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BADAN METEOROLOGI KLIMATOLOGI DAN GEOFISIKA

Hazard Mitigation Analysis of The “Gunung Anak Krakatau”Eruption and its Tsunami (22 December 2018)

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kumparan

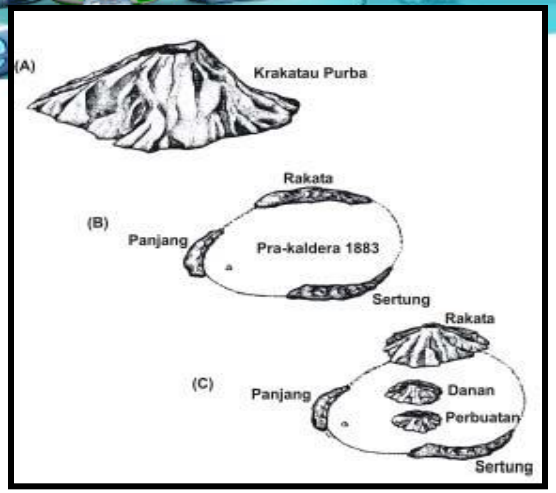
Outline

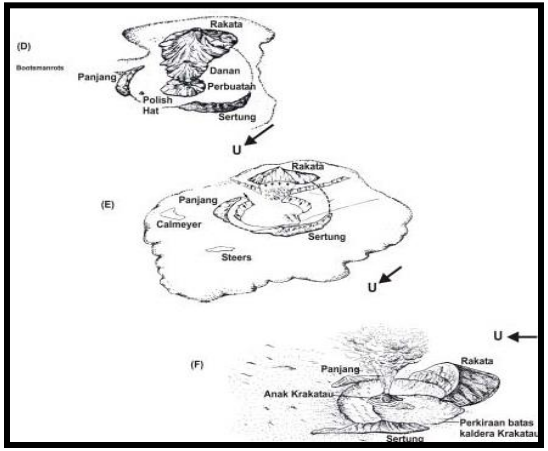
1. History of Ancient Krakatau
2. Gunung Anak Krakatau Present
3. Eruption of Gunung Anak Krakatau December 22, 2018
4. BMKG Analysis
5. Conclusions
6. Recommendations

FLASH OF KRAKATAU HISTORY

HISTORY OF VOLCANO

(Escher, 1919; Francis,1985; Self & Rampino,1981; Simkin & Fiske, 1983)





1. **Pre Krakatau History**
   - Composite Volcano
   - Formation of 416 M Caldera
2. **Krakatau History**
   - The Growth of Rakata Island – Danan – Perbuwatan
3. **Katastropic Eruption 1883**
   - The Eruption Volume is 18 km^3
   - The Eruption Column Height is 80 km
   - The Tsunami is 30 m on the coast of Banten dan south of Lampung

Comparison Chart of The Krakatau Eruption in 1883 with The Appropriate Moment and Energy

The initial eruption illustration of krakatau in 1883 was drawn by an artist. Source: http://www.geology.sdsu.edu/how_volcanoes_work/Images/Historic/Krak_symmons1888_l.jpg

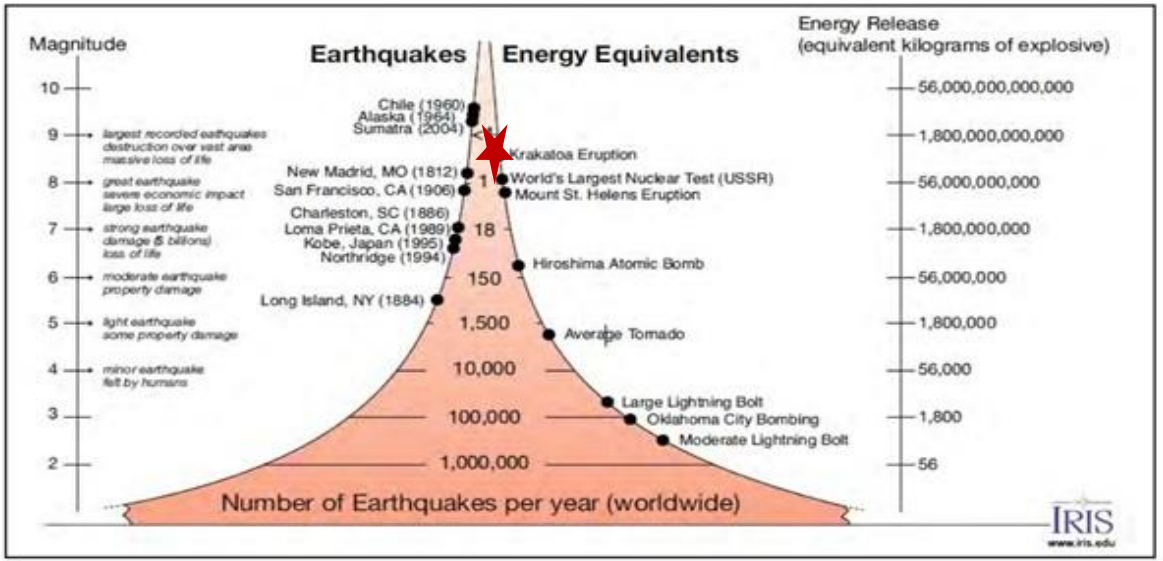


Figure 1. Comparison of the Moment Magnitude and Corresponding Energy Release of Large Earthquakes and Other High-energy Phenomena

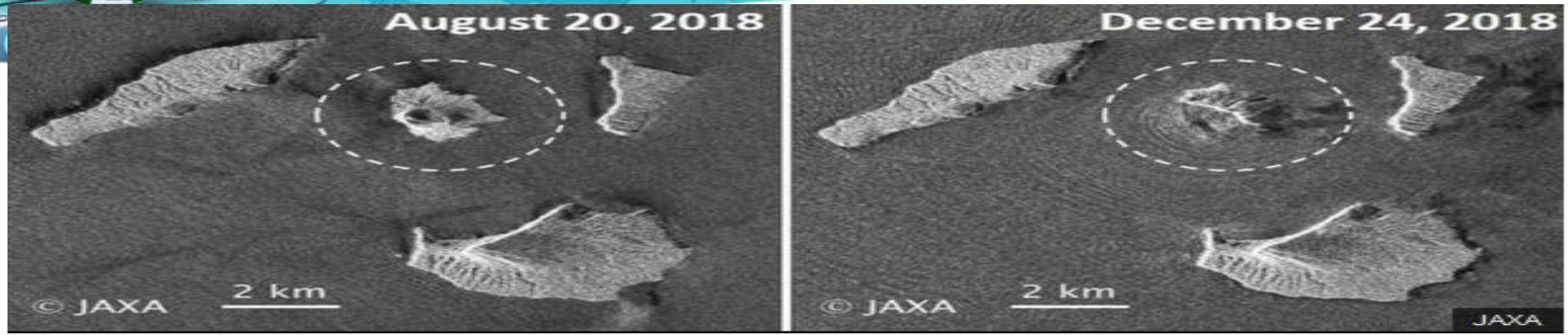
Source: Incorporated Research Institutions for Seismology.

