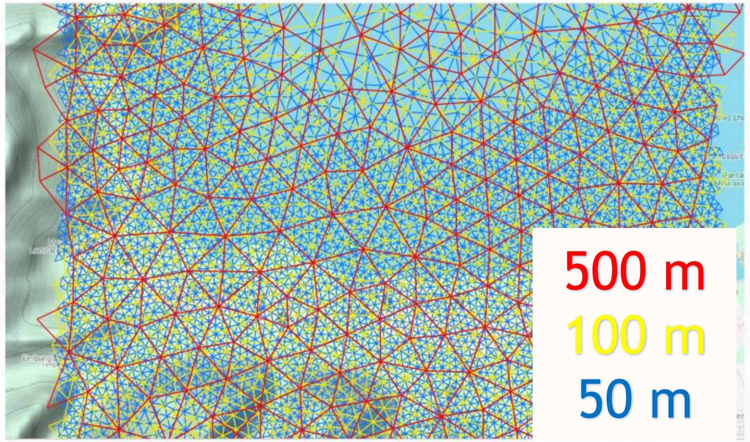
BMKG

DETAIL CONFIGURATION SOURCES TSUNAMI SCENARIOS DATABASE

No	Source Zone	Source Type	Sense	Number Of Sub Fault (x ; y)	Mag. Range	Patch Size (km)	Depth Range Centroid (km)	Number Skenarios
1	North Sulawesi (NS)	Subduction	Thrust	13 x 5 = 65	7.0 - 9.0	40 x 25	4.68 - 42.14	535
2	East Molucca (EM)	Crustal	Thrust	25 x 6 = 150	7.0 - 8.6	25 x 10	2.5 - 27.5	1350
3	West Molucca (WM)	Crustal	Thrust	24 x 4 = 96	7.0 - 8.4	25 x 10	2.5 - 17.5	768
4	Manokwari (MI)	Crustal	Thrust	10 x 4 = 40	7.0 - 8.0	25 x 10	2.3 - 15.9	240
5	North Papua (NP)	Subduction	Thrust	26 x 13 = 338	7.0 - 9.0	40 x 15	1.9 - 48.5	1896
6	Seram (SM)	Subduction	Thrust	22 x 10 =220	7.0 - 9.0	40 x 15	2.6 - 48.7	1392
7	South Seram (SS)	Crustal	Normal	18 x 4 = 72	7.0 - 8.4	25 x 10	2.5 - 17.5	576
8	Wetar (WR)	Crustal	Thrust	39 x 6 =234	7.0 - 8.8	15 x 10	2.5 - 27.5	1602
9	Timor (TR)	Crustal	Thrust	15 x 7 = 105	7.0 - 8.8	40 x 15	3.75 - 48.75	720
10	Flores (FS)	Crustal	Thrust	31 x 6 = 186	7.0 - 8.8	25 x 10	2.27 - 24.97	1314
11	Makassar (MR)	Crustal	Thrust	23 x 5 = 115	7.0 - 8.6	25 x 10	2.11 - 19.02	800
12	Tolo (TO)	Crustal	Thrust	12 x 4 = 48	7.0 - 8.2	25 x 10	2.5 - 17.5	336
13	Sulu (SU)	Crustal	Thrust	15 x 4 = 60	7.0 - 8.2	25 x 10	2.5 - 17.5	420
14	Palu-Koro (PK)	Crustal	Strike Slip	13 x 3 = 39	7.0 - 8.0	25 x 10	4.92 - 24.62	180
15	Sunda Zone (SZ)	Subduction	Thrust	150 x 25 = 3750	7.0 - 9.0	40 x 15	0 - 100	6117

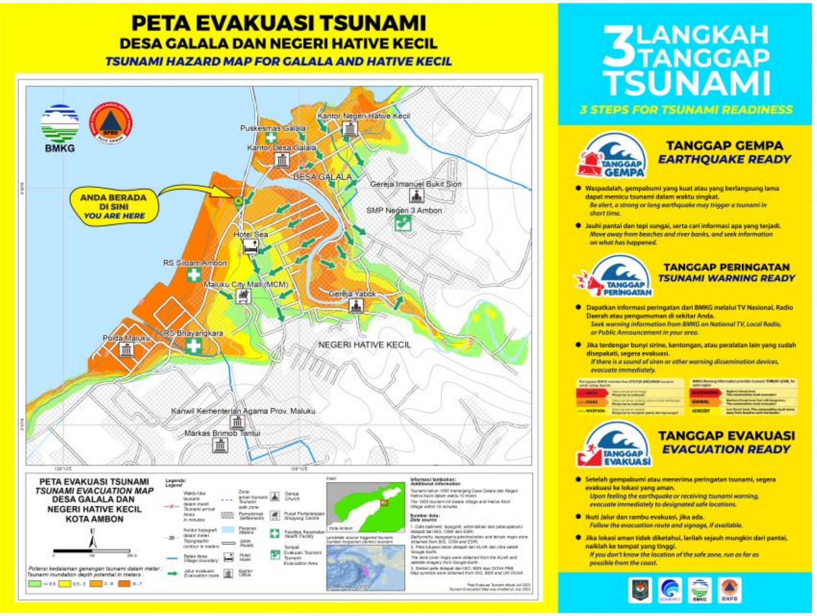


Database 22.000 scenario



Finite Element -Triangular Grid

2- Produce evacuation maps & confirm shelter



- The basis for creating evacuation map routes to support infrastructure development
- Potential hazard map and increase public awareness
- Collaboration with BNPB, BPBD, regional governments and disaster resilient villages

3 - Guide for stakeholders of disaster

UNESCO Tsunami ready communities

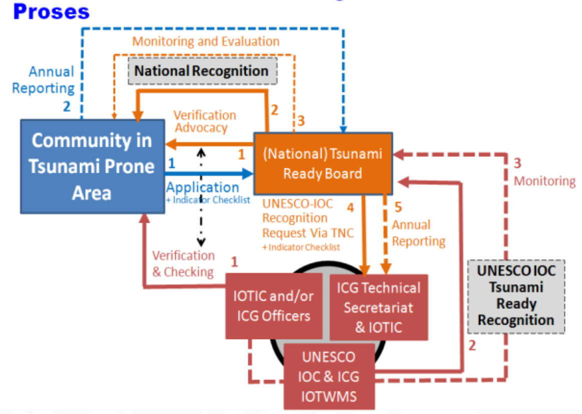
- Certificate
- Preparedness Training

01 Assesment of tsunami hazard map

02 Preparedness for the evacuation procedure

03 Tsunami emergency response

UNESCO IOC Tsunami Ready Recognition



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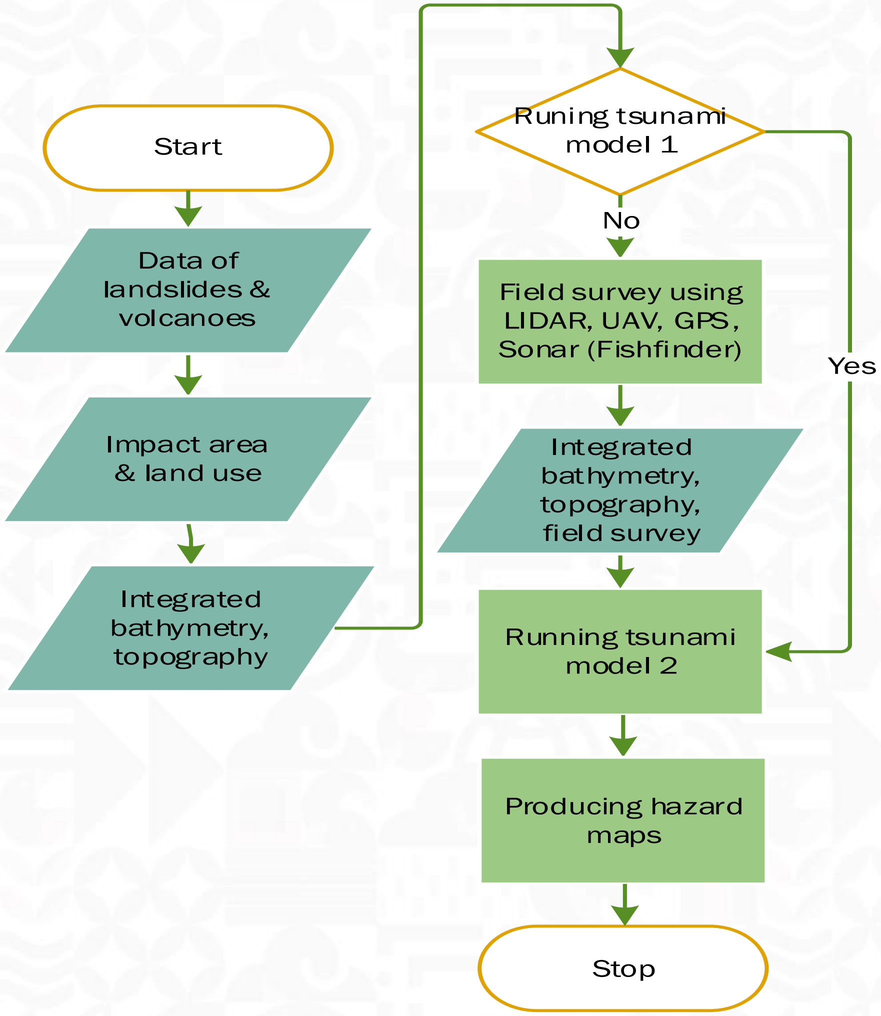
2. The need of high resolution data



COMCOT model

(https://github.com/AndybnACT/GPU-comcot/find/master)

- COrnell Multi-grid Coupled Tsunami (COMCOT) is a numerical model based on Shallow Water Equations (Wang and Power, 2009). Lecturer from GNS New Zealand
- This tsunami modelling package is developed to study the entire life-span of tsunami, including generation, propagation, run-up and inundation.
- The model uses a modified **leap-frog finite difference scheme** to solve shallow water equations in both Spherical and Cartesian Coordinates.
- Fulfills the requirements: hydrodynamics, alignment of actual applied cases, **operational conditions of work and scientific evaluation (high resolution)**.
- Supporting applications: Matlab, Arc Map, Global Mapper, Surfer, and QGis.
- Tsunami sources are caused by **earthquakes, volcanic activity, and landslides.**
- Requires detailed data on bathymetry, topography, land cover and slope.

