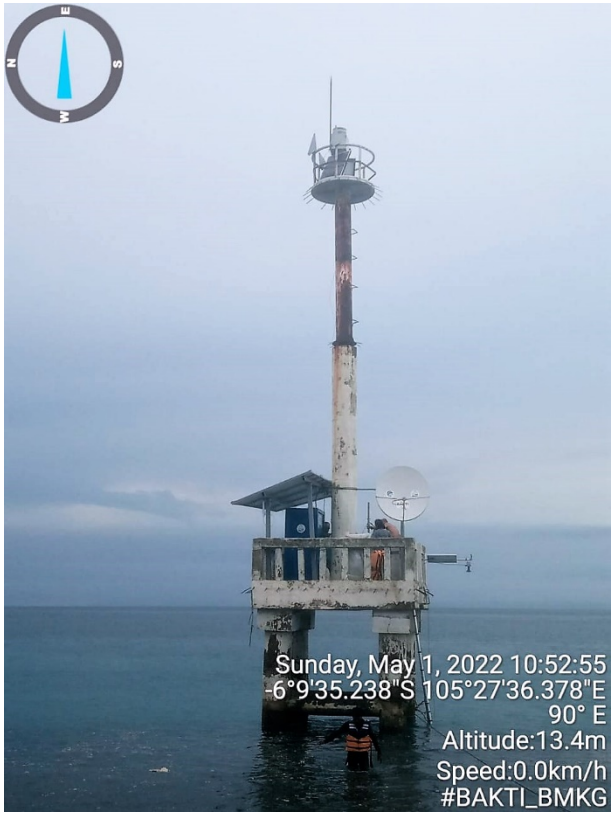
Installation of the Tsunami Early Warning System for the Anak Krakatau Volcano

On 1st May 2022 a collaboration between BMKG, BRIN, BAKTI, PVMBG, BKSDA (MoEF), HUBLA (MoT), IATsI, Balawista and the JRC led to the installation of a new set of devices in one of the closest islands around the Anak Krakatau Volcano. The instruments measure the sea level and transmit the data in real-time to the server so that in case of abnormal sea level height, they will generate an alert and send an email/SMS to BMKG for further warning decision and dissemination.



The installed IDSL device (*Inexpensive Device for Sea Level Monitoring*) is part of a Tsunami Early Warning System for the Krakatoa Volcano and is composed of a series of sensors positioned in the closest islands around the volcano. Once a number of stations identify an alerting condition, appropriate measures for informing the local authorities of a potential Tsunami being generated from the Volcano can be issued.

On 22 Dec 2018. a Tsunami was generated by the collapse of nearly half of the Anak Krakatau Volcano, with waves propagating in all directions inside the Sunda Strait, the sea portion between the Java and Sumatra Islands. The Tsunami caused **437** fatalities. On **24 April 2022**, Anak Krakatau erupted and the ash column reached up to 3,000 m high from the summit of the volcano. National Authorities (PVMBG) raised the Alert Level to III (Standby Phase).

Immediately after the event of 2018, The Marine Research Centre of MMAF (Now part of BRIN), the Indonesian Tsunami Society (IATSI) and JRC-EC installed 2 IDSL devices in **Sebesi** Island and in **Marina Jambu**, the closest locations where GSM communication was available. The current installation at **Rakata island** allows the detection of the waves much earlier, just a few minutes after the initiation of the events. Therefore, the teams involved in the early warning system are confident the devices will be able to provide alerts before the wave reaches populated places across the Sunda Strait and

beyond that had a typical travel time of tsunami from the volcano to the shore around Sunda Straits is in between 20-40 minutes.

The installation of the devices was done on an already existing navigation platform operated under The Ministry of Transportation and it was particularly complex because no communication network was available there. To solve this, BAKTI (The Ministry of Communication and Information) installed a dedicated satellite system that now provides the IDSL instrument (made of 2 devices) internet connection that allows sending high-frequency sea level data in real-time to the server.

In order to strengthen the early detection of tsunami, BRIN, BMKG, JRC, IATsI and The University of Lampung (UNILA) will install 2 units of PUMMA (Perangkat Ukur Murah untuk Muka Air laut) in Panjang island (another island next to Rakata island) in coming weeks. The telecommunication infrastructure (4G) in the island will be provided by PT. Telkomsel tbk. The telecommunication tower in Sebesi island was just constructed in April 2022. PUMMA is the Indonesian version of IDSL, jointly developed and maintained by BRIN, UNILA, and JRC. Additional 2 (two) units of PUMMA will also be ready in 2022 to be installed in Sertung island. The combination of IDSL, PUMMA and BMKG-AWS installed in the Krakatau islands (Rakata, Panjang and Sertung) will provide more “eyes” and “ears” of InaTEWS for better detection of tsunami generated by volcanic activities of the Anak Krakatau Volcano.