On August 27, 1883 there was a nearly 9 magnitude eruption (corresponding Energy magnitude and Other High-Energy Phenomena), which destroyed 60% of the krakatau body in the middle so that a 7 km caldera hole formed.

Gunung Anak Krakatau Present

Starting in 1927 or approximately 40 years after the eruption of Krakatau, a volcano emerged known as Gunung Anak Krakatau from the ancient caldera region which was still active and still rising in height.

Eruption of Gunung Anak Krakatau December 22, 2018



Satelitte Images of Gunung Anak Krakatau from The Japanese alos-2 radar

Aerial photos of Gunung Anak Krakatau eruption in the Sunda Strait, source Antara

SUNDA STRAIT TSUNAMI TIMELINE

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DEC 21, 2018 - 07.00 | BMKG Provides High Wave Early Warning

The BMKG provides high-wave early warning that takes effect on **December 22 until 25 at 07:00 a.m.** local time in the Sunda Strait waters area of **1.5 - 2.5 meters**

DEC 21, 2018 - 13.51 | Eruption of Gunung Anak Krakatau

There has been a **volcanic eruption of Anak Krakatau, Lampung on December 21, 2018 at 01:51 p.m.** with the height of the ash column observed **± 400 m above the peak (± 738 m above sea level).** The ash column was observed in black with thick intensity leaning towards the north. The status of Gunung Anak Krakatau is at **level II (alert) status.** (source: KESDM, Badan Geologi, PVMBG)

DEC 22, 2018 - 20.56 | There was Volcanic Eruption of Gunung Anak Krakatau

Eruption that triggered a landslide slope of Gunung Anak Krakatau covering an area of **64 hectares**

DEC 22, 2018 - 20.56 | Vibration recorded by BMKG Sensor

Recorded at the BMKG sensor seismograph in **Cigeulis Pandeglang (CGJI) at 08:56 p.m.** and several sensors in the Banten and Lampung regions. The BMKG earthquake detection system does not process automatically because **the vibration signal recorded is not a tectonic earthquake signal**

DEC 22, 2018 - 21.30 | BMKG Officers Received Reports of Tidal Seawater Abnormal

Earthquake and Tsunami Center Officers BMKG received reports of community panic in the Banten and Lampung regions because **tidal sea water was abnormal**

DEC 22, 2018 - 21.30-22.00 | Earthquake and Tsunami Center Officers BMKG did marigram checking Tide Gauge Geospatial Information Agency

Indicated changes in sea level: Marina Jambu Tide Gauge, Ciwandan Tide Gauge, Kota Agung Tide Gauge, Pelabuhan Panjang Tide Gauge

DEC 22, 2018 - 22.30 | BMKG Issued a Press Release

TSUNAMI HAS BECOME AGAINST BANTEN AND LAMPUNG NOT TAKEN BY GEMPABUMI TEKTONIK

DEC 23, 2018 - 01.30 | BMKG Conducted a Press Conference

BMKG said that it was true that the tsunami had occurred **was not caused by a tectonic earthquake**

DEC 23, 2018 - 16.40 | BMKG ensures a vibration center on Gunung Anak Krakatau

BMKG ensures that the vibration center is at Gunung Anak Krakatau, **115.46 BT - 6.10 LS, 1 km depth**. The vibration is with the power of **M 3.4**

Source BMKG

The Analysis of the Volcanic Activity of the Gunung Anak Krakatau

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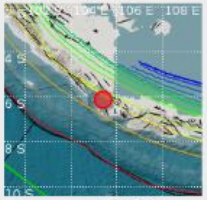
File Edit View Settings Help

Preferred | Current |

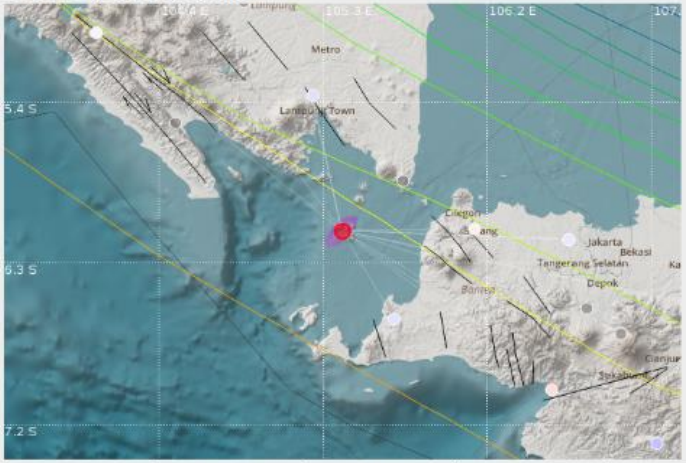
2018-12-22 13:55:48
143d and 13h ago
M 4.9
Sunda Strait, Indones
Depth 0 km
6.12° S 105.40° E



MLv	3.5 (12)
mb	4.3 (1)
mB	-
Mw(mB)	-
Mwp	-
Mw(Mwp)	-
M	3.8 (12)
Phases:	14
RMS Res.:	0.9
Event ID:	bmg2018yzre
Agency ID:	BMKG
final	manual
	Mw 4.9
	2 km

Location | Magnitudes | Event | Events |

Sunda Strait, Indonesia

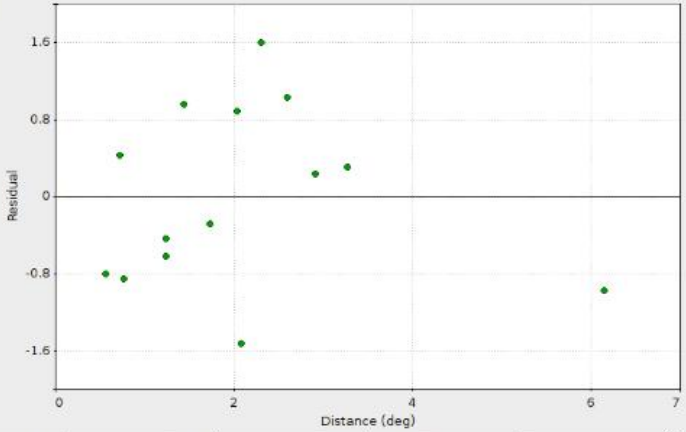


Time: 2018-12-22 13:55:48
Depth: 0 km fixed
Lat: 6.12 ° S +/- 5 km
Lon: 105.40 ° E +/- 4 km
Phases: 14 / 14
RMS Res.: 0.9 s
Az. Gap: 159 °
Min. Dist.: 0.6 °

EventID: bmg2018yzre
Agency: BMKG
Author: scolv@gts-tg-gui-prod.te
Evaluation: final (M)
Method: LOCSAT
Earth model: iasp91
Updated: 2019-03-11 07:33:06

