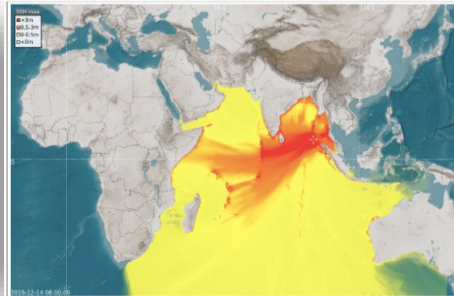




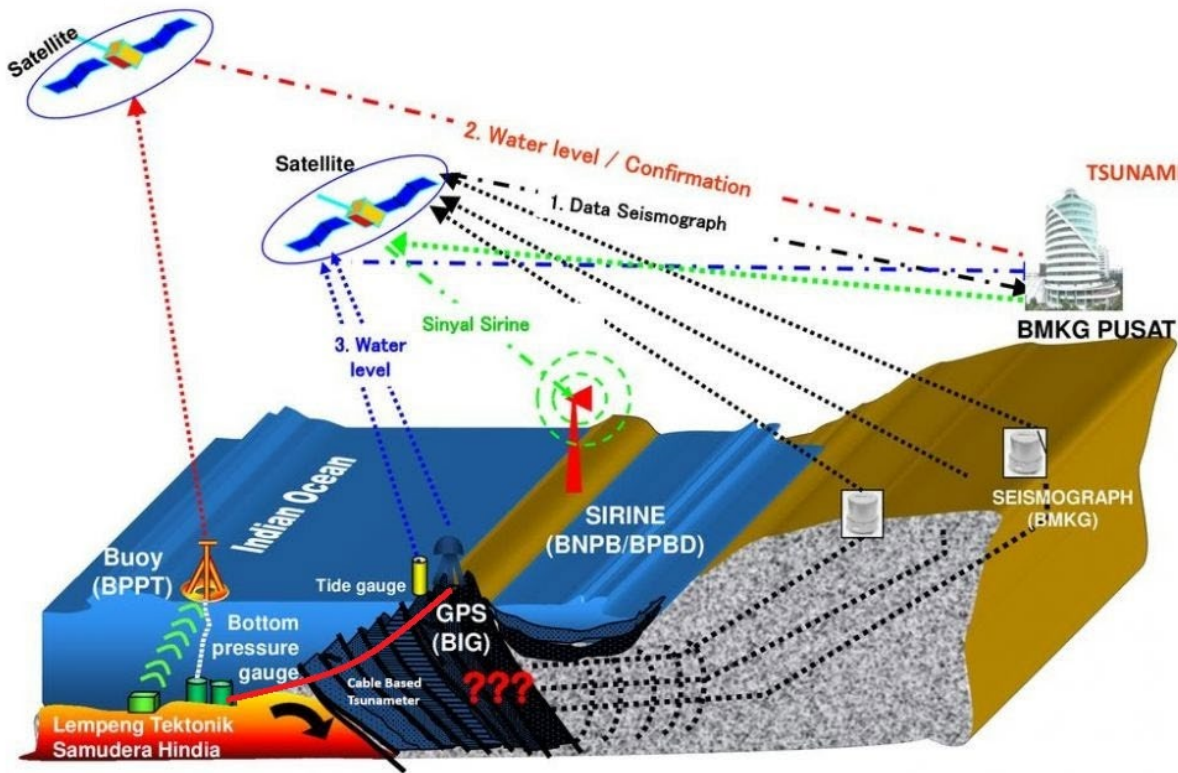
STRENGTHENING TSUNAMI EARLY WARNING IN INDONESIA THROUGH OFFSHORE OBSERVATIONS AND EEWS INTEGRATION



CRESCENT ANNUAL MEETING, 10/27/2025

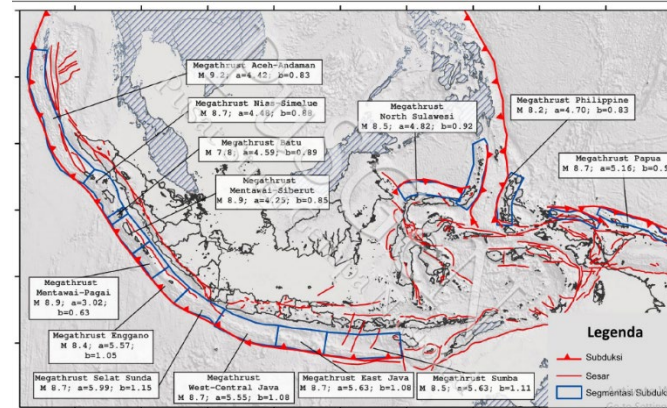
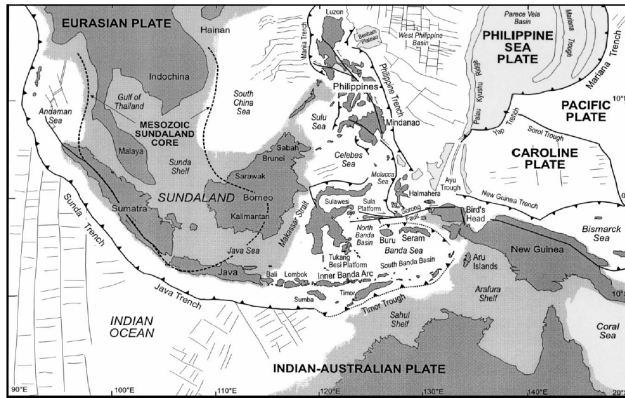
INDONESIA'S EARTHQUAKE AND TSUNAMI THREAT

CONCEPT OF INATEWS



1. Coastal Sea-Level Stations
(Shallow Water)
2. Bottom Pressure Sensors (DARTs)
(Deep Water)
3. Cabled sensors
(Intermediate Depths – Deep Water)

INDONESIA'S EARTHQUAKE AND TSUNAMI THREAT

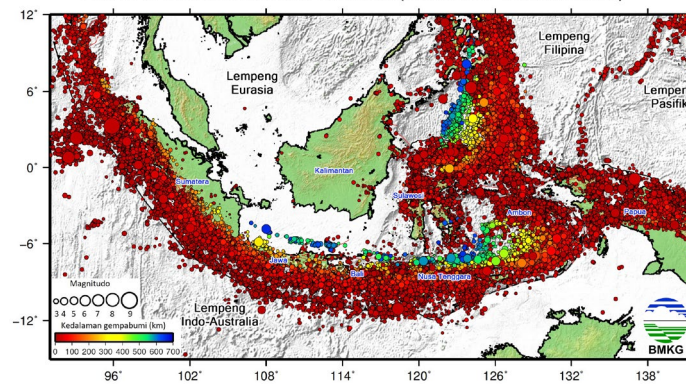


Consequence of Indonesia is being located on 4 tectonic plates: **13 megathrust** and **295 active faults**

Indonesia is located on the border of 4 tectonic plates

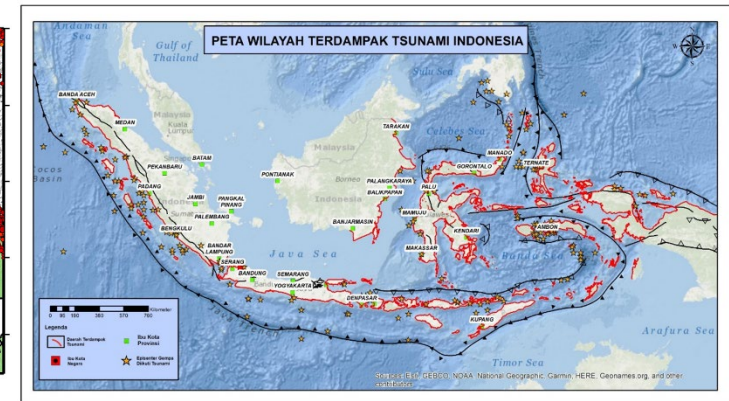
1. Indo-Australia
2. Eurasia
3. Pacific
4. Philippines.