COMCOT numerical model

Sensitivitas Model (Tutupan Lahan) - (5)

NUMERICAL MODEL – 1D

- **Numerical Method:**

The shallow water theory

$$\frac{\partial \eta}{\partial t}+\frac{\partial M}{\partial x}+\frac{\partial N}{\partial y}=0$$

$$\frac{\partial M}{\partial t}+\frac{\partial}{\partial x}\left(\frac{M^2}{D}\right)+\frac{\partial}{\partial y}\left(\frac{MN}{D}\right)+gD\frac{\partial \eta}{\partial x}+\frac{gn^2}{D^{7/3}}M\sqrt{M^2+N^2}=0$$

$$\frac{\partial N}{\partial t}+\frac{\partial}{\partial y}\left(\frac{N^2}{D}\right)+\frac{\partial}{\partial x}\left(\frac{NM}{D}\right)+gD\frac{\partial \eta}{\partial y}+\frac{gn^2}{D^{7/3}}N\sqrt{N^2+M^2}=0$$

Resistant coefficient in the model (Morison equation)

$$dF=\frac{1}{2}Cd\,\rho Au\,|u|+Cm\,\rho V\frac{Du}{Dt}$$

$$\frac{\partial M}{\partial t}+\frac{\partial}{\partial x}\left(\frac{M^2}{D}\right)+\frac{\partial}{\partial y}\left(\frac{MN}{D}\right)+gD\frac{\partial \eta}{\partial x}+\frac{gn^2}{D^{7/3}}M\sqrt{M^2+N^2}+\frac{Cd}{2}\frac{Ao}{\Delta X\Delta Y}\frac{M|M|}{D^2}=0$$

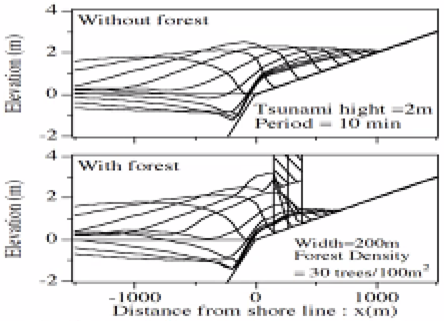
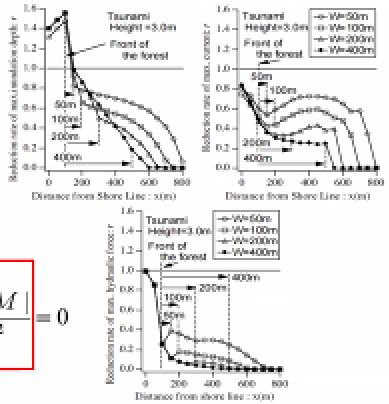


Fig.3 Calculated results without and with forest



Numerical Model for Mass Movement

Governing equation: $\frac{\partial \mathbf{M}}{\partial t}+\beta(\mathbf{Mu'})\nabla=-g_z h\nabla H+g'h-\frac{\mathbf{T}}{\rho_m}$

Equation of continuity: $\frac{\partial h}{\partial t}+\nabla\cdot\mathbf{M}=0$

1. Hyperconcentrated solid-liquid mixture flow model
   (Egashira et al., 1997,2001; Miyamoto, 2010; Fathani et al., 2017)

$$\mathbf{T}_s=\alpha\rho_m(1-r_u)g_z h\cos\theta\tan\phi_s\frac{\mathbf{u}}{|\mathbf{u}|}$$

$$\mathbf{T}_d=\frac{25}{4}k_g\rho_s(1-e^2)c_s^{1/3}\left(\frac{d}{h}\right)|\mathbf{u}|\mathbf{u}$$

$$\mathbf{T}_f=\frac{25}{4}k_f\rho_l(1-c_s)^{5/3}/c_s^{2/3}\left(\frac{d}{h}\right)|\mathbf{u}|\mathbf{u}$$

$$\mathbf{T}=\mathbf{T}_s+\mathbf{T}_d+\mathbf{T}_f$$

$\mathbf{T}_s$: shear stress due to static inter-granular contact
$\mathbf{T}_d$: shear stress due to particle-to-particle collision
$\mathbf{T}_f$: shear stress by the interstitial liquid phase

2. Voellmy-fluid friction model
   (Fathani et al., 2017)

$$\mathbf{T}_s=\rho_m(1-r_u)g_z h\cos\theta\tan\phi_s\frac{\mathbf{u}}{|\mathbf{u}|}$$

$$\mathbf{T}_d+\mathbf{T}_f=\frac{\rho_m g}{\xi}|\mathbf{u}|\mathbf{u}$$

3. Mohr-Coulomb model
   (Fathani et al., 2017)

$$\mathbf{T}_s=\rho_m\left(H_c+(1-r_u)g_z h\cos\theta\tan\phi_s\right)\frac{\mathbf{u}}{|\mathbf{u}|}$$

$$\mathbf{T}_d+\mathbf{T}_f=0$$

Source of tectonic

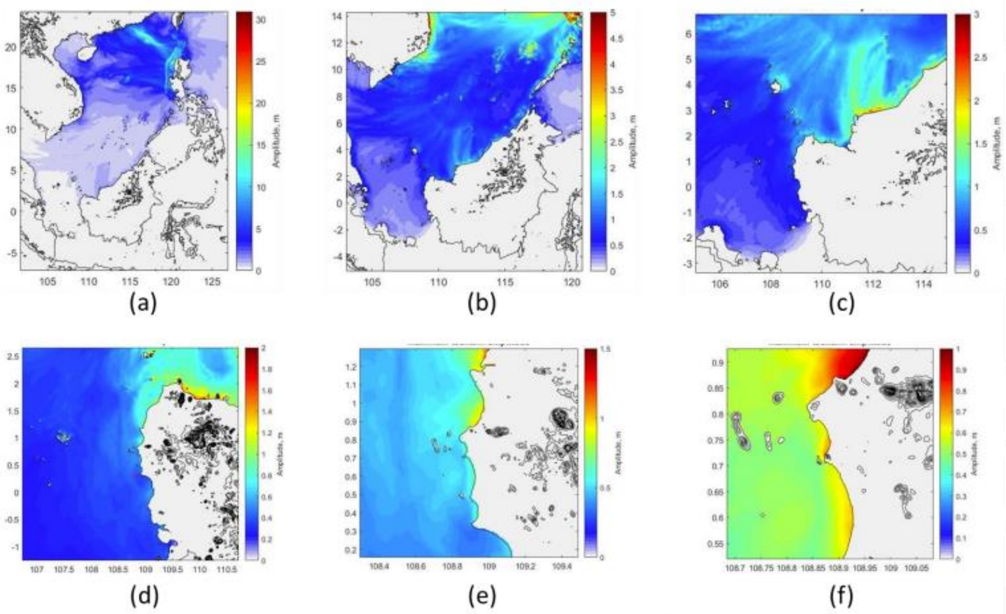


Fig.6 The tsunami modeling results at domain 1 (a), domain 2 (b), domain 3 (c), domain 4 (d), domain 5 (e), and domain 6 (f) utilizing the Manila Trench source.

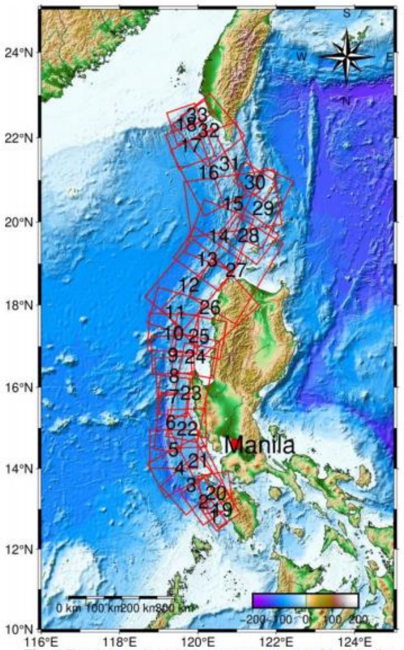


Fig. 5 Tsunami source of 33 segments generated by Manila trench.

Probabilistic of Manila trench earthquakes with 33 segments accumulated magnitude of M9.1 (Megawati et al., 2009 in Pribadi et al, 2021).