Distance | Azimuth | TravelTime | MoveOut | Polar | FirstMotion |

Filter is not active



Used	Status	Phase	Net	Sta	Loc/Cha	Res	Dis (deg)	Az	Time (UTC)	+/-
T	M	P	IA	TNG	SHZ	-0.61	1.24	92	13:56:10.9	
T	M	P	IA	CNJI	SHZ	-1.52	2.08	124	13:56:22.9	
T	M	P	IA	BBJI	SHZ	1.03	2.60	120	13:56:32.6	
T	M	P	IA	TNGI	00.BHZ	-0.43	1.24	92	13:56:11.0	
T	M	P	IA	MDSI	SHZ	0.89	2.03	323	13:56:24.6	
T	M	P	IA	LWLI	SHZ	-0.28	1.73	309	13:56:19.0	
T	M	P	IA	LEM	BHZ	1.59	2.30	107	13:56:29.1	
T	M	P	IA	CGJI	SHZ	-0.79	0.57	149	13:55:58.5	
T	M	P	IA	SKJI	SHZ	0.96	1.44	127	13:56:15.7	
T	M	P	IA	BLSI	SHZ	-0.85	0.76	348	13:56:02.2	
T	M	P	IA	SBJI	SHZ	0.43	0.72	89	13:56:02.7	
T	M	P	IA	JCJI	SHZ	0.24	2.91	102	13:56:36.0	
T	M	P	IA	PMBI	SHZ	0.31	3.27	347	13:56:41.2	
T	M	P	IA	NGJI	SHZ	-0.97	6.14	101	13:57:19.4	

Source BMKG

SEISMIC RECORDS FROM CGJI STATION LOCATION IN CIGEULIS PANDEGLANG, WEST JAVA

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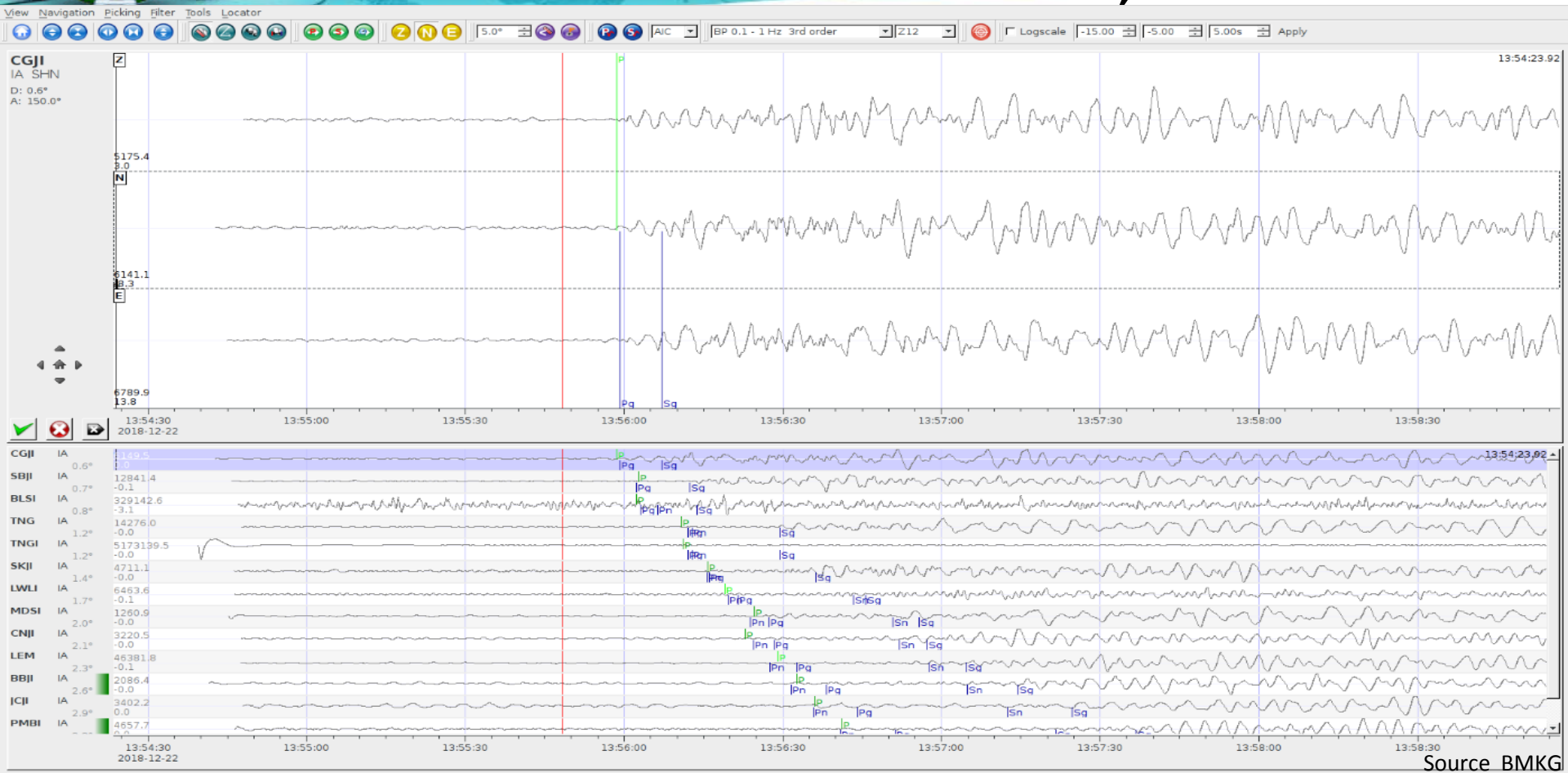
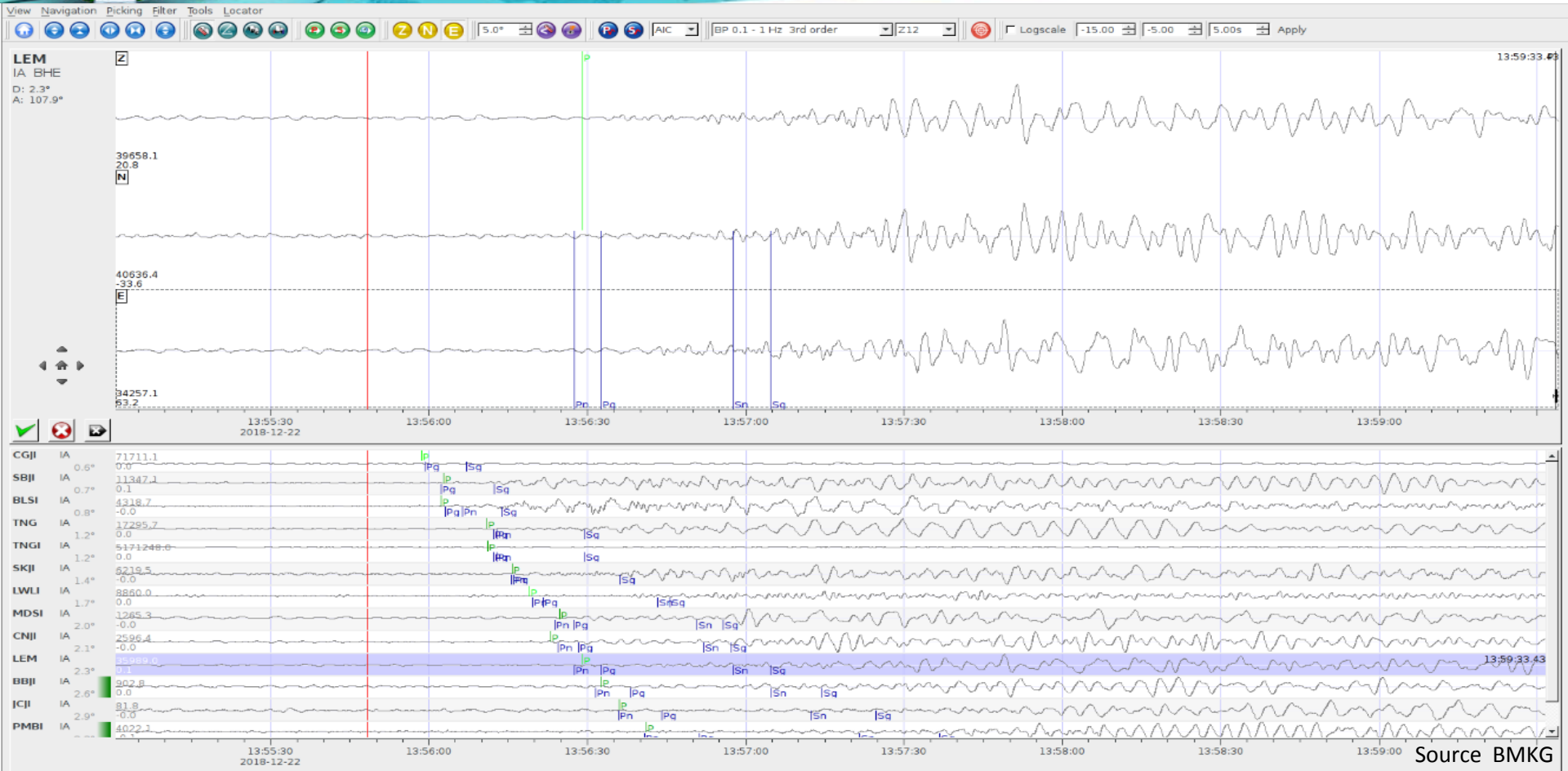