PETA EPISENTER GEMPABUMI DI INDONESIA (TAHUN 1963 - 31 JANUARI 2022)



Seismicity of Indonesia

The impact not only to Indonesia but also to ASEAN and many countries in Indian Ocean coastal area



46% of Indonesia's coastline are prone to tsunami



INAUGURATION OF INDONESIA TSUNAMI EARLY WARNING SYSTEM



Inaugurated on November 11, 2008



InaTEWS' main products: earthquake information and tsunami early warning

Dissemination within **3 minutes after earthquake (2023 – now)**

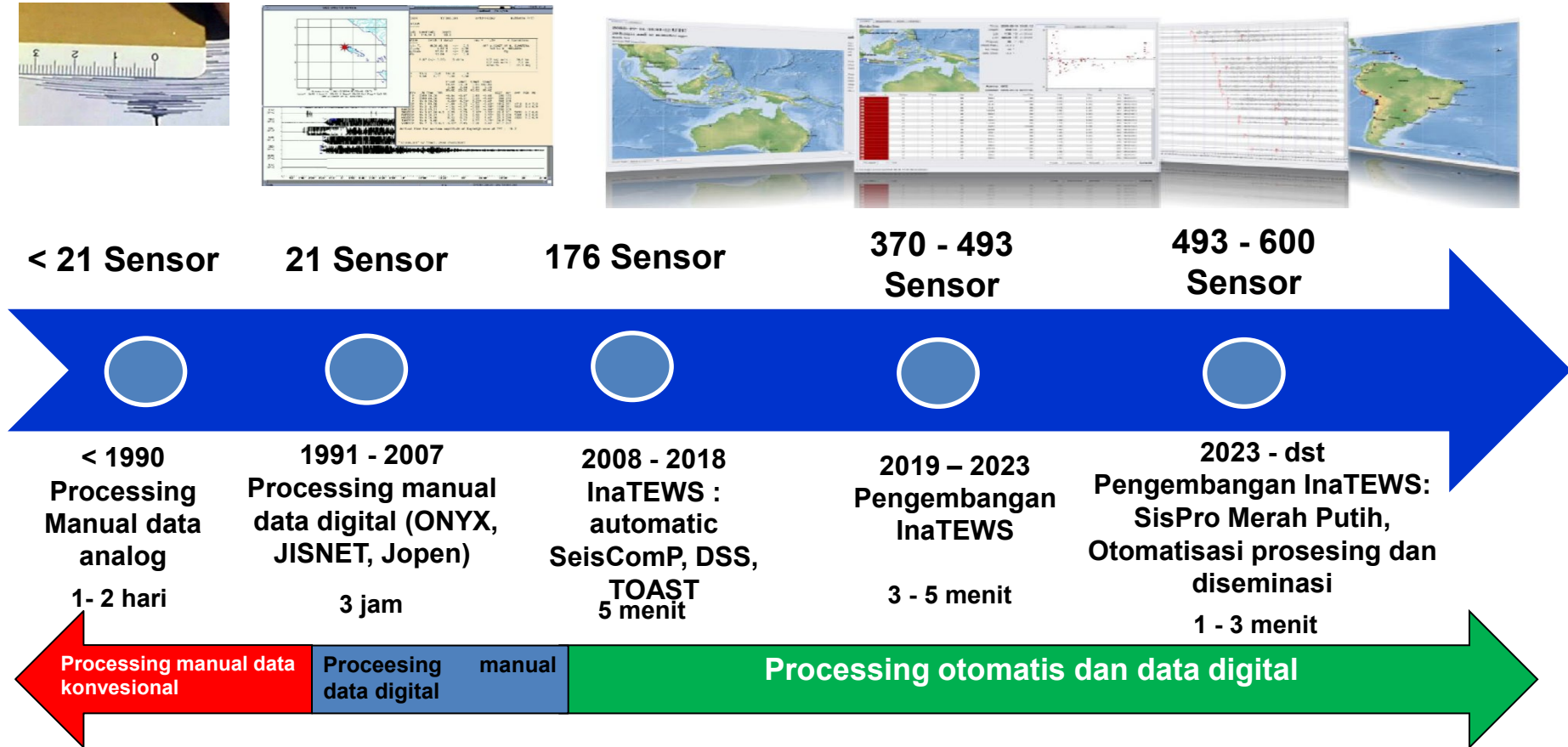
Indonesia's target of Tsunami Early Warning System:

Quickly detecting earthquake and inform tsunami early warning to stakeholders

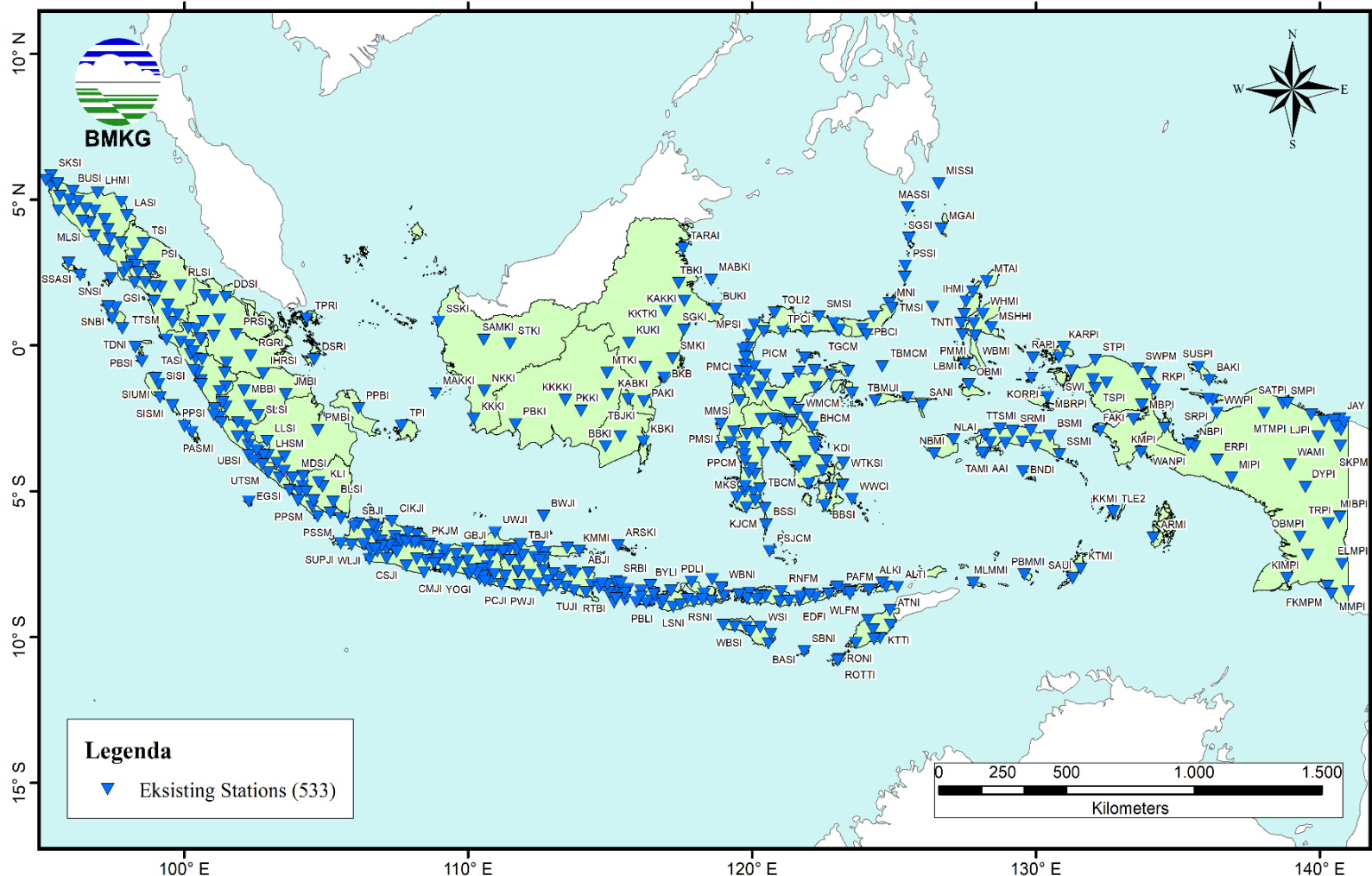


Exact response from the community to reduce and minimize disaster impact

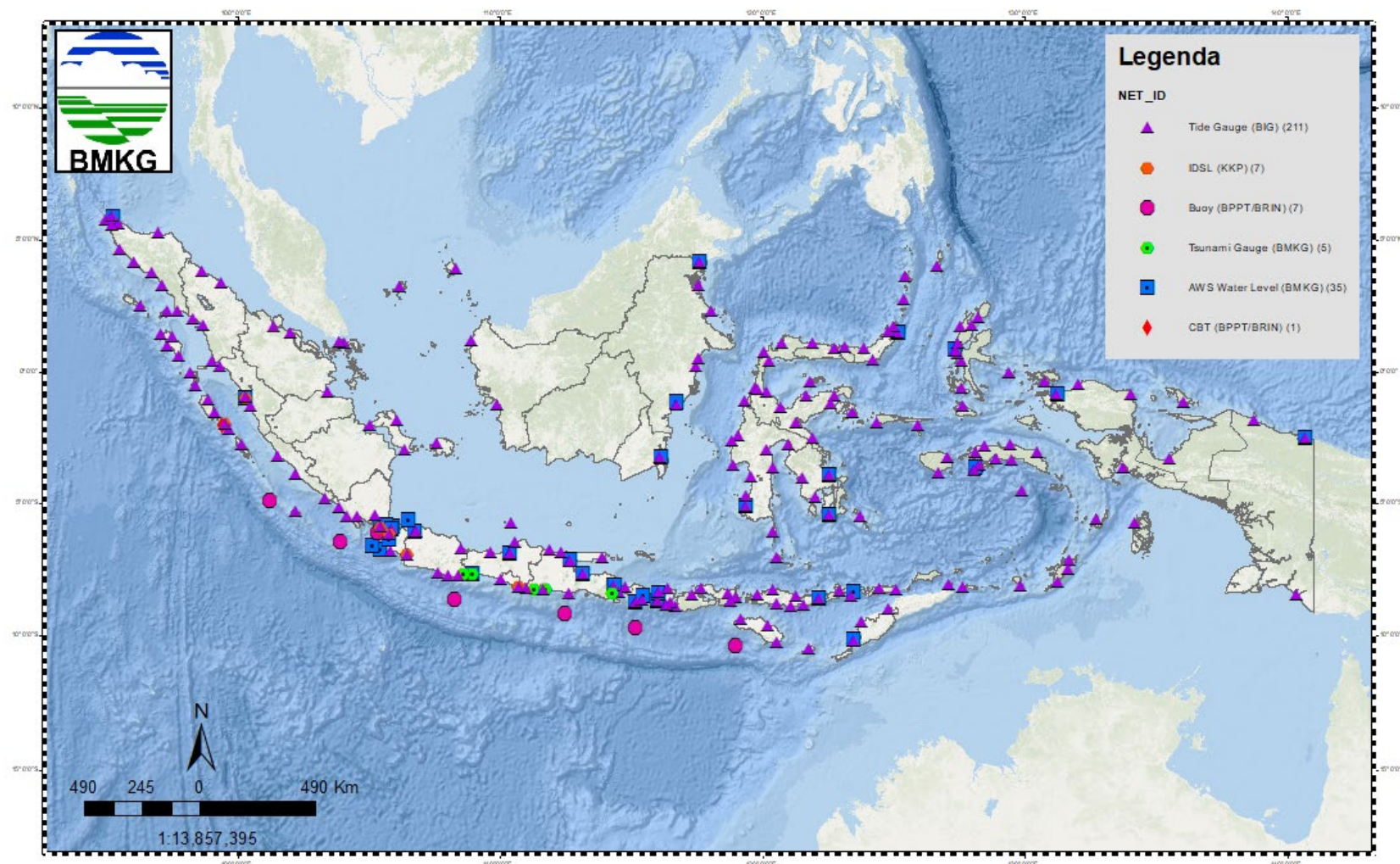
MILESTONE OF MONITORING AND PROCESSING INATEWS



INDONESIA SEISMIC SENSORS NETWORK



SEA LEVEL MONITORING NETWORK OF INATEWS



Sea level sensors network : 266 sensors

SEA LEVEL MONITORING NETWORK OF INATEWS

PGT - BMKG



TSUNAMI GAUGE

PUSMAR - BMKG



AWS – WATER LEVEL

KKP



IDSL – WATER LEVEL

BPPT/BRIN



TSUNAMI BUOY

BPPT/BRIN



Cable Based Tsunameter (CBT)

BIG



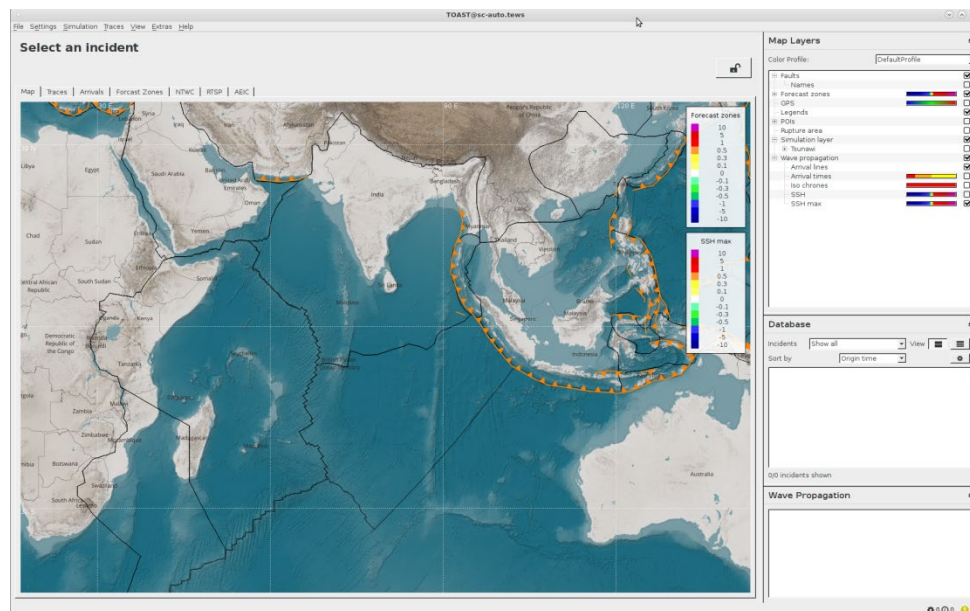
TIDE GAUGE

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	157	BIG	1 minute	5 minutes
4	Tide Gauge 2 (RT)	54	BIG	5 seconds	5 seconds
5	IDSL	7	KKP	11 seconds	11 seconds
6	Buoy	7	BPPT	15 minutes (normal mode) / 15 seconds (tsunami mode)	1 hour (normal model) / 1 minutes (tsunami mode)
7	CBT	1	BPPT	15 seconds	15 seconds

Number of Integrated Sea Level Monitoring Sensors : 266 Sensors



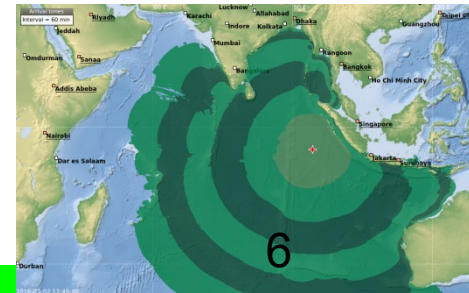
TOAST (Tsunami Observation And Simulation Terminal)
Using real time and pre-calculated tsunami database simulation