- Prospective site for thePantai Gosong Nuclear Power Plant (NPP) in Bengkayang, West Kalimantan
- More detail with UAV data & field survey
- Serawak landslide need higher resolution of bathy

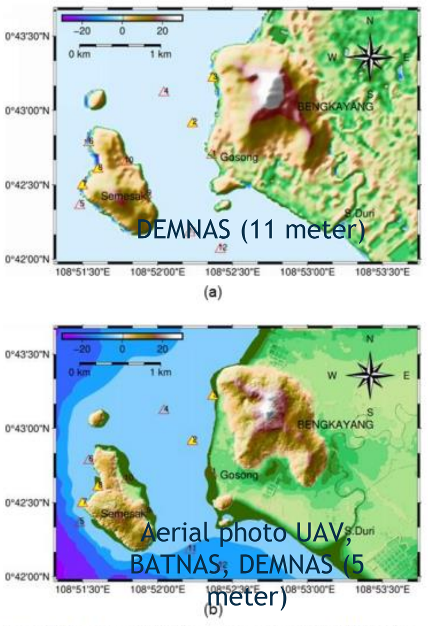


Fig. 10 Map of the initial tide gauge locations. (a) DEMNAS data, (b) a combination of BATNAS, DEMNAS, GNSS, UAV, and Bathymetry.

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Assessing the potential tsunami source of the Manila trench at the Bengkayang nuclear power plant site in Kalimantan using topographical details

Sugeng Pribadi[a], Widjo Kongko[b], Nurkhalis Rahili[b]*, F. Fauzi[a], Hadi Suntoko[c], Sapto Nugroho[b], S. Sunarko[d], Telly Kurniawan[a], Euis Etty Alhakim[c]

Parameter	LAYER	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Scoup	Region	Province	Regency	District	Village
Area (deg)	10x10	5x5	1x1	0.5x0.5	0.05x0.05
Source	GEBCO	BATNAS	DEMNAS	UAV+RBI	LIDAR
Scale	1:500K	1:250K	1:50K	1:5K	1:1K
Res. deg	0.004167	0.001667	0.0004	0.0001	<0.0001
Res. (m)	473	185	11	5	3

Source of Non tectonic

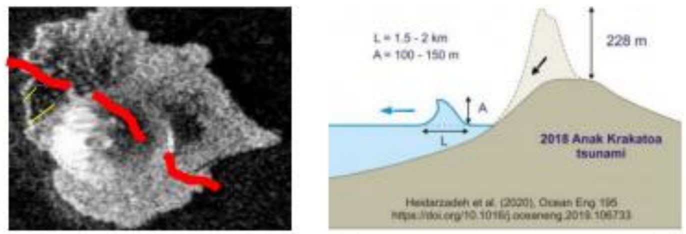


Fig. 1. (Left) Dimensions of the landslide of Mount Anak Krakatau in horizontal (JAXA). (Right) Vertical cartoon show crater collapsed dimension [3].

Fig. 2. CCTV camera of observation office in Pasauran, Cinangka, Banten shows before (top) and after (bottom) eruption of Mount Anak Krakatau (esdm.go.id).

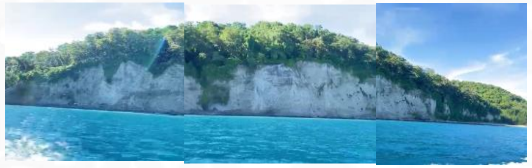
- Landslide dimensions of 2000 m long, 1500 m wide and 228 m thick. Volume of 0.4 km3 and max slope of 40 degrees.
- The direction of the landslide starts from Mount Anak Krakatau to the southwest refer to the recent Scientific Publication

The Mount Anak Krakatau landslide scenario for tsunami modeling in Banten

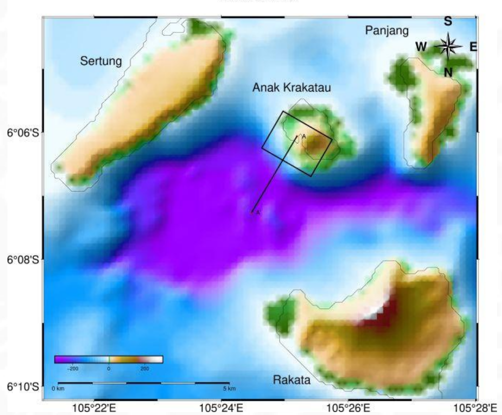
Sugeng Pribadi[1*], *Muhammad* Luqman Hakim[1], *Fauzi*[1], *Telly* Kurniawan[1], *Hanif* Andi Nugraha[1], *Daryono*[1], *Dwikorita* Karnawati[1], and *Suko* Prayitno Adi[2]

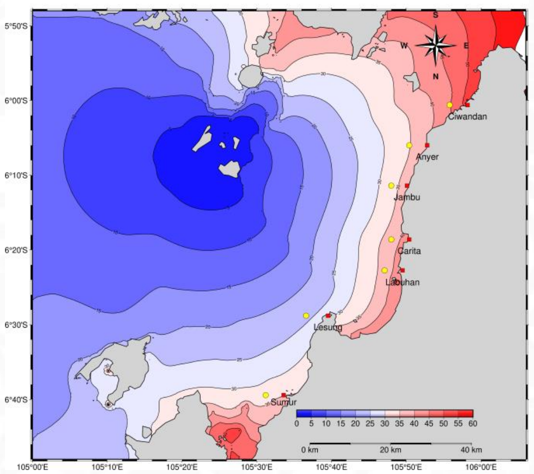
[1]Meteorology, Climatology and Geophysics Agency (BMKG), Kemayoran, Jakarta, Indonesia
[2]School of Meteorology, Climatology and Geophysics Agency (STMKG), Pondok Betung, South Tangerang, Indonesia

https://doi.org/10.1051/e3sconf/202346401010

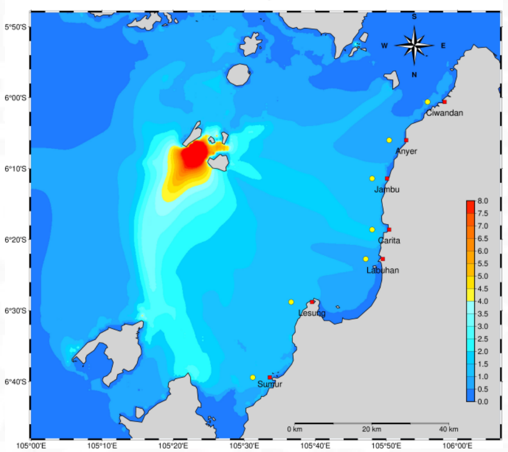


Visual observations of the complex morphology of Mount Anak Krakatau, Sertung Island, and Rakata