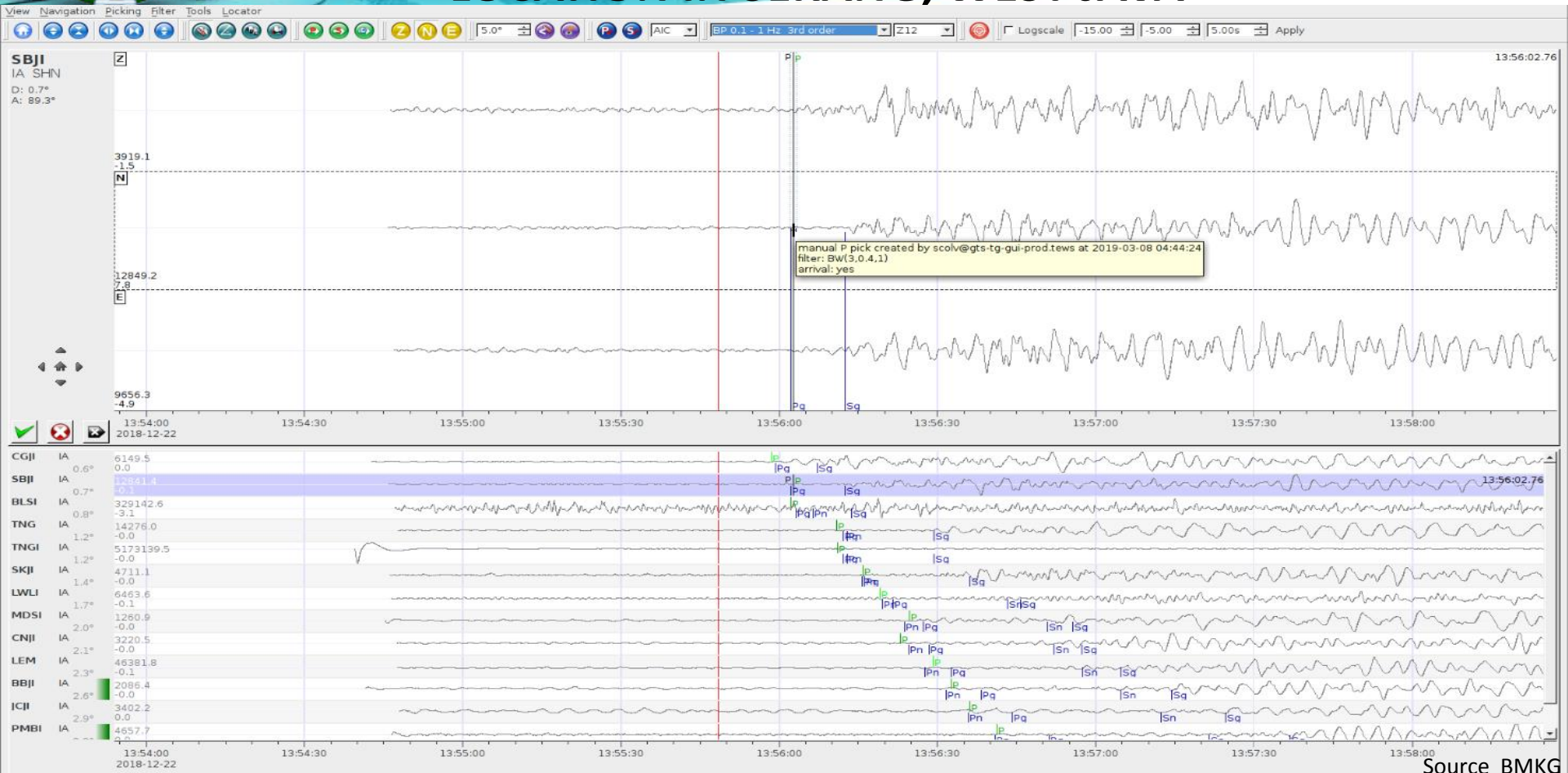
Source BMKG

SEISMIC RECORDS FROM LEM STATION CTBTO LOCATION IN LEMBANG, WEST JAVA

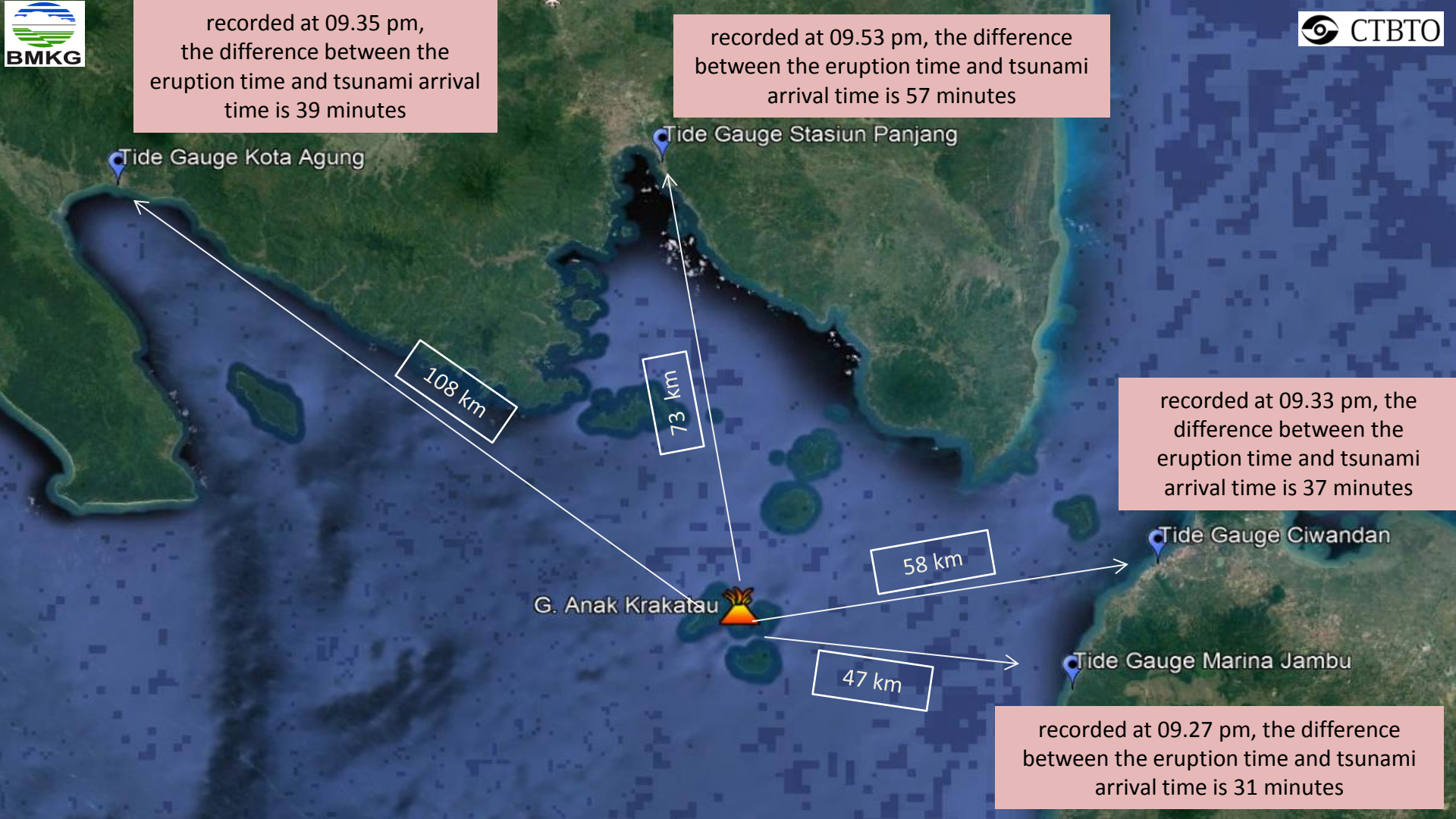


Source BMKG

SEISMIC RECORDS FROM SBJI STATION LOCATION IN SERANG, WEST JAVA



Source BMKG


BMKG
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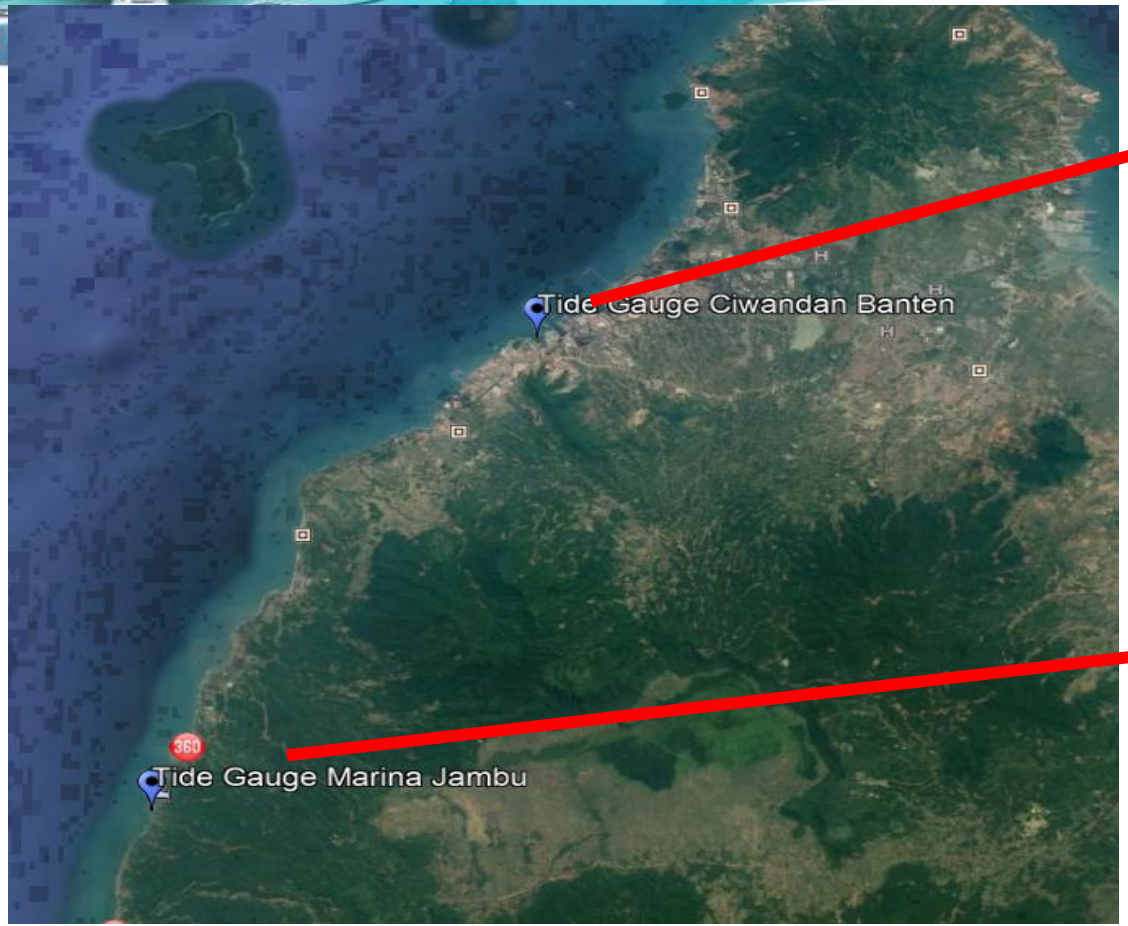
recorded at 09.35 pm, the difference between the eruption time and tsunami arrival time is 39 minutes
recorded at 09.53 pm, the difference between the eruption time and tsunami arrival time is 57 minutes
Tide Gauge Kota Agung
Tide Gauge Stasiun Panjang
108 km
73 km
recorded at 09.33 pm, the difference between the eruption time and tsunami arrival time is 37 minutes
Tide Gauge Ciwandan
58 km
G. Anak Krakatau
47 km
Tide Gauge Marina Jambu
recorded at 09.27 pm, the difference between the eruption time and tsunami arrival time is 31 minutes