Earthquake Information

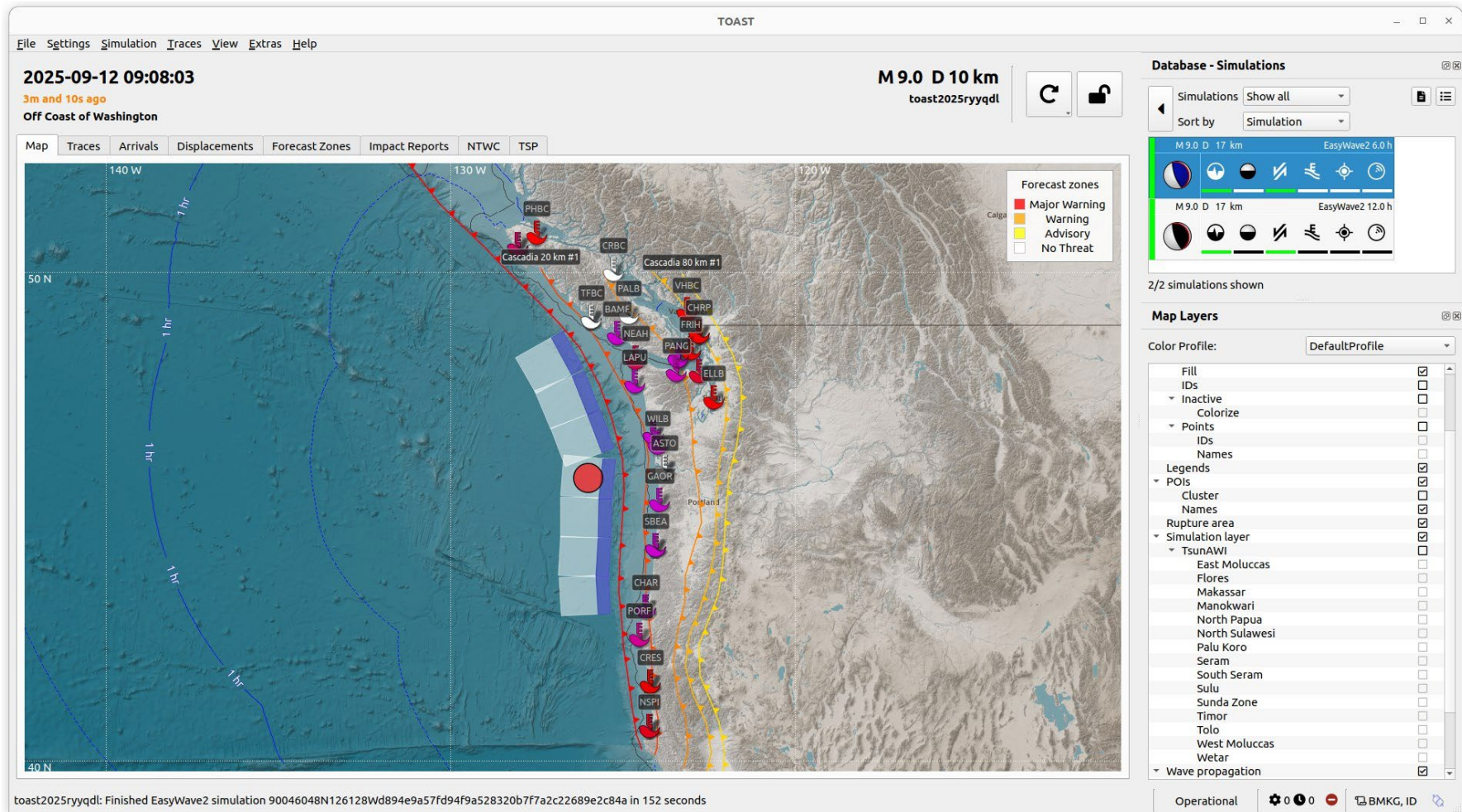
Tsunami Warning

- **Origin Time**
- **Magnitude**
- **Depth**
- **Location**



TSUNAMI PROCESSING SYSTEM

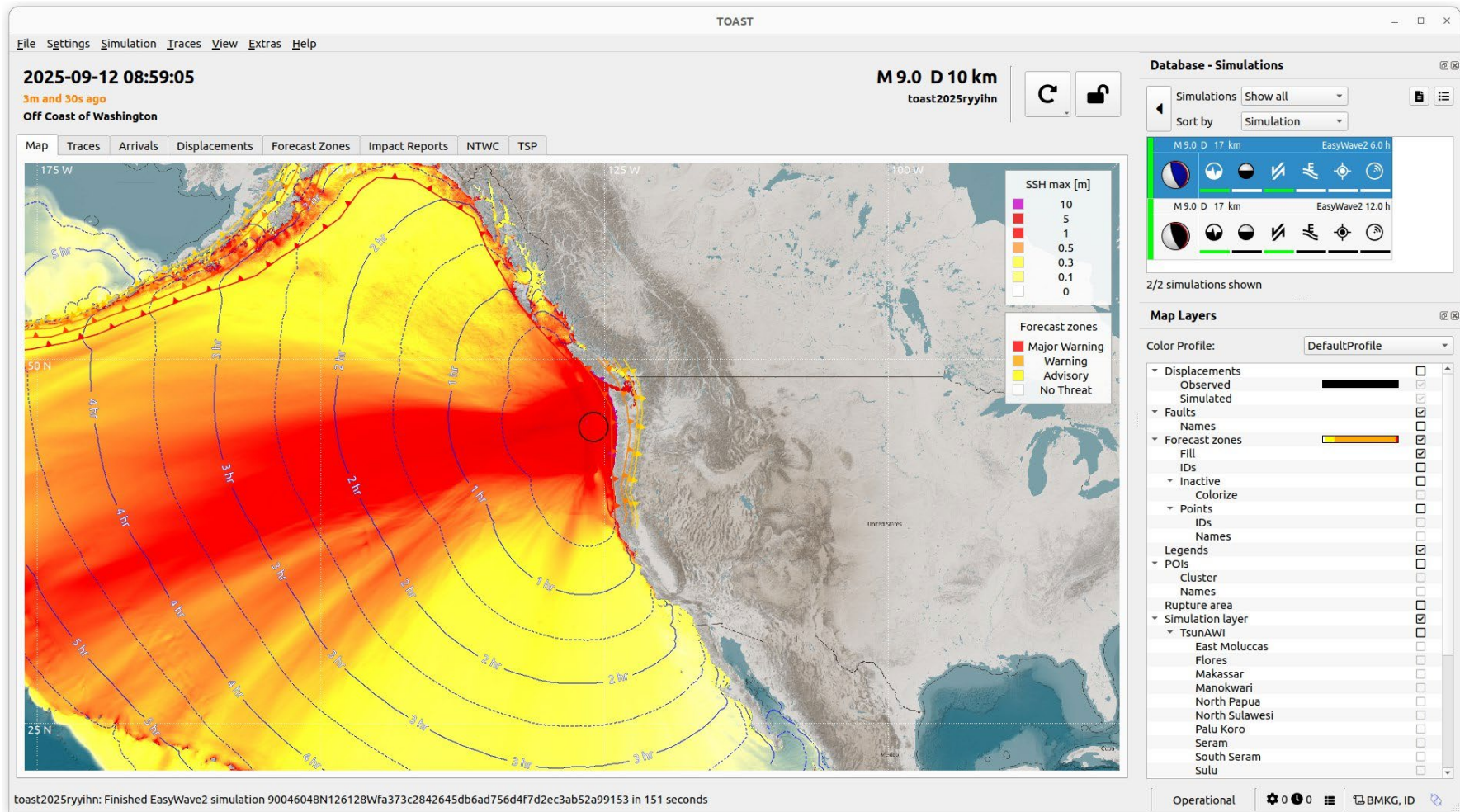
TOAST (TSUNAMI OBSERVATION AND SIMULATION TERMINAL)



1. easyWave (Dr. Andrey Babeyko (GFZ-Germany))
2. TsunAWI (Alfred Wagener Institute-Germany)

TSUNAMI PROCESSING SYSTEM

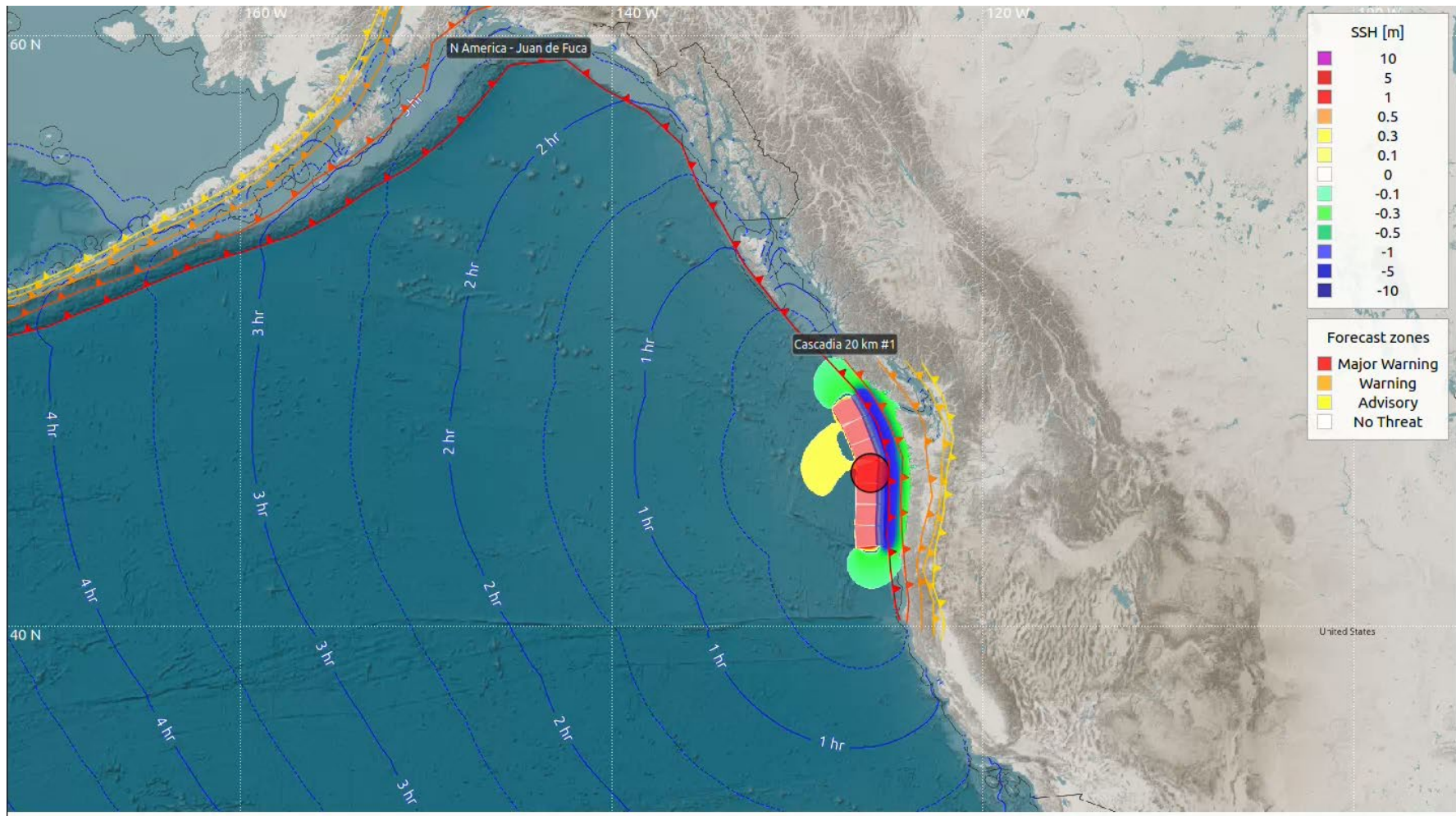
TOAST (TSUNAMI OBSERVATION AND SIMULATION TERMINAL)



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2. TsunAWI (Alfred Wagener Institute-Germany)