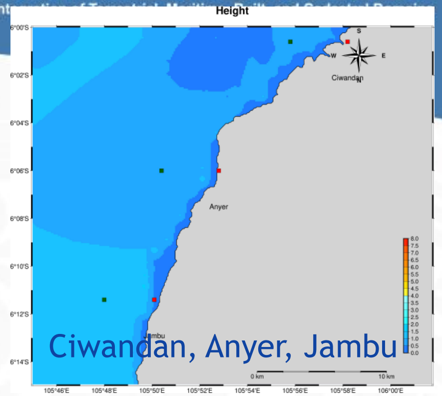


Travel time

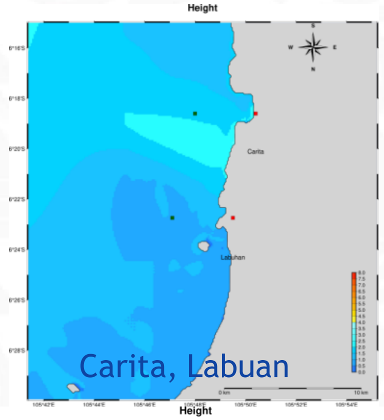


Yellow circle denotes the tide model. Red box shows the coastal model

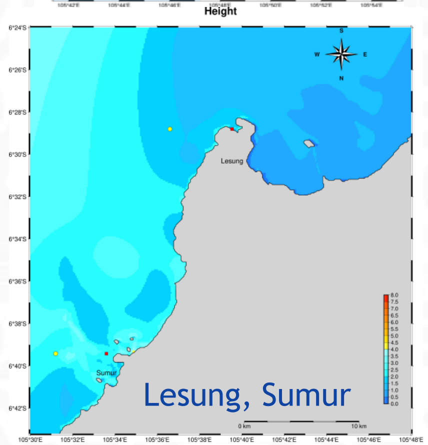
Tsunami height



Ciwandan, Anyer, Jambu

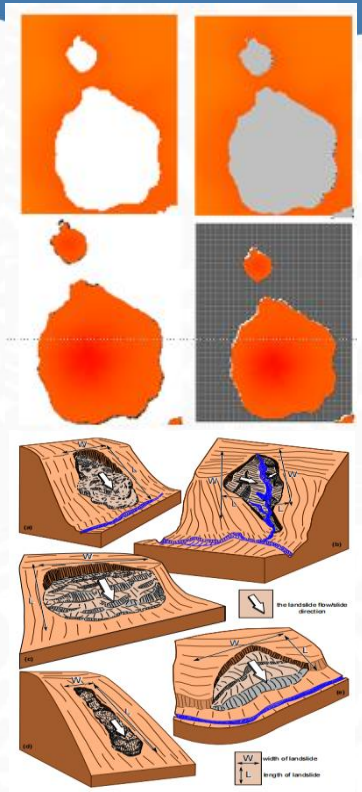


Carita, Labuan

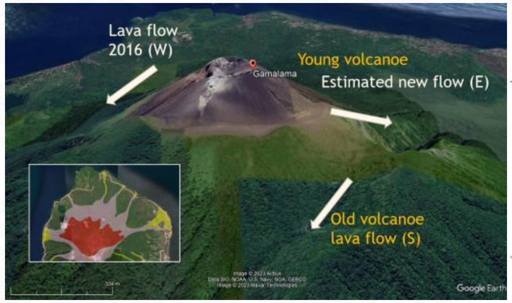


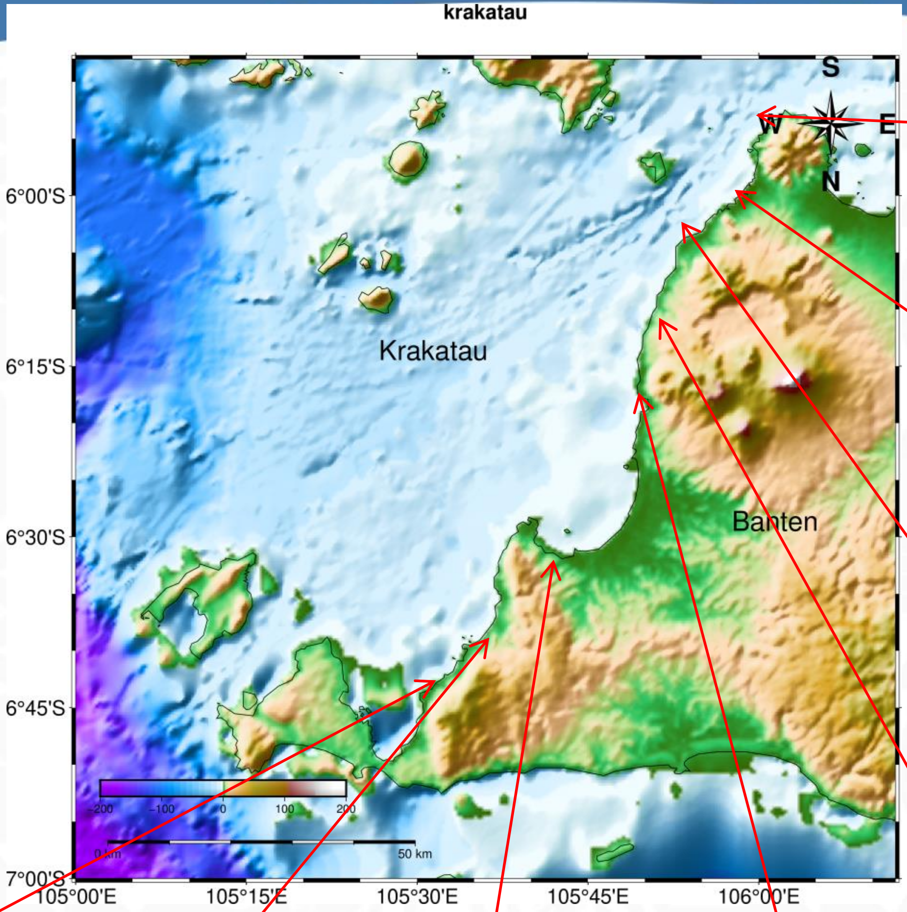
Lesung, Sumur

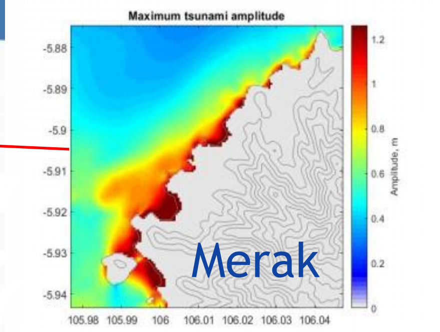
Mount Anak Krakatau

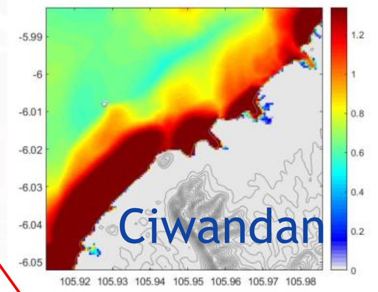


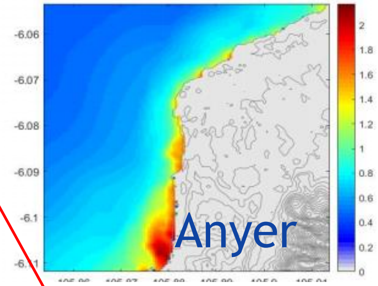
- Batnas & Demnas integration technique by eliminating wet areas in Demnas, and dry areas in Batnas.
- Then combined with several smoothing techniques
- The impact of the landslide tsunami covered a limited area, but varying heights in West Banten and South Lampung.

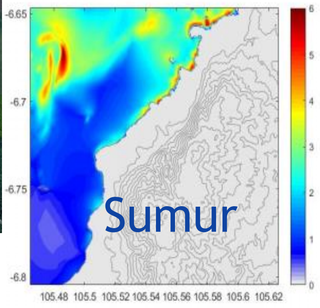


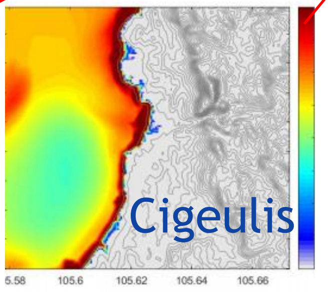


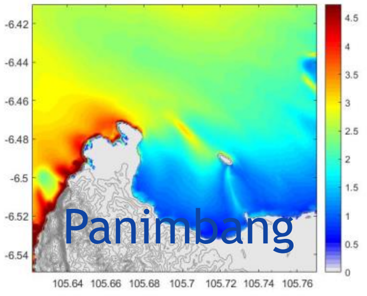


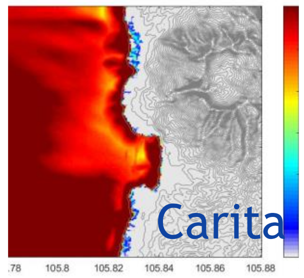


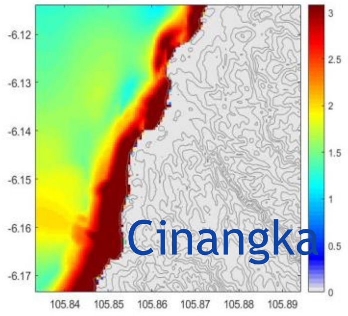












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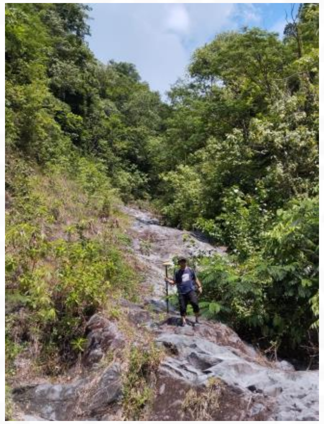
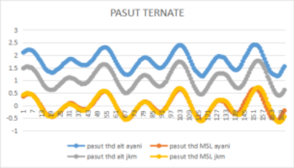
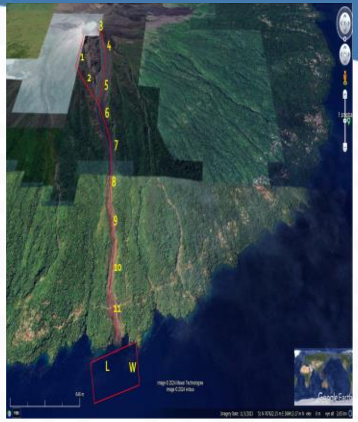
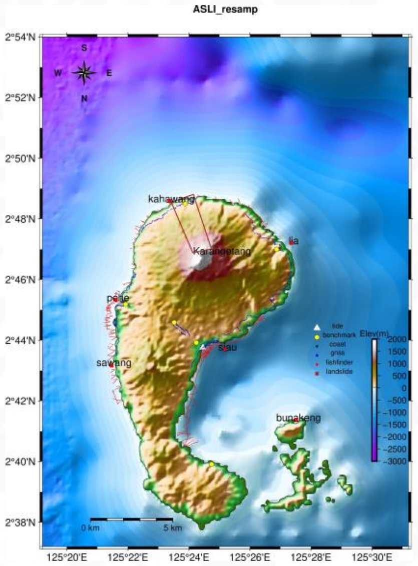
Topo-bathy field survey

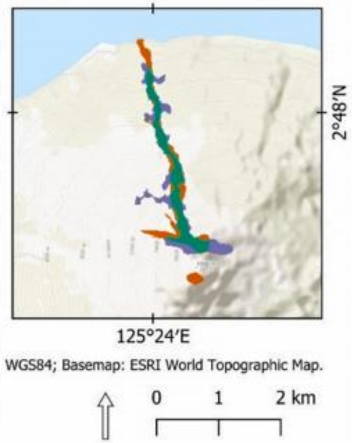
6.8. G. KARANGETANG, P. Siau – Sulawesi Utara