TIDE GAUGE RECORDS OF BANTEN AREA



Source BMKG

TIDE GAUGE RECORDS OF LAMPUNG AREA

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Source BMKG

The Data on Casualties and Damages

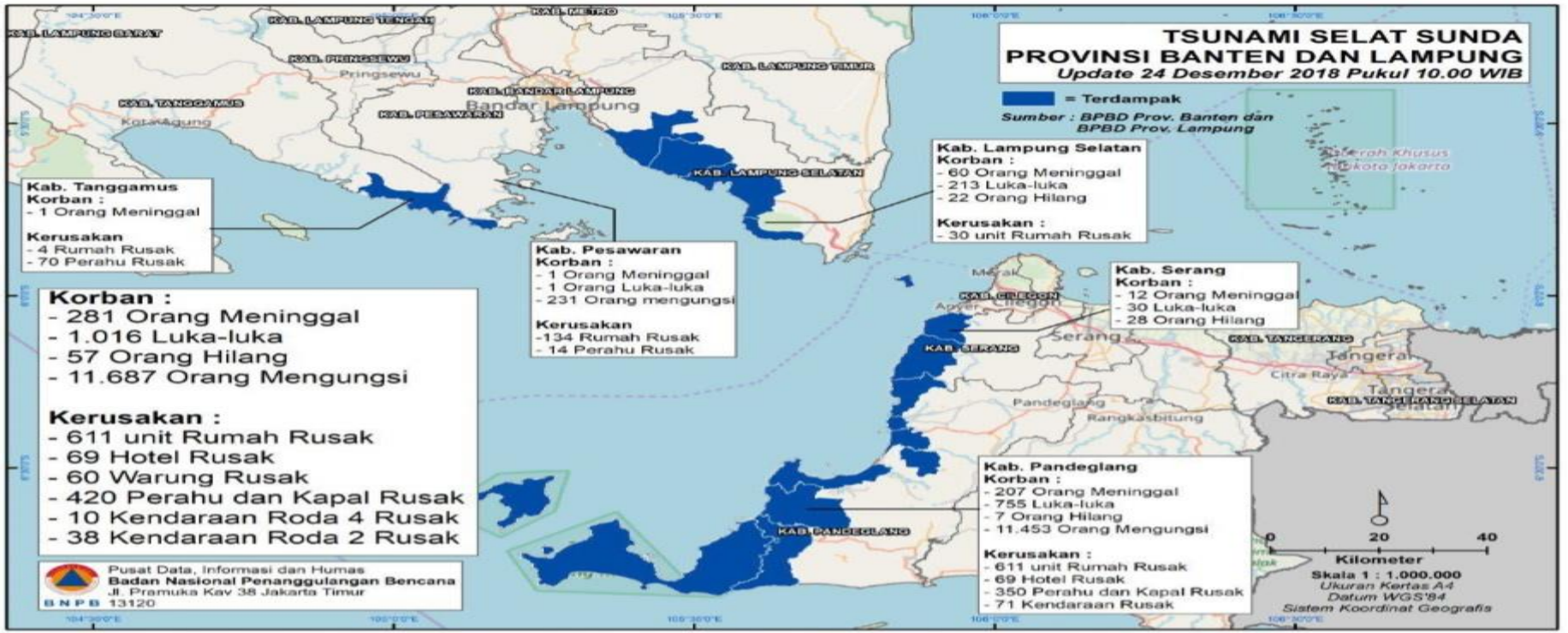


Figure 14 *- Situation map as of 24 December 2018, 03:00 UTC (source: BNPB's spokesperson's twitter account) (LEGEND: Orang Meninggal=victims; luka-luka=injured; orang hilang=missing person; orang mengungsi=people fled; rumah rusak=damaged houses; hotel rusak=damaged hotels; warung rusak=damaged shop; perau dan kapal rusak=boats/ships damaged; kendaraan roda=damaged vehicles)*

Source BNPB

Conclusions

1. With available data, it seems that the tsunami had hit the Sunda Strait on 22/2018 was caused by the landslide of Gunung Anak Krakatau.

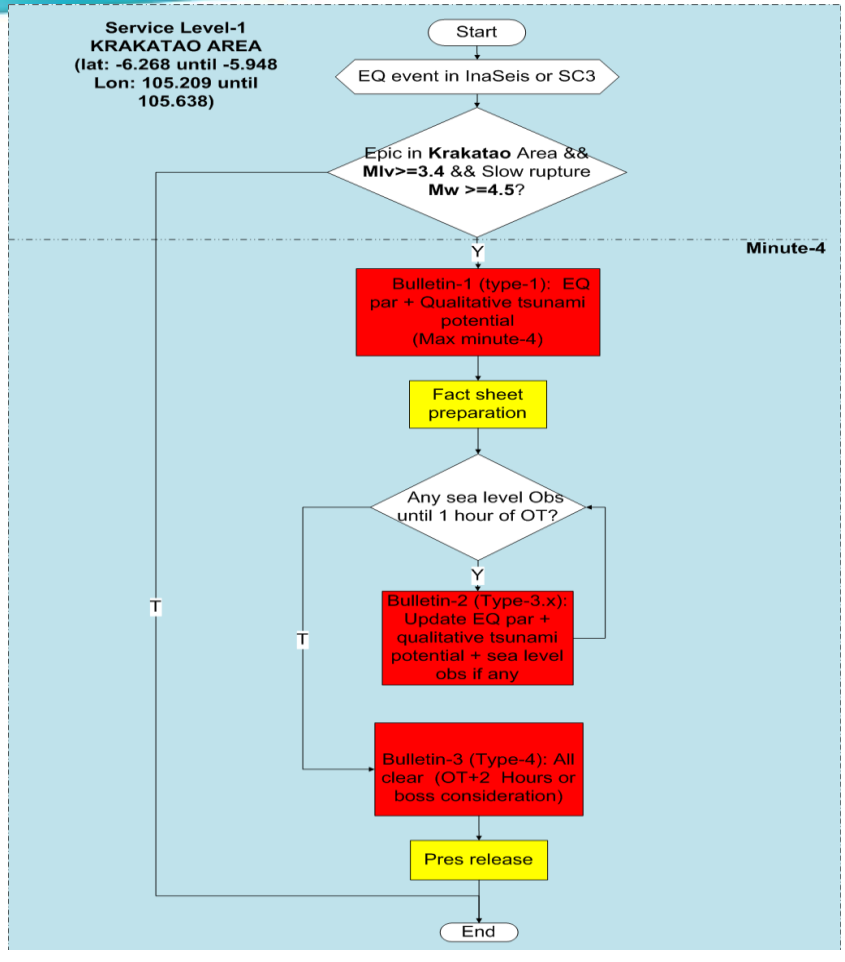
2. There are no landslide models that can model tsunami waves.