TSUNAMI PROCESSING SYSTEM

TOAST (TSUNAMI OBSERVATION AND SIMULATION TERMINAL)



1. easyWave (Dr. Andrey Babeyko (GFZ-Germany))
2. TsunAWI (Alfred Wagener Institute-Germany)

EQ TSUNAMI KAMCHATKA M8.7

Date : Wednesday, 30 July 2025 Magnitudo : M8,7
 Time : 06:24:50 WIB Epicenter : 52,51° N; 160,26° E
 Location : East Coast Kamchatka, Rusia Depth : 18 Km

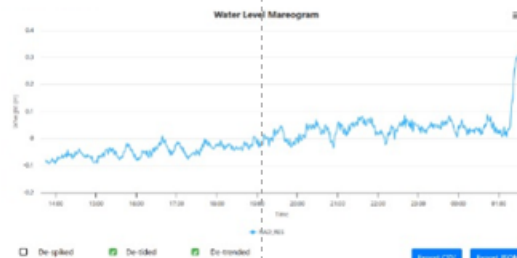
Last Sea Level Anomaly Alerts (Auto Update)

ID	CHANNEL	TS_AIC	TS	WH	LAST_DATA	LEVEL	METHOD	SNR	EVENT_ASSOC	SRC	
1753841881540	TS.SMBJI.RAD	2025-07-30 02:12:30	2025-07-30 02:17:17	-0.228	2025-07-30 02:17:45	7.514	zd	-0.532	None	INT	View
1753841743040	TS.TLBJI.RAD	2025-07-30 02:07:44	2025-07-30 02:13:58	0.152	2025-07-30 02:15:29	7.511	zd	1.663	None	INT	View
1753841541525	TO.ADAK.WLS	2025-07-30 01:55:00	2025-07-30 02:00:00	0.137	2025-07-30 02:06:00	8.021	sl	2.968	None	INT	View
1753840783561	TS.SMBJI.RAD	2025-07-30 01:55:06	2025-07-30 01:59:30	-0.327	2025-07-30 01:59:38	7.585	zd	-0.657	None	INT	View
1753840708610	TO.HANA.RAD	2025-07-30 01:21:00	2025-07-30 01:17:00	0.307	2025-07-30 01:49:00	8.694	sl	1.426	None	INT	View
1753840660871	TS.SMBJI.RAD	2025-07-30 01:48:22	2025-07-30 01:56:30	-0.339	2025-07-30 01:57:32	7.520	zd	-0.704	None	INT	View
1753840352277	TS.SMBJI.RAD	2025-07-30 01:44:33	2025-07-30 01:49:56	-0.256	2025-07-30 01:52:18	7.613	zd	-0.671	None	INT	View
1753839995571	TS.SMBJI.RAD	2025-07-30 01:39:52	2025-07-30 01:44:13	-0.263	2025-07-30 01:46:21	7.538	zd	-0.736	None	INT	View
1753839508857	TS.SMBJI.RAD	2025-07-30 01:31:49	2025-07-30 01:36:56	-0.261	2025-07-30 01:38:20	7.516	zd	-0.819	None	INT	View
1753839388735	TS.TLBJI.RAD	2025-07-30 01:32:38	2025-07-30 01:35:09	0.125	2025-07-30 01:36:15	7.535	zd	0.980	None	INT	View
1753839185732	TS.TLBJI.RAD	2025-07-30 01:24:24	2025-07-30 01:32:11	0.129	2025-07-30 01:32:55	7.510	zd	0.941	None	INT	View
1753838270385	TS.TLBJI.RAD	2025-07-30 01:14:02	2025-07-30 01:15:41	0.135	2025-07-30 01:17:41	7.518	zd	0.949	None	INT	View
1753838132301	TO.NKSK.RAD	2025-07-30 00:50:00	2025-07-30 00:55:00	0.076	2025-07-30 01:06:00	8.938	sl	3.108	None	INT	View

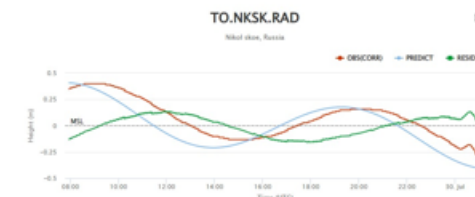
IOC TIDE GAUGE RECORDS



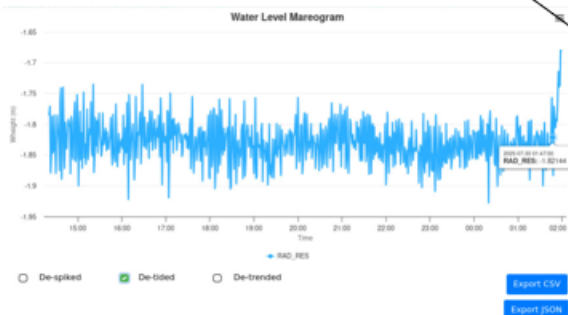
TG Kushiro, Jepang measured 0,1 m at 08:30 WIB



TG Hanasaki, Jepang (TO.HANA) measured 0,3 m at 08:16 WIB



TG Nikol skoe, Rusia (NKSK) measured 0,3 m at 07:17 WIB



TG Ofunato, Jepang measured 0,4 m at 08:47 WIB

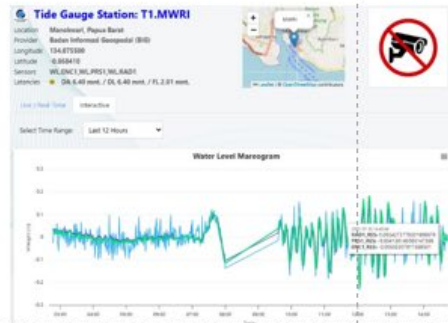


TG IOC Petropavlovsk, Rusia measured 0,1 m at 07:00 WIB

AWS MARITIM, TIDE GAUGE & TSUNAMI GAUGE RECORDS



TG. Sausapor at 21:36 WIB



TG. Manokwari at 21:40 WIB



TG. SARMI at 21:28 WIB



TG. Depapre at 21:35 WIB



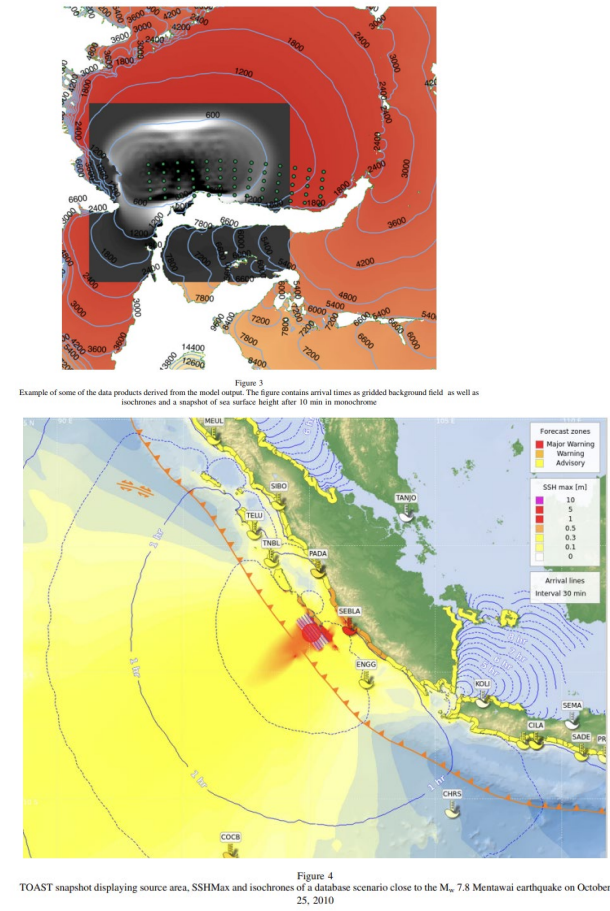
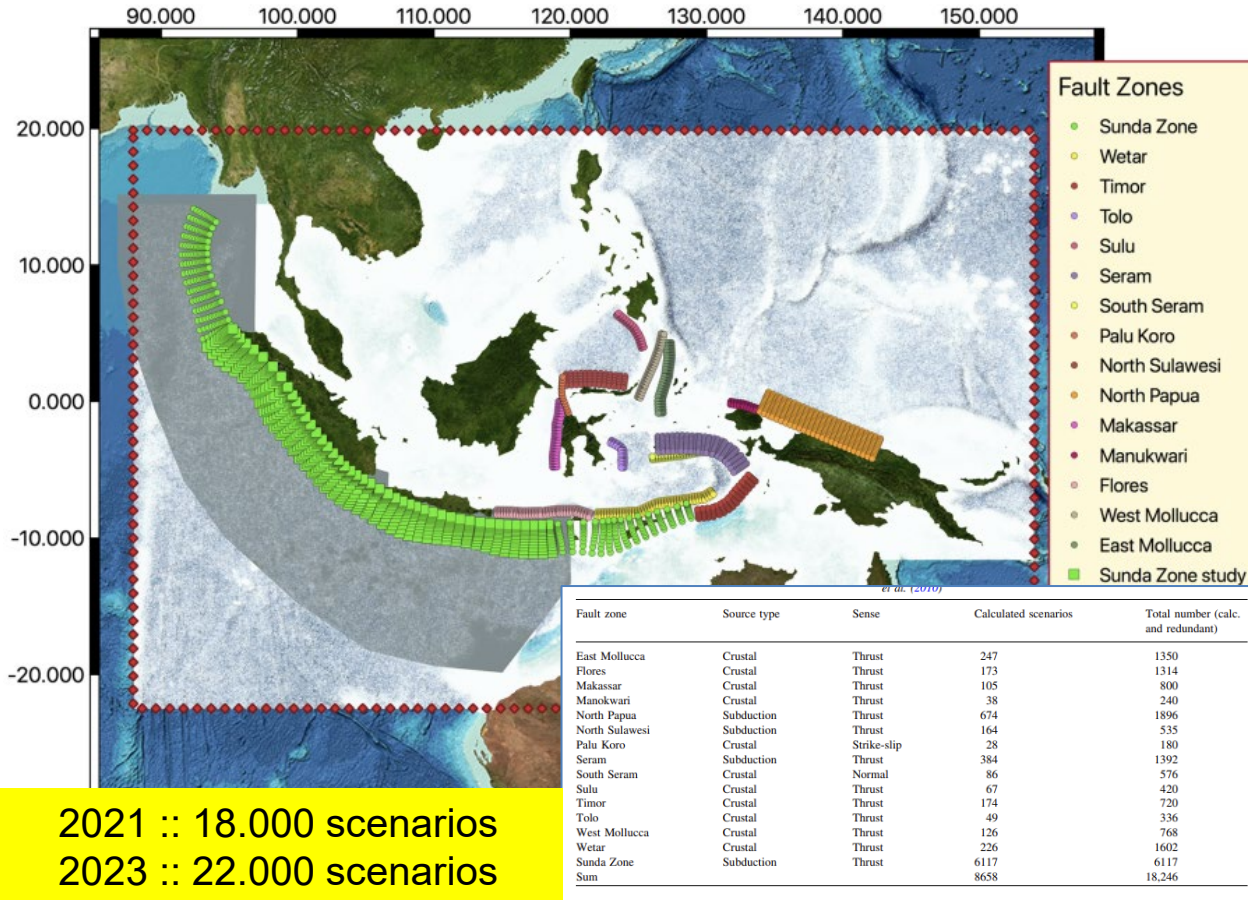
TG. Sorong at 21:38 WIB