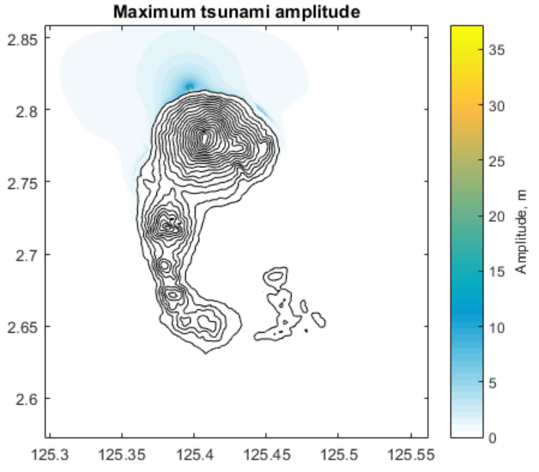
ESTIMATED LANDSLIDE DIMENSION OF KARANGETANG VOLCANOE

No	Length m	Width m	Wide m2	Thick m (25% L)	Volume m3	Slope %	Slope deg
1	884	180	159,120	221.0	35,165,520	-51.0	45.9
2	975	310	302,250	243.8	73,673,438	-53.6	48.2
3	253	130	32,890	63.3	2,080,293	-60.8	54.7
4	738	230	169,740	184.5	31,317,030	-73.0	65.7
5	749	190	142,310	187.3	26,647,548	-74.0	66.6
6	611	190	116,090	152.8	17,732,748	-61.0	54.9
7	379	120	45,480	94.8	4,309,230	-37.0	33.3
8	529	90	47,610	132.3	6,296,423	-28.1	25.3
9	436	110	47,960	109.0	5,227,640	-43.0	38.7
10	406	100	40,600	101.5	4,120,900	-32.0	28.8
11	436	120	52,320	109.0	5,702,880	-32.2	29.0
dim1	**582**	**161**	**105,125**	**146**	**19,297,604**	**-50**	**45.0**
dim2	**440**	**239**	**105,160**	**183**	**19,202,216**	**-34.5**	**31.0**

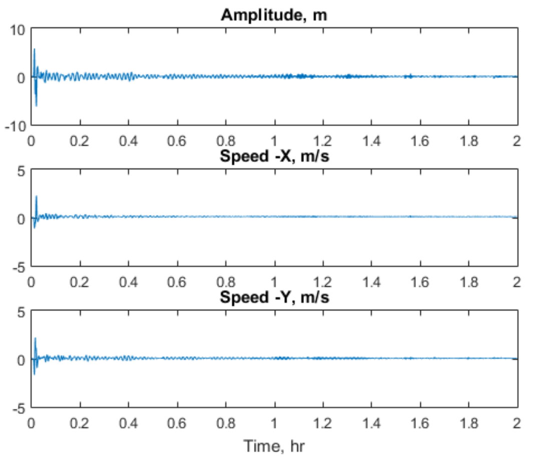
- Consider the dimension, direction and shape of potential landslides
- Carry out surveys using geodetic GPS, tide data and simple fishfinder
- High resolution topographic and bathymetric data is needed for affected areas using field surveys, UAVs and LIDAR.
- Need jointly study the sources of tsunami generators, landslides and volcanoes using geophysical methods to define lava flow, and dimensions.

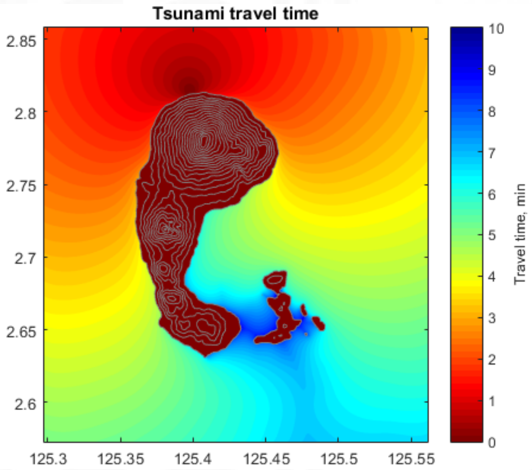
Draft - interim results

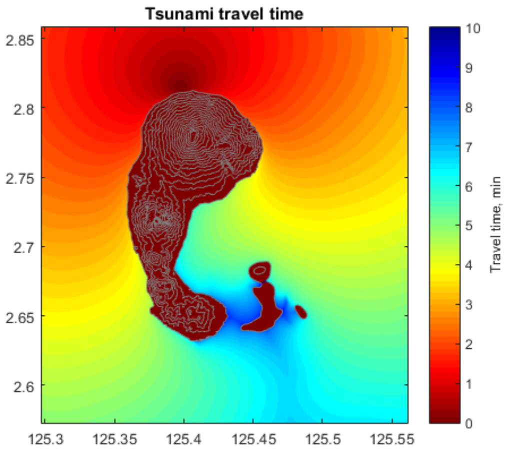
Batnas



Batnas+SRTM+field survey

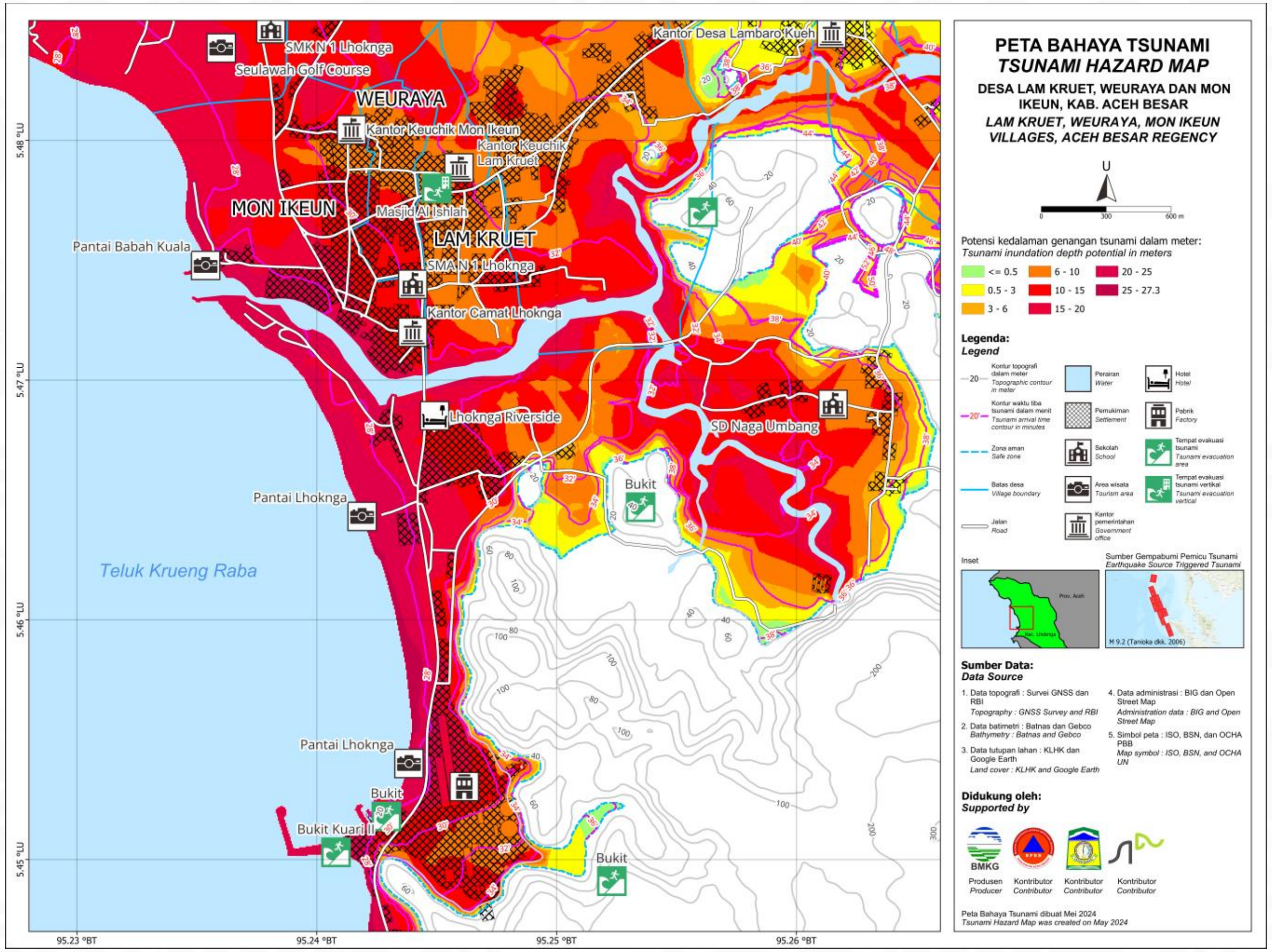


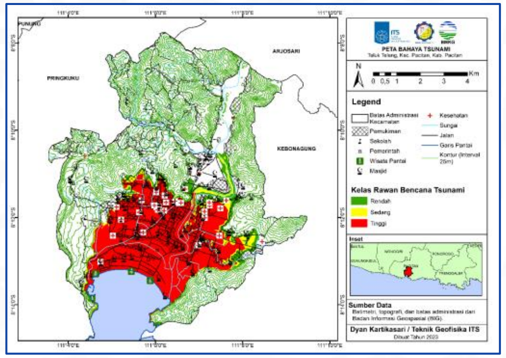


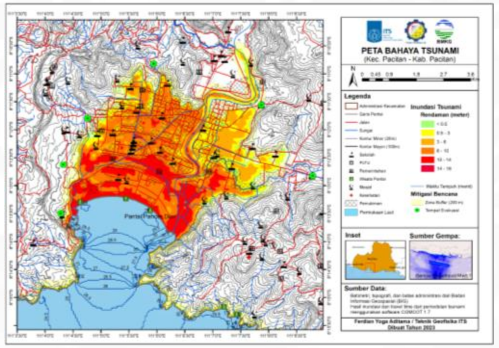


1. The integration (assimilation) of Batnas+SRTM+field survey increases resolution and produces lower tsunami heights. Meanwhile, the tsunami arrival time is relatively the same.
2. The closest location to the source gives a maximum value of 8 meters (Kahawang).
3. The effects of tsunamis are very local and vary significantly.
4. The intensity of the tsunami was influenced by the deep sea around Siau Island.
5. Landslide dimensions have length 440 m, width 239 m, thickness 183 m, and slope angle 31 degrees.
6. We used non linear for governing equation and grid size 0.01 meters.
7. The pixel width of integration data is 0.0002778 meters and Batnas 0.001667 meters.