3. The difference between the origin time landslide and the arrival time of the tsunami is around 30 minutes.

Recommendations

IMPLEMENTED SOP:
1. **BASED ON MAG && EPIC**
2. **STILL NO TSUNAMI MODEL**
3. **BACK TO SL-1**

1. Rearange a new SOP tsunami early warning caused by non tectonic activity.
2. Increase detection of BMKG seismic sensors in the Sunda Strait.
3. Deploy more monitoring equipment in the Sunda Strait such as water level equipment to detect Tsunami waves.



Existing Tsunami Warning System Arround Gunung Anak Krakatau

NO	NAMA	TYPE	PROVIDER	STATUS
1	Bengkunat	Tide Gauge	BIG	Online
2	Kota Agung	Tide Gauge	BIG	Online
3	P. Panjang	Tide Gauge	BIG	Online
4	P. Panjang	AWS Maritim	BMKG	Offline
5	Bakaheuni	AWS Maritim	BMKG	Online
6	P. Sebesi	Tide Gauge	BIG	Online
7	P. Sebesi	Water Level	BMKG	Online
8	Merak	AWS Maritim	BMKG	Online
9	Ciwandan	Tide Gauge	BIG	Online
10	Marina Jambu	Tide Gauge	BIG	Online
11	Labuhan	AWS Maritim	BMKG	Offline
12	Ujung Kulon	AWS Maritim	BMKG	Online
13	Binuangeun	Tide Gauge	BMKG	Online
14	Anyer	HF Radar	BMKG	Online
15	P. Sebesi	IDSL	KKP	Online
16	Marina Jambu	IDSL	KKP	Online

THANK YOU

TERIMA KASIH

DANKE

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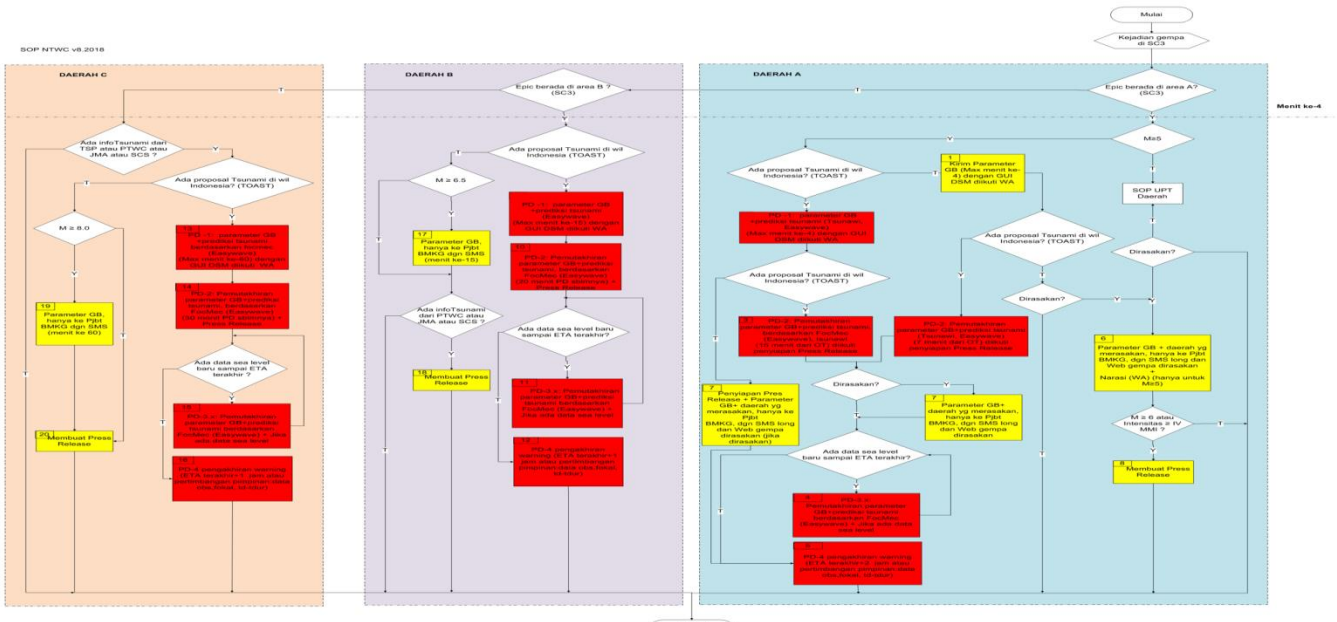
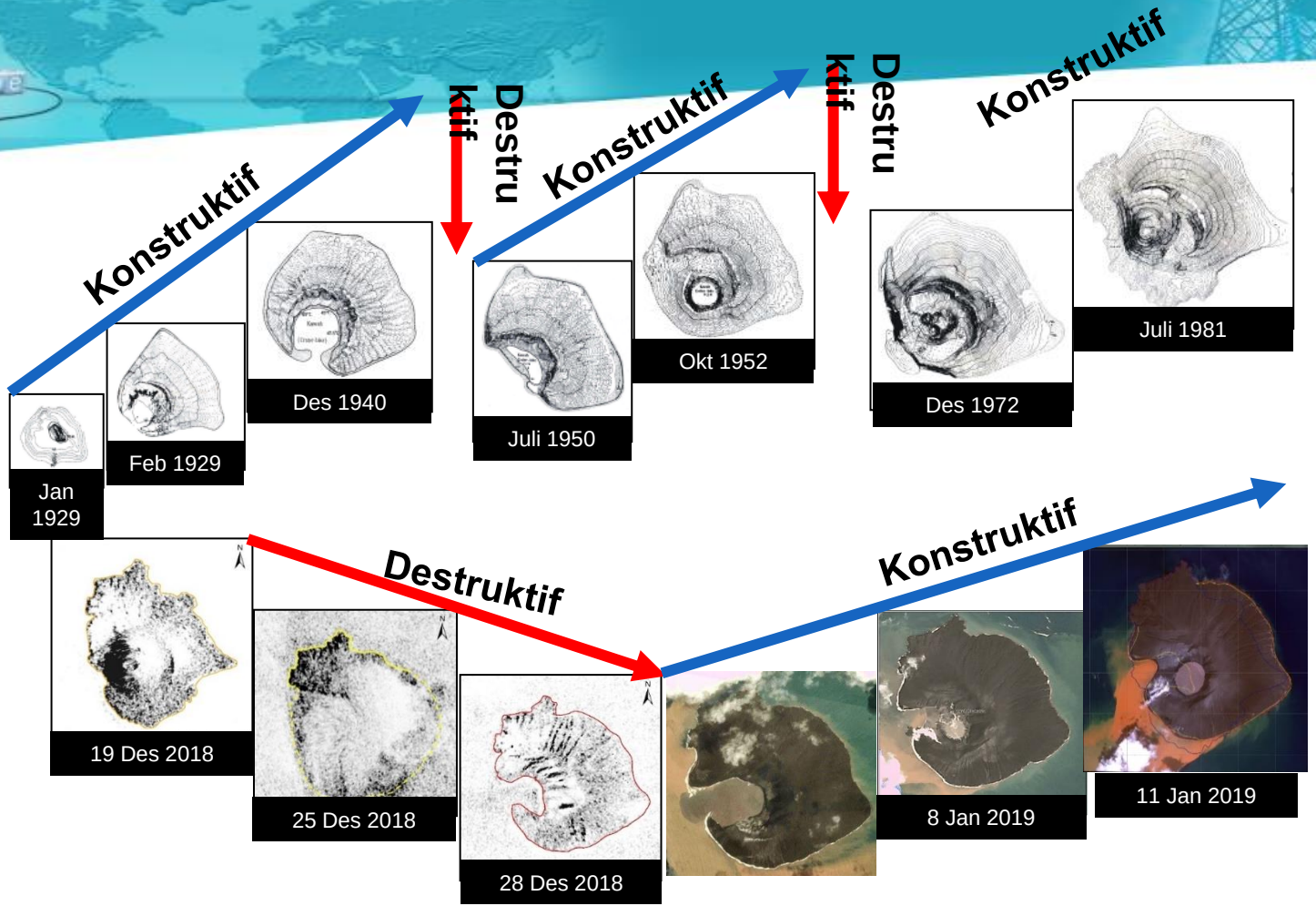
SOP INATEWS SEBAGAI NTWC