TG DOK II at 21:32 WIB

TSUNAMI MODELING DATABASE

TOAST (TSUNAMI OBSERVATION AND SIMULATION TERMINAL)



DISSEMINATION MODES



SMS



Fax



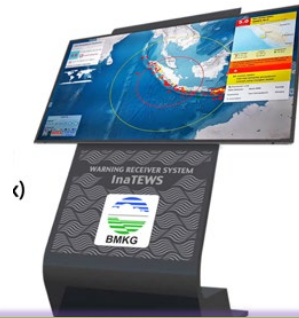
Email



Web



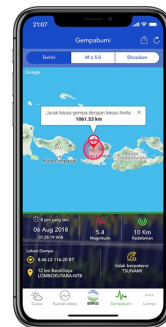
Warning Receiver System



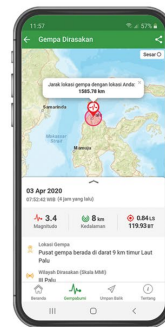
Warning Receiver System New Generation



Smartphone Apps

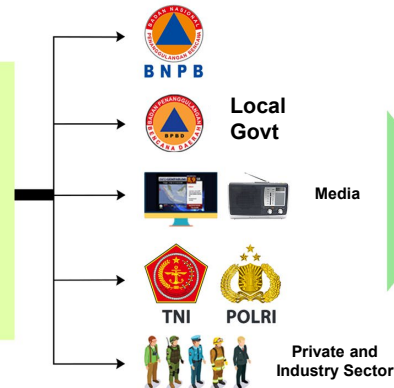


Info BMKG



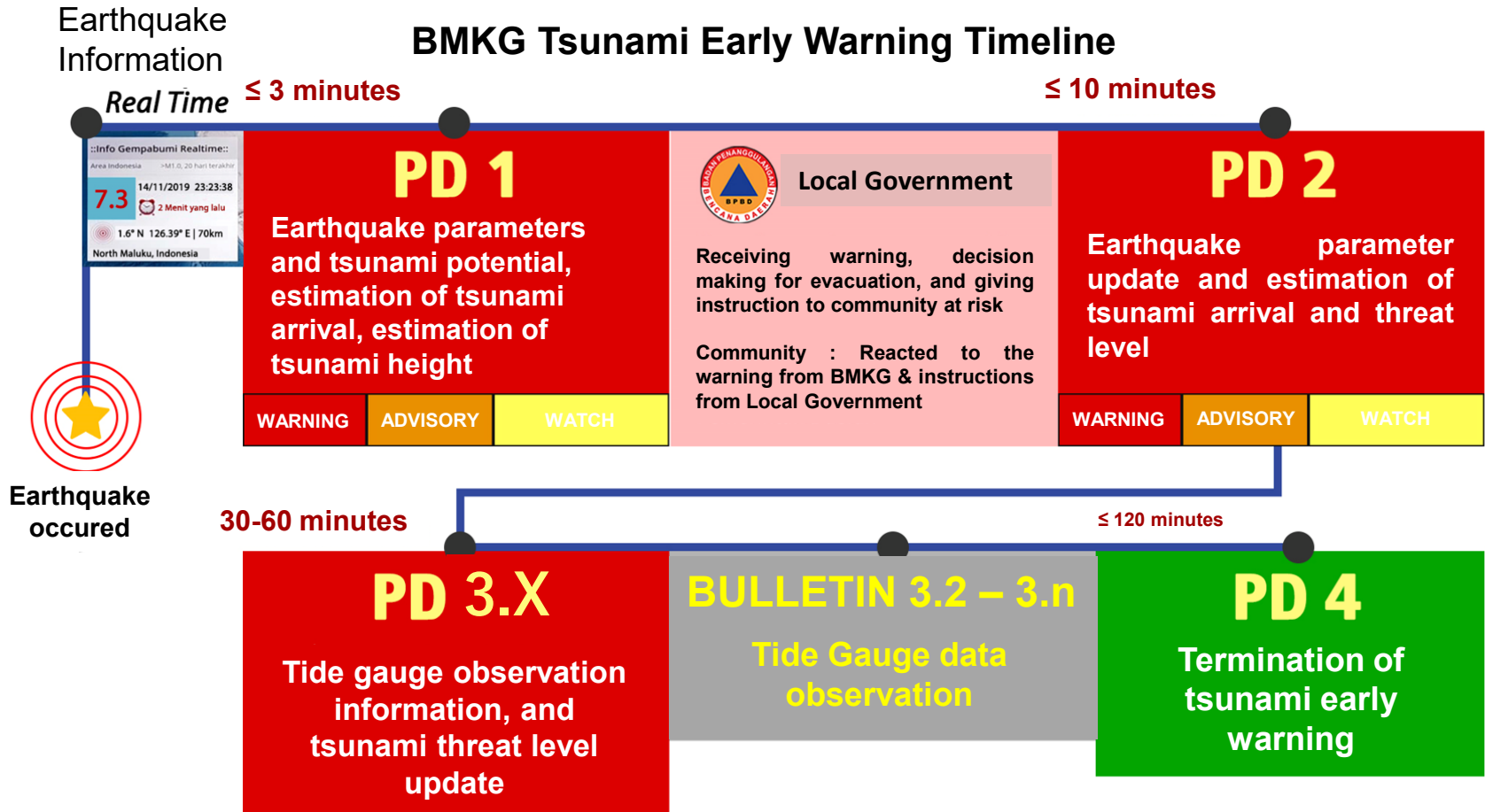
WRS - BMKG

BMKG
Earthquake
Information
and Tsunami
Early Warning



Dissemination Flow

TSUNAMI EARLY WARNING TIMELINE



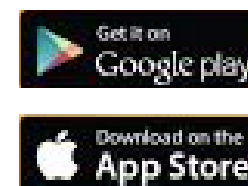
TSUNAMI THREAT LEVEL STATUS

Status	Description
WARNING > 3 M	The Regional Government in "Warning" status is expected to pay attention and immediately direct the public to conduct a complete evacuation . This status indicates a high level of danger, with the potential for waves exceeding 3 meters.
ADVISORY 0,5 -3 M	The Regional Government in "ADVISORY" status is expected to pay attention and immediately direct the public to evacuate. This status indicates a significant level of danger, with the potential for waves between 0.5 and 3 meters.
WATCH 0,25 – 0,5 M	The Regional Government in "WATCH" status is expected to pay attention and immediately direct the public to stay away from beaches and riverbanks. This status indicates a heightened level of caution, with the potential for waves less than 0.5 meters.