Tsunami hazard map

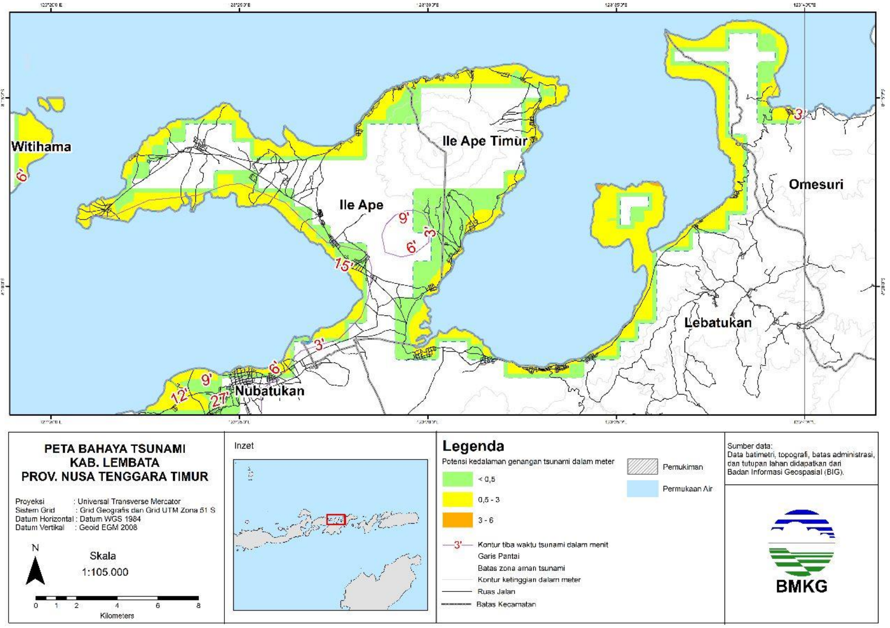


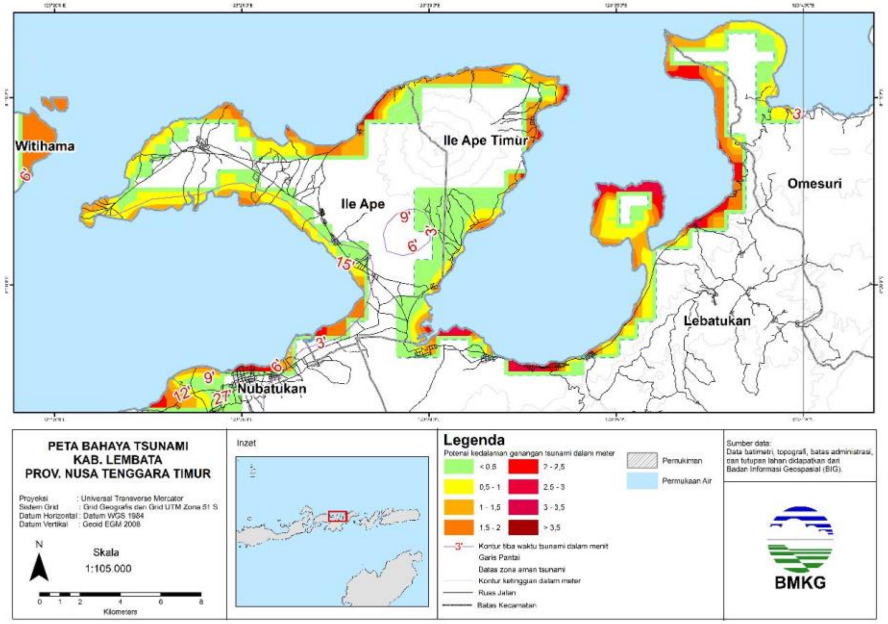




Features
1. Village scale (5m resolution, starting 2023)
2. Potential tsunami inundation depth
3. Topographic contour
4. Tsunami arrival time contour
5. Maps produced more than 250 pcs (BMKG, BNPB, Municipality) + 30 pcs (BMKG, ITS)

Mount Lewi Tolok, Lembata NTT





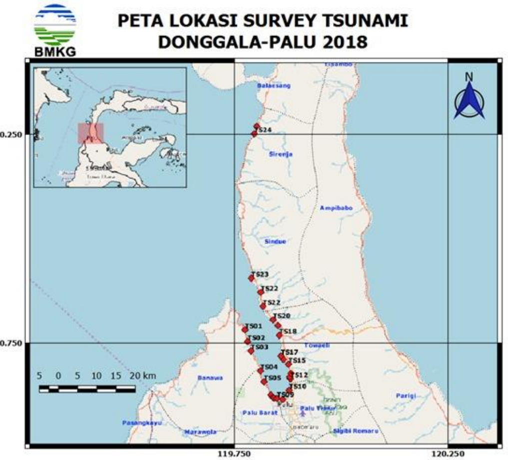
BEFORE

1. Low resolution
2. Medium processing model
3. Max height only 2.8 m
4. Narrow impact area
5. Arrival time 30 minutes
6. Reaching the bay in 15 minutes
7. Results less precise

AFTER INTEGRATION BATHYMETRY - TOPOGRAPHY

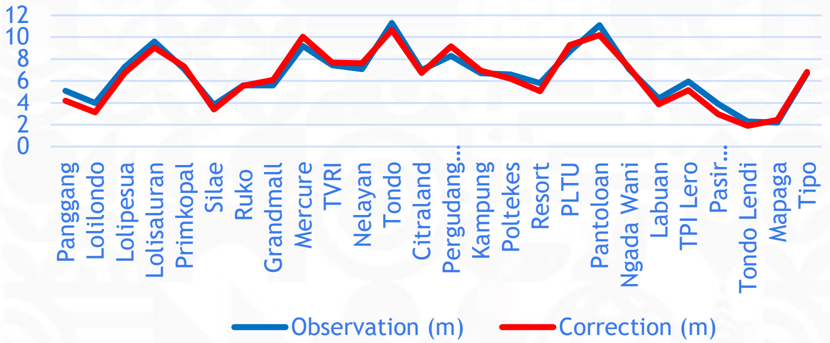
1. High resolution
2. Long processing model with data acquisition
3. Max height greater than 3 m
4. Wider impact area
5. Arrival time 55 minutes longer
6. Reaching the bay takes 20 minutes longer
7. More precise results

Tsunami survey used tide correction

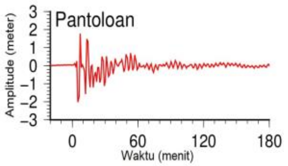


- There are differences in measurement results.
- Tsunami survey team of BMKG came at the first time 3 days after
- Traces of the tsunami were still clearly visible before being cleaned with an excavator.
- Consider time stamp of tide gauge