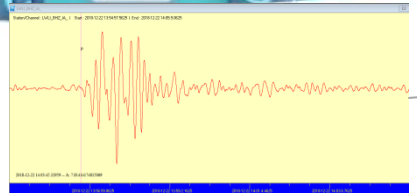


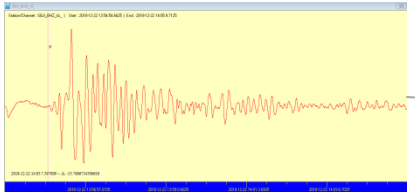


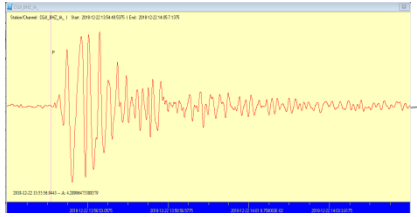
(Mamay, 2018)

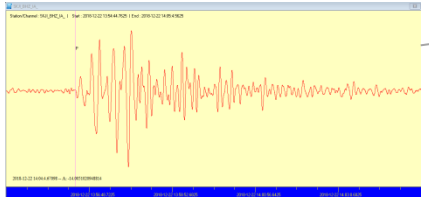
Source : Simkin & Fiske, 1983; Sutawidjaya, 2006; COSMO-SKYMED (CSK) spotlight; Sentinel-1; Planetcope; Worldview-2)

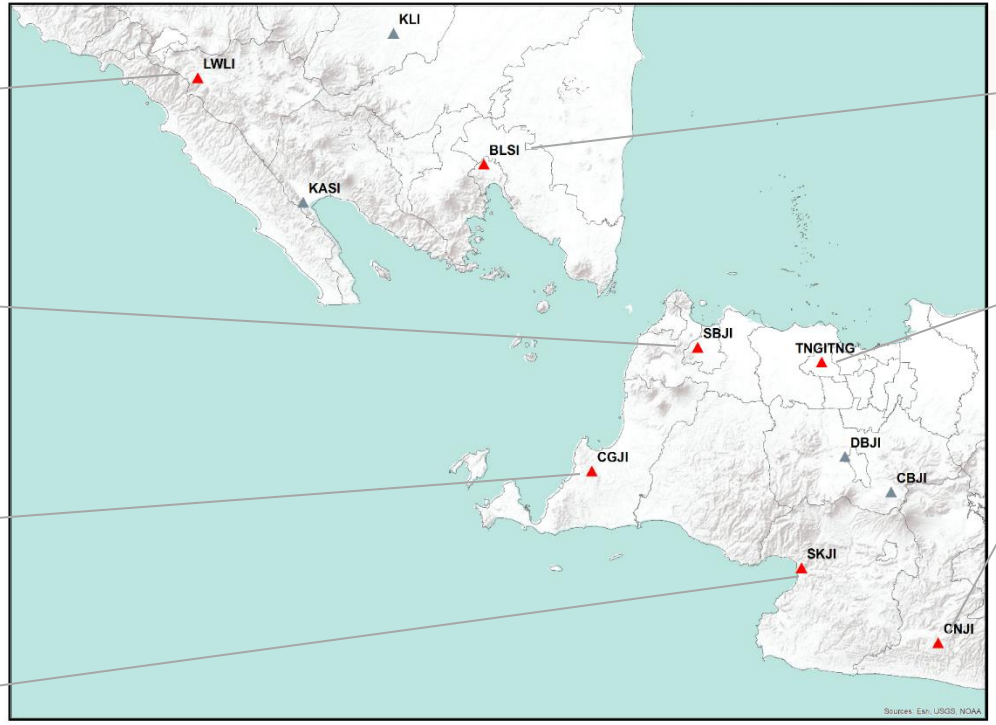
SEISMIC RECORDS GUNUNG ANAK KRAKATAU ERUPTION, DECEMBER 22 2018

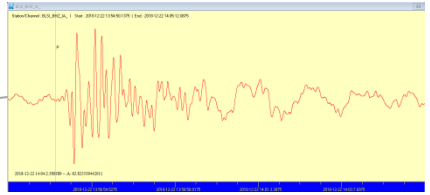


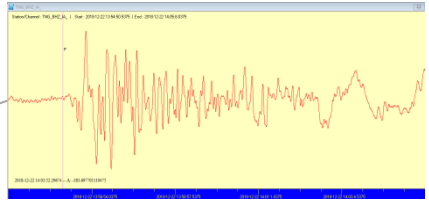


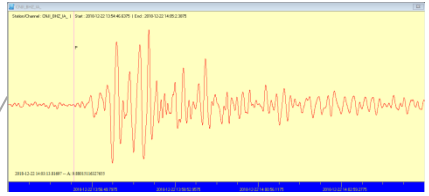












Phase List

Channel	Phase	Phase Time
CGJI_BHZ_IA_	P	2018-12-22 13:55:57.06
BLSI_BHZ_IA_	P	2018-12-22 13:56:00.44
SBJI_BHZ_IA_	P	2018-12-22 13:56:00.45
TNG_BHZ_IA_	P	2018-12-22 13:56:11.45
TNGI_BHZ_IA_00	P	2018-12-22 13:56:20.10
CNJI_BHZ_IA_	P	2018-12-22 13:56:23.22
SKJI_BHZ_IA_	P	2018-12-22 13:56:28.31
LWLI_BHZ_IA_	P	2018-12-22 13:56:46.40

Filter Signal Bandpass 0.01 Hz – 0.1 Hz