EXAMPLE OF INFORMATION ON MOBILE APP WARNING RECEIVER SYSTEM

Tsunami early warning can be received through phone with informative map display and text information, quick and massive.

Application available on Google Play and App Store

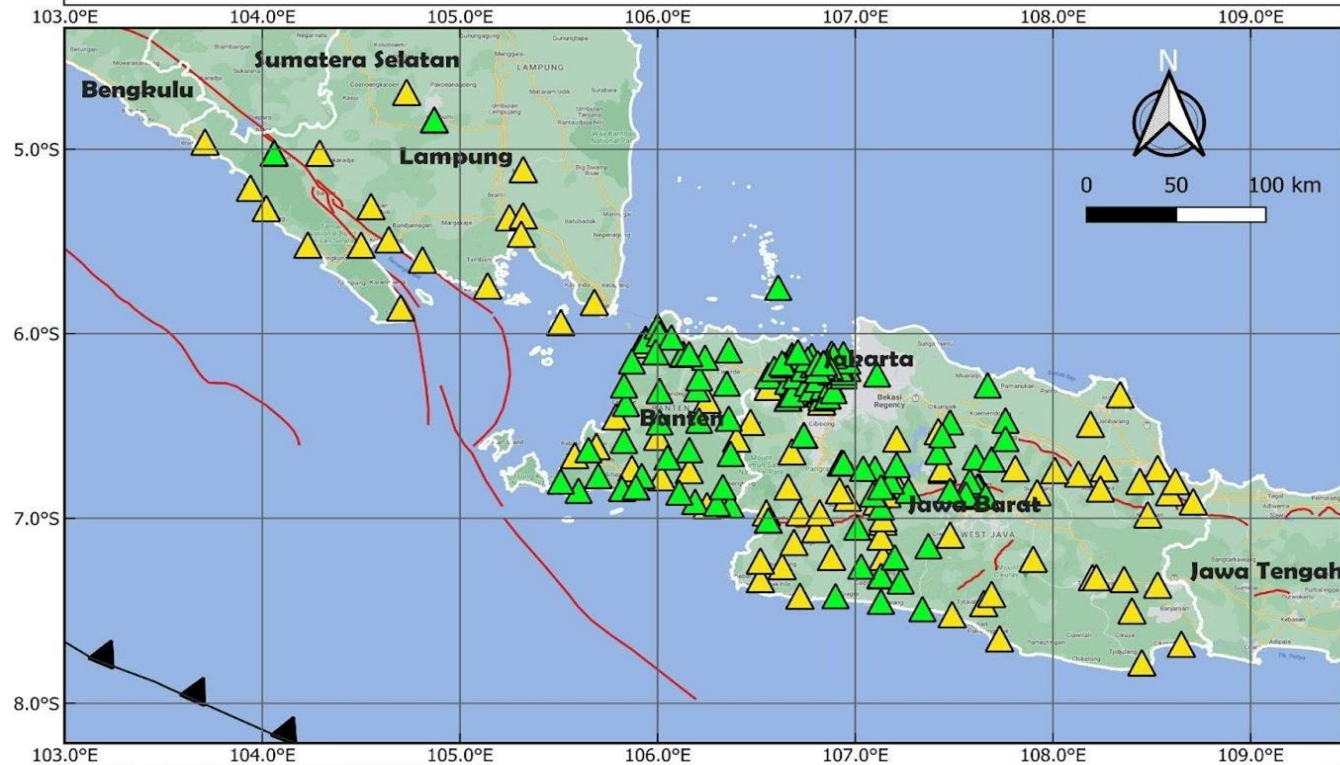


INDONESIA EARTHQUAKE EARLY WARNING SYSTEM



We need to detect seismic events in real time and provide early warning, allowing for timely evacuation and safety measures.

EXISTING SENSOR DISTRIBUTION MAP FOR EEWs PROTOTYPE

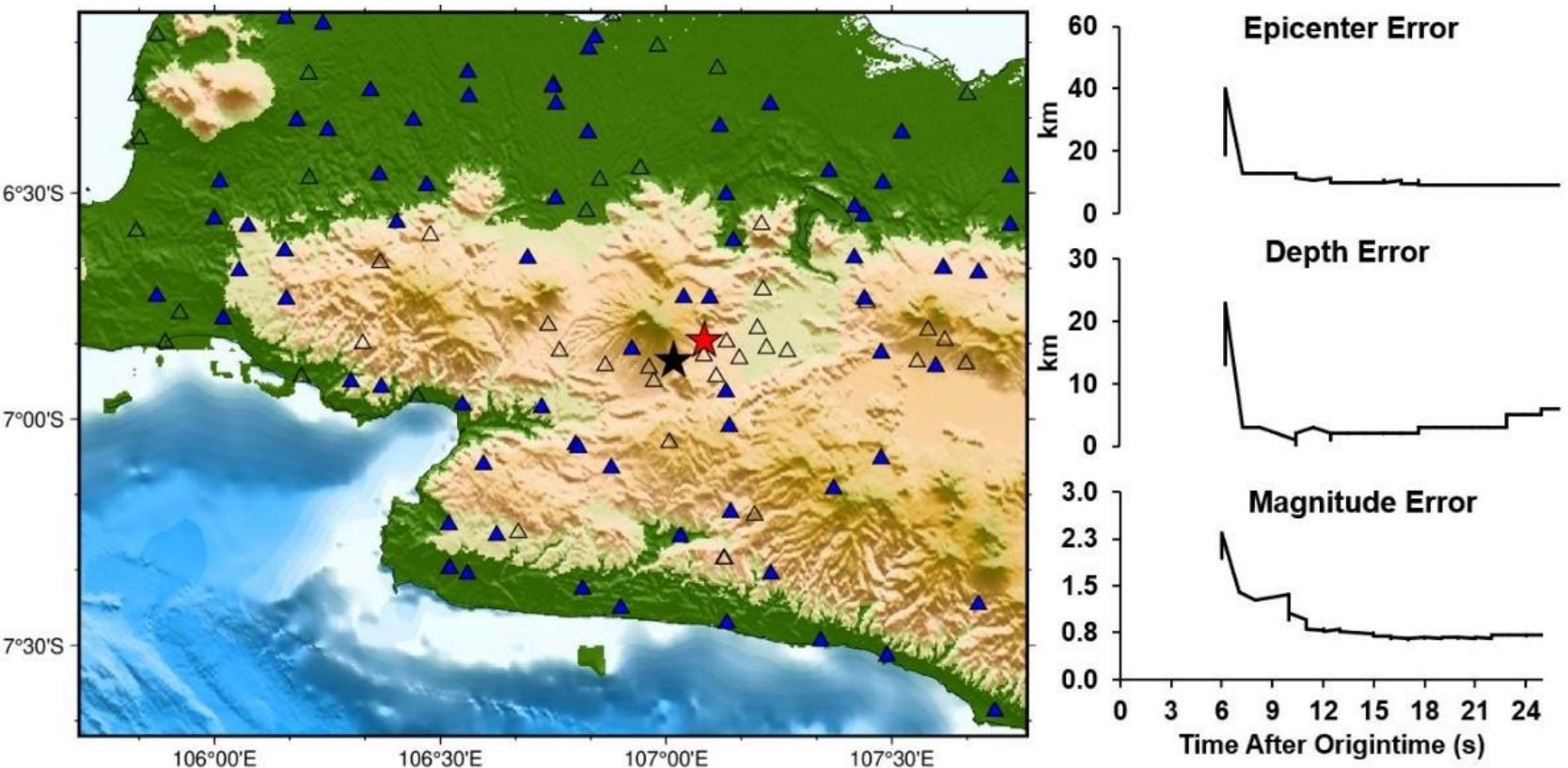


LEGEND

- ▲ Accelerograph
- ▲ Intensitymeter
- Fault
- ▲ Subduction

TOTAL
301
SENSOR

PERFORMANCE EEW ON CIANJUR M5.6 EQ 21 NOVEMBER 2022



- Warning 6 seconds after OT with significant error
- The error decreased gradually and stable after 7.5 seconds (epicenter and depth), and 12 seconds (magnitude)
- Final error: 15km (epicenter), 2km (depth), 0.8 (magnitude)

InaEEWS MONITORING WEBSITE



LATENCY

Berfungsi untuk quality control sensor data latency yang bertujuan memonitoring nilai latency sensor yang digunakan



VERIFIKASI

Berfungsi untuk quality control terhadap true dan false event gempa bumi yang dihasilkan EEWS dan Pusat Gempa Nasional

EEWS MONITORING WEBSITE



RS EEWS

Receiver system yang berfungsi menampilkan event gempa bumi dengan fitur countdown waktu tiba gelombang S. parameter dan nilai MMI gempa bumi



REAL MMI

Menampilkan nilai MMI observasi dari sensor accelerometer dan intensimeter yang merekam sinyal gempa bumi