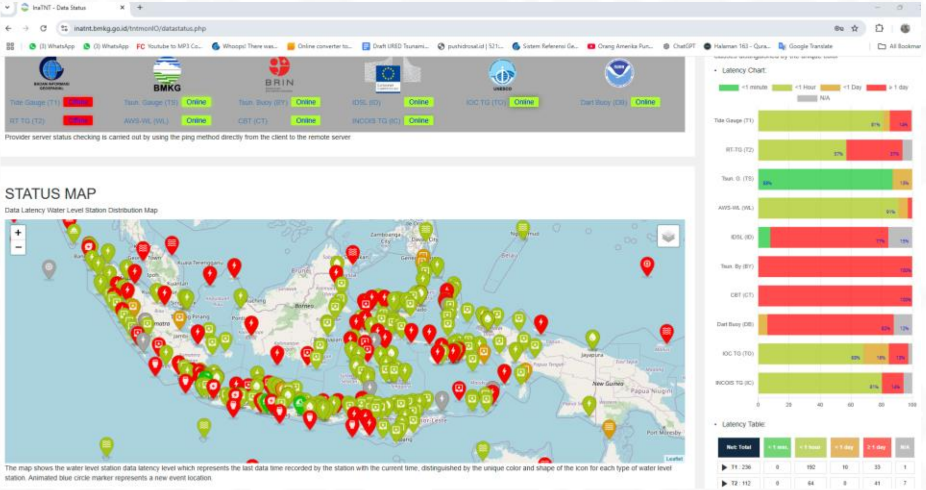
Tsunami height Palu 2018



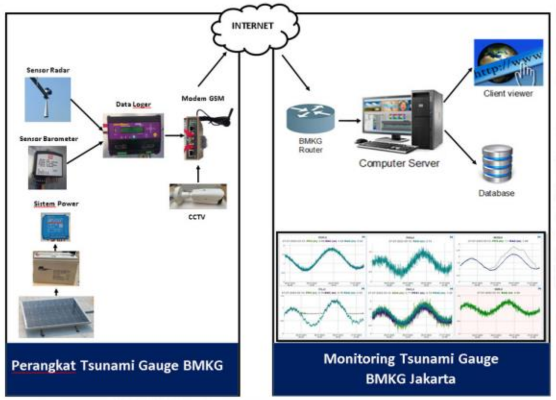
No	Location	Lon	Lat	Height (m)	Tide corr. (m)	Inundation(m)
TS1	Panggang	119,774556	-0,718956	5,1	4.18	106,7
TS2	Lolilondo	119,780534	-0,747154	4,0	3.15	97,7
TS3	Lolipesua	119,788484	-0,769695	7,3	6.76	75,6
TS4	Lolisaluran	119,818903	-0,843634	9,6	9.05	101,0
TS5	Primkopal	119,810797	-0,817553	7,1	7.31	74,0
TS6	Silae	119,834851	-0,874983	3,8	3.39	101,8
TS7	Ruko	119,840053	-0,881112	5,6	5.57	320
TS8	Grandmall	119,842891	-0,882230	5,6	6.08	320
TS9	Mercure	119,849500	-0,883610	9,2	10.03	468,8
TS10	TVRI	119,862850	-0,885830	7.45	7.67	428,9
TS11	Nelayan	119,878140	-0,863900	7,1	7.61	75,0
TS12	Tondo	119,881030	-0,836580	11,3	10.67	165,0
TS13	Citraland	119,879800	-0,831800	7,0	6.73	197,0
TS14	Pergudangan	119,882350	-0,823540	8,3	9.17	378,9
TS15	Kampung	119,876590	-0,801600	6,7	6.95	247,1
TS16	Poltekes	119,864500	-0,790020	6,6	6.2	42,0
TS17	Resort	119,858940	-0,781830	5,8	5.06	145,3
TS18	PLTU	119,855050	-0,732040	8,7	9.29	168,8
TS19	Pantoloan	119,851840	-0,708460	11,1	10.2	216,0
TS20	Ngada Wani	119,840330	-0,695010	7,1	7.23	158,4
TS21	Labuan	119,816600	-0,662510	4,4	3.88	29,3
TS22	TPI Lero	119,811520	-0,629120	5,96	5.15	132,7
TS23	Pasir Marana	119,789340	-0,595290	3,9	2.95	41,2
TS24	Tondo Lendi	119,796204	-0,249244	2,3	1.9	133,8
TS25	Mapaga	119,802160	-0,231051	2,2	2.45	136,7
TS26	Tipo	119,828593	-0,860717	6,7	6.81	105,0

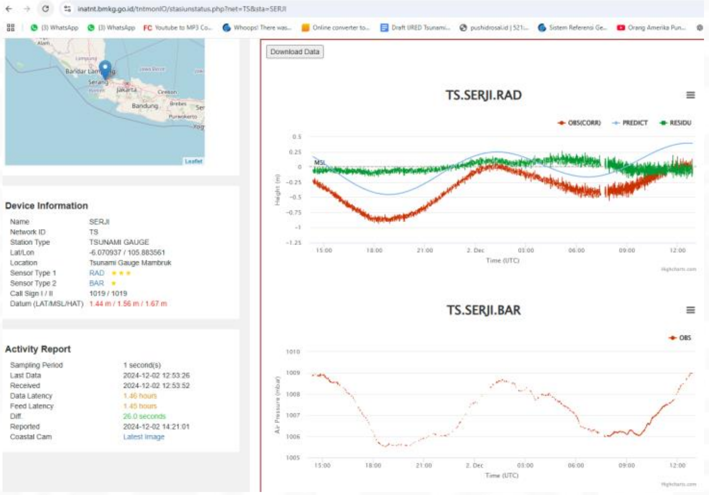


Tsunami gauge



NO	NETWORK	TOTAL	OWNER	SAMPLING RATE	TRANSMIT RATE
1	AWS Water Level	35	BMKG	1 minute	1 minute
2	Tsunami Gauge	5	BMKG	1 minute	5 minutes
3	Tide Gauge 1	237	BIG	1 minute	5 minutes
4	Tide Gauge 2 (RT)	26	BIG	5 seconds	5 seconds
5	IDSL	11	KKP/BRIN	11 seconds	11 seconds

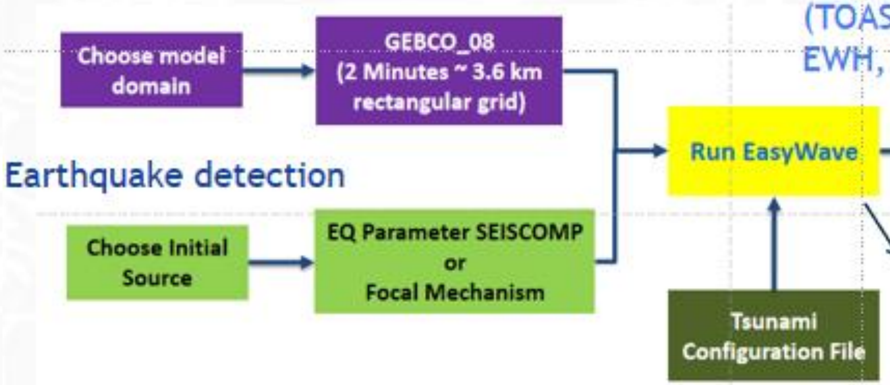




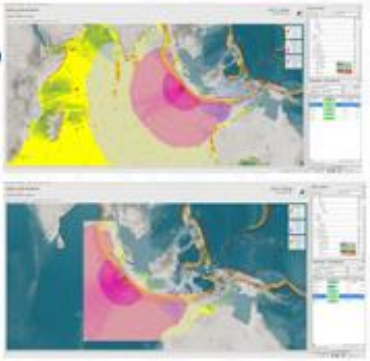
- There are 298 BMKG, BIG and KKP/BRIN water level sensors that have been integrated into the InaTEWS system and monitored on the InaTNT display.
- This year, BMKG provided 100 tsunami gauges with 1 second sampling to quickly confirm tsunami warnings.

Existing condition

1 - Tsunami early warning has 24 operational hours /7 days



Operational model:
Tsunami Observation And Simulation Terminal (TOAST),GEBCO-08, ETH, EWH, warning zone

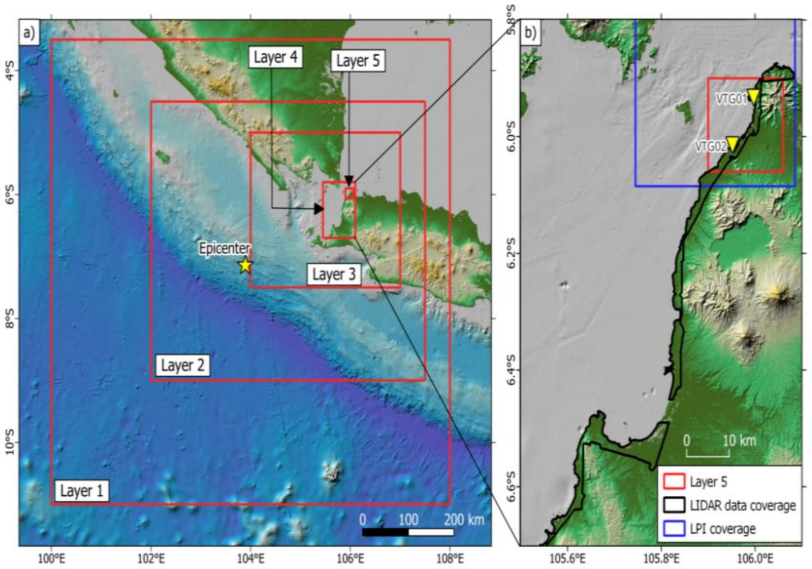


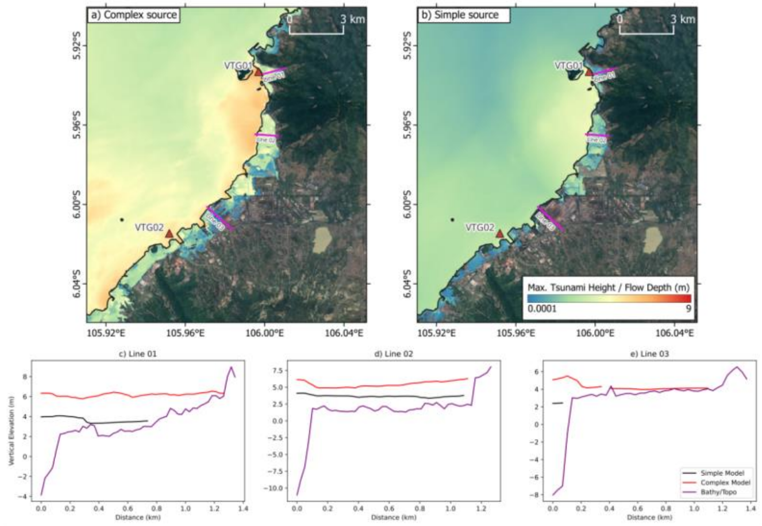
Easy wave
- On fly simulation
- South-East Asian and Indian Ocean Basin (RTSP)
- Finite different
- Linier long wave

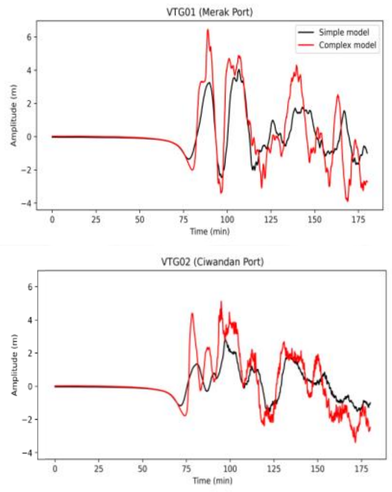
Tsunawi
- Database 22.000 scenario
- National region
- SRTM90
- Finite element
- Triangular mesh
- Inundation