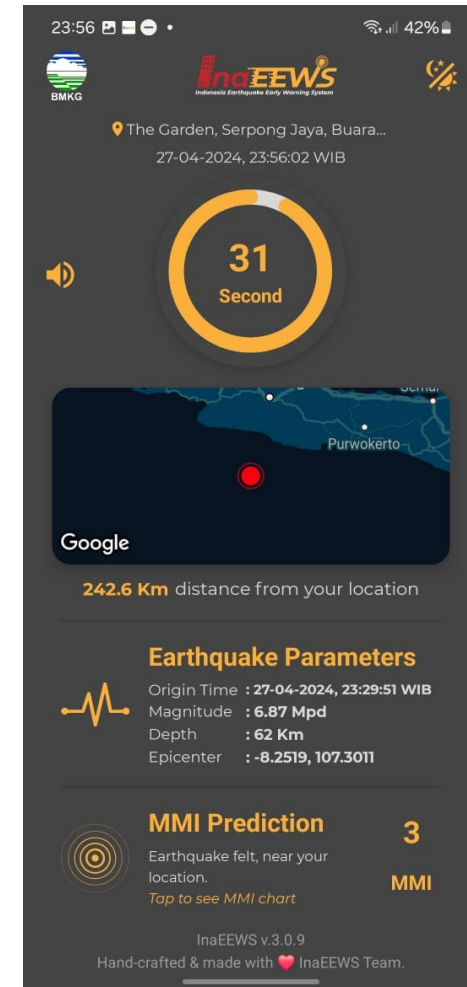
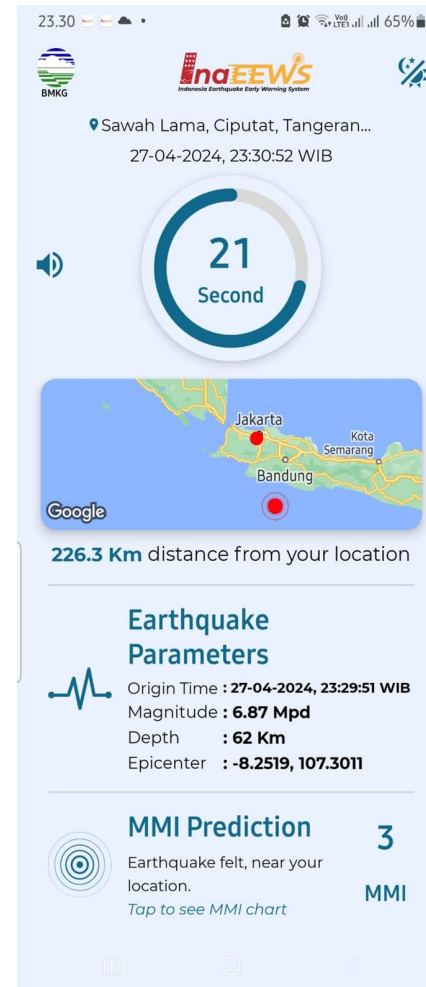


REAL PGA

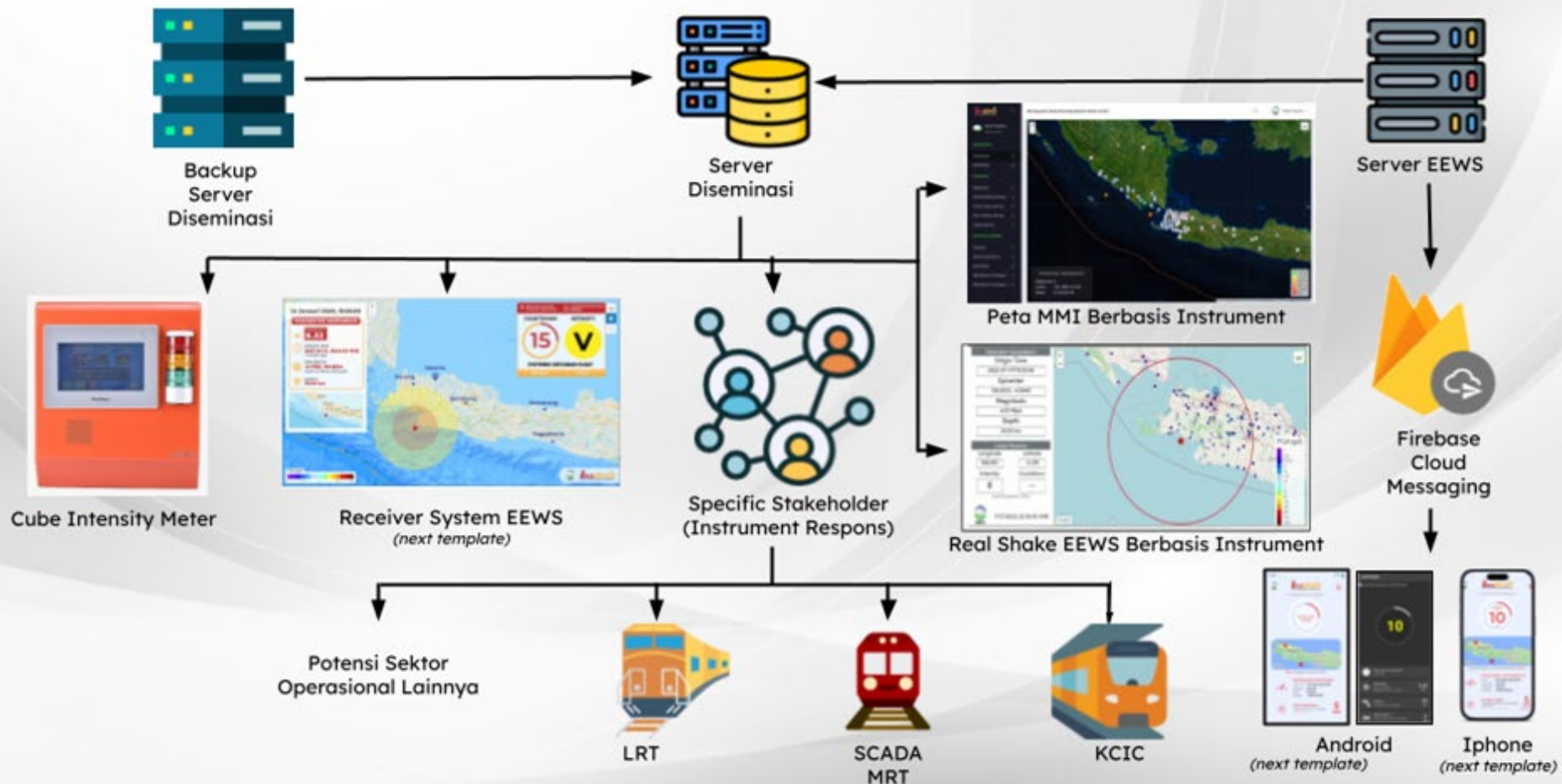
Menampilkan nilai pga disetiap sensor yang direpresentasikan dengan warna dan memberikan informasi parameter gempa bumi

DOCUMENTATION OF DISSEMINATION USING INAEWEWS MOBILE (ANDROID APPS)

- **April 27, 2024 at 23:29:47 WIB (UTC +7)** a tectonic earthquake with a magnitude of **M6.2** occurred in the **Indian Ocean, South of West Java**
- The epicenter of the earthquake was located at **8.39° S** and **107.11° E**, precisely located at sea at a distance of **156 km southwest of Garut Regency, West Java**
- **THE APPS STILL UNDER INTERNAL TESTING**



PLANNED DISSEMINATION



Shared Threat, Shared Solutions

Indonesia (from the Sunda Arc) and Cascadia face similar, time-critical megathrust tsunami threats. Our presentation even utilized TOAST simulation models for an M 9.0 Cascadia event, demonstrating the global nature of this threat and the need for shared solutions.

Offshore Observations are Non-Negotiable

Our experience shows that seismic data alone, while critical for the *initial* warning (now <3 minutes), is not enough. Our network of offshore observations (Buoys, Tide Gauges, CBTs) is crucial for:

- Confirmation:** Providing the "ground truth" that a tsunami has been generated.
- Modeling Accuracy:** Updating wave height and arrival time estimations.
- Building Trust:** Reducing false alarms and enabling timely warning terminations (PD 4)

Key Lesson: EEWS Integration is a Game-Changer

As Cascadia plans its offshore network, we offer a critical lesson from our own development: **integration with an Earthquake Early Warning System (EEWS)**.

- Our InaEEWS can issue alerts in *seconds* (e.g., 6 seconds after the Cianjur EQ).
- This creates a robust, layered system:
 - 1.Seconds-Warning (EEWS):** A shaking alert for self-evacuation *before* the wave's arrival.
 - 2.Minutes-Warning (TEWS-Seismic):** The initial tsunami potential warning based on seismic parameters.
 - 3.Confirmed Warning (TEWS-Sea Level):** An updated, validated warning confirmed by offshore observation data.



THANK YOU

CENTER FOR EARTHQUAKE AND TSUNAMI BMKG