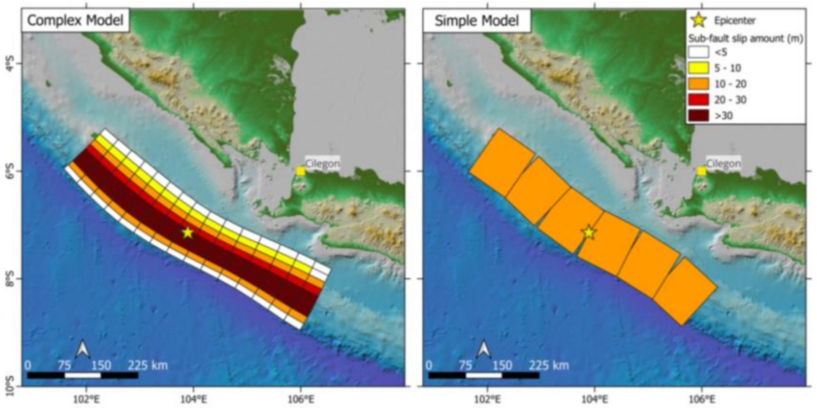
- Existing TOAST & base CPU server, base Linux, on-fly simulation,
- Low resolution (1 km wide grid scale, GEBCO)
- Scenario 22,000 run-up data base
- Not yet inundated,
- Scale province, municipality

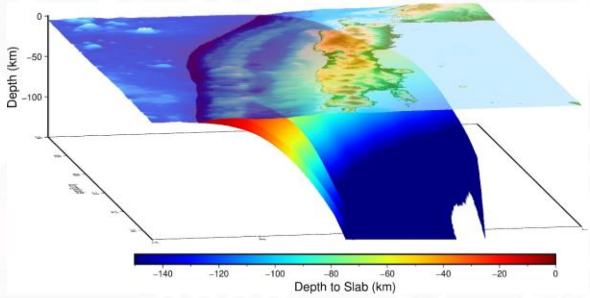
Detailed modeling with complex variations











- Detailed modeling with complex variations (multi-segment, depth, large-scale affected areas) requires detailed data with long processing but will produce optimal results.
- Unfortunately, DEMNAS of Eastern Indonesia is still very rare.

Manuscript Journal : Sesar Prabu Dwi Sriyanto, et.al

Challenges

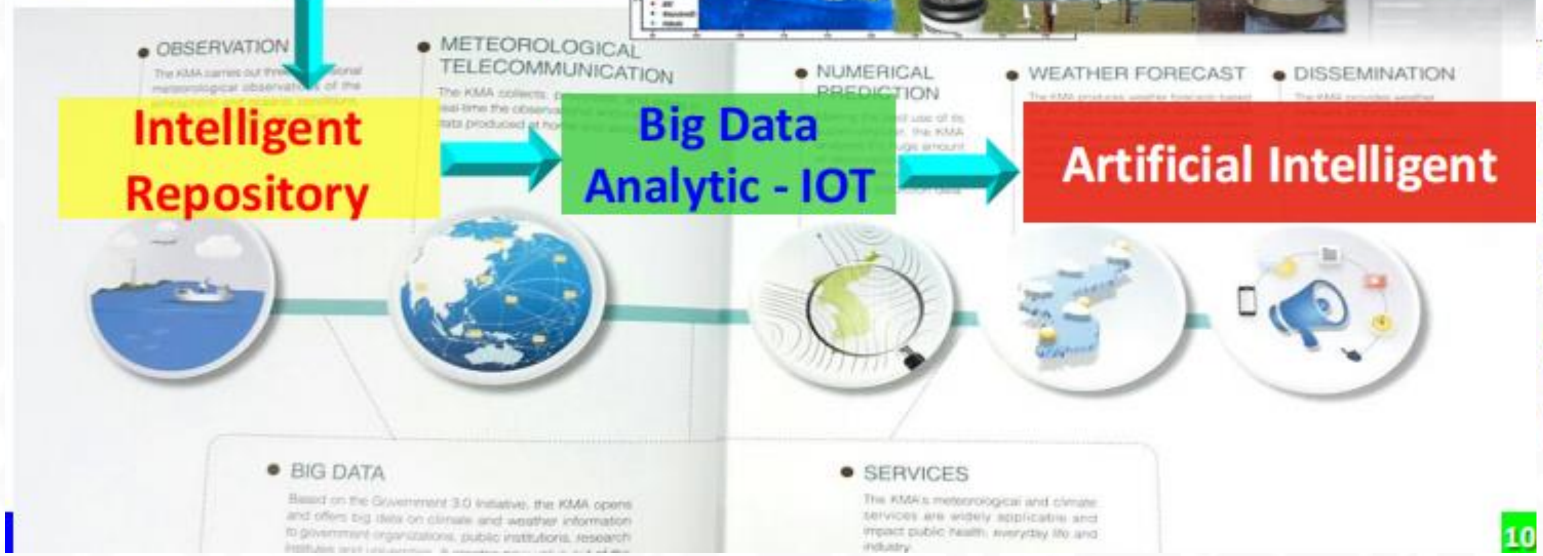
Intelligent data and system:
- Data requirements & integration
- Scalling-up IT System
- Smart EWS (MHEWS)

a. Observation Technology
b. Processing Technology
c. Dissemination Technology

2025

Scale up

HPC-GPU & Merah Putih system pcocessing Paralel to operational model (TOAST)



Intelligent Repository → Big Data Analytic - IOT → Artificial Intelligent

10

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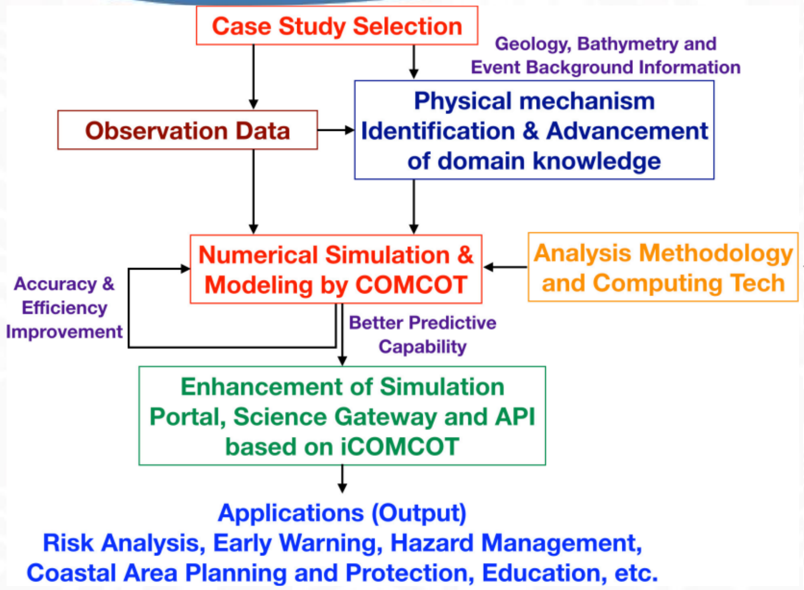

COMPARISON OF CPU & GPU PROCESSING TIME

NO	SKENARIO	GRID (menit)	SCOUP AREA (degree)	SIMULATION TIME	STORAGE (GB)	CPU SP (32 core)	GPU A40 SP (1core)	GPU A100 SP (1 core)
1	Sulawesi – Kalimantan - Jawa	1	26 x 18	24 hrs	0,2	5 hrs	8 mnt	10 mnt
2	Filipina - Kalimantan	1	25 x 32	10 hrs	0,9	1 hrs	5 mnt	7 mnt
3	Banten - Cilegon	1	3 x 3	5 hrs	0,8	**3 mnt**	1,3 mnt	4,1 mnt
4	Aceh - Afrika	1	82 x 72	12 hrs	11,8	22 hrs	51 mnt	42,3 mnt

Data	Sumber	Resolusi (degree)	Resolusi	Resolusi	Grid dimension
GEBCO	https://download.gebco.net	0,004167	15 sec	463 m	0,3 mnt

- Speed @ 1 server = 144 Cores
- Capacity @ 1 server = 500 TB
- 12 servers required (parallel computing)
- Total storage: 6-10 Petabytes
- IP public security (Load balancer + firewall)
- Consists of processing & storage servers
- The tsunami & GIS application is installed on the server for final presentation

- The need to mass produce high resolution maps in large quantities for national community mitigation and tsunami early warning services
- BMKG conducted procurement for HPC tsunami and climate modeling.

Summary and recommendation

1. Making absolute tsunami maps requires high resolution topo-bathy maps, land cover, MSL lines, and a number of nested modeling grids.
2. The future challenges of creating high resolution maps require fast and robust processing so the existence of an HPC-GPU is very important.
3. Fast means that tsunami warnings become more specific (tsunami height, land area) and mitigation becomes more planned.
4. Field measurements using LIDAR, GPS and tidal data are needed to correct tsunami hazard maps.
5. The availability of BIG data in the Eastern Indonesia region, which is still scarce, is very necessary to fulfill disaster mitigation services in the region.
6. Collaborative data sharing between institutions holding high resolution data between government agencies and abroad is very necessary to create higher quality disaster maps.

BADAN INFORMASI GEOSPASIAL

Terima Kasih!

WA 081221901409
sugengphd52@gmail.com
sugeng.pribadi@bmkg.go.id