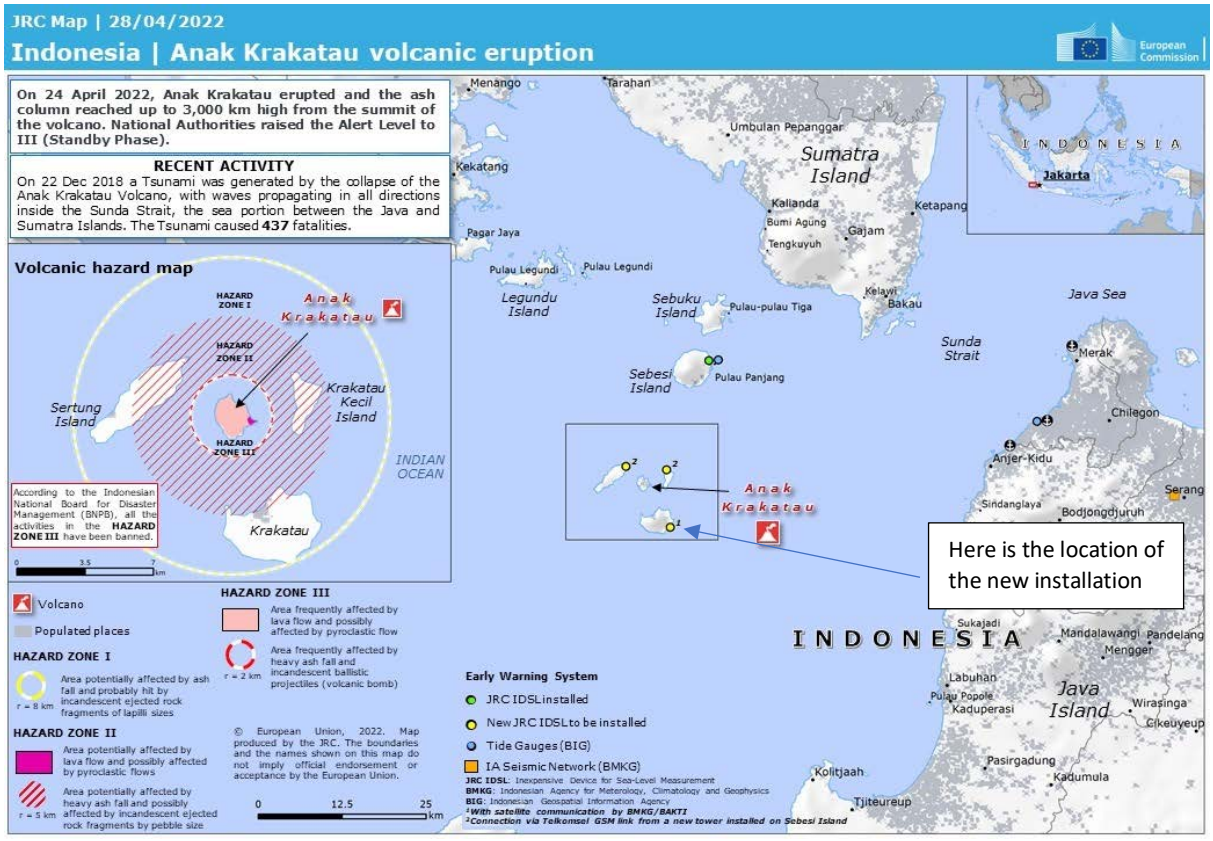


Fig. 1: JRC publication map on the latest eruption of Anak Krakatau

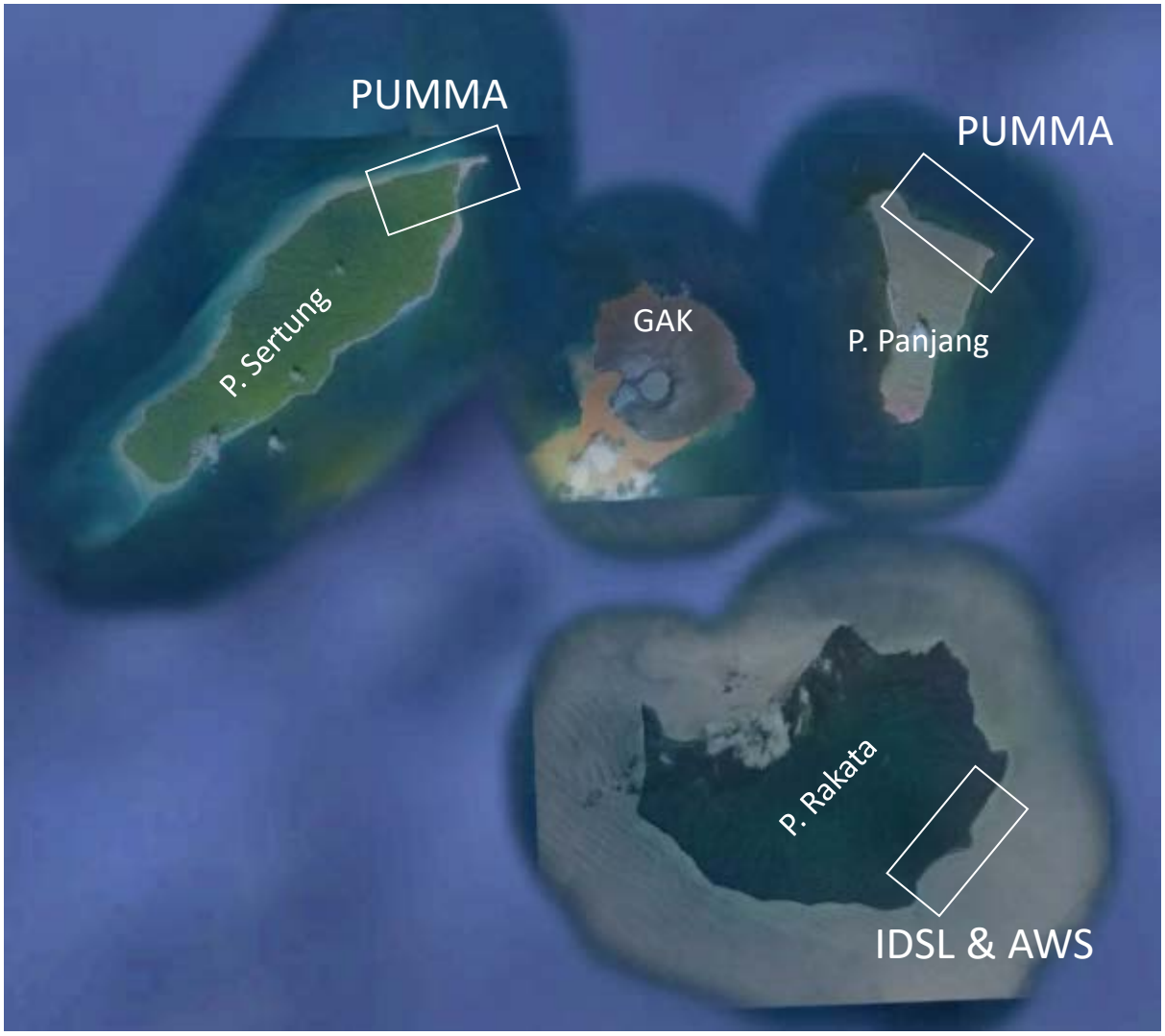


Fig. 2: Log term plan to install early tsunami detection devices (IDSL, AWS, & PUMMA) in the Krakatau Volcanic Islands

Technical details

The satellite communication system built by BAKTI to support data communication for IDSL and BMKG-AWS devices, was positioned in the same location at the HUBLA navigation platform. The satellite communication system technology of BAKTI is the Ku-Band VSAT with bandwidth tailored to the needs of IDSL and AWS-BMKG devices, which is dedicated to 512 Kbps. Ku-band VSAT technology operates in frequency band with uplink width range from 14 GHz to 14.5 GHz, and downlink width range from 10.95 GHz to 11.7 GHz or 11.7 GHz to 12.20 GHz. The advantages of this Ku-Band VSAT technology allow the use of a smaller antenna and lower operating costs than other VSAT technologies such as C-Band. Ku-Band has better data connectivity stability than GSM technology. BAKTI designed this satellite communication system to be integrated with a solar-based independent power system that can last up to 5 days without any sunlight.

The IDSL device, developed by the Joint Research Center of the European Commission (JRC-EC) is a new type of sea level instrument. It is a particularly low-cost device for wide installation and its main feature is a software that detects anomalous waves; sending alerts via SMS and email to a list of

prescribed addresses. It also has a webcam that takes pictures during normal conditions every 2 and 15 minutes when alert conditions are identified. The device has been extensively adopted in the Mediterranean Sea as part of the Regional Tsunami Monitoring system.

The IDSL device includes a Raspberry Pi Linux system, connected with a radar sensor for sea level measurement and a router to communicate with the external world. In this case, the router was not used as the internet connection was provided by the BMKG/BAKTI satellite system. A webcam using a Raspberry nano and a camera sensor is connected in WIFI with the router.

IDSL in Indonesia is a research collaboration between JRC, The Marine Research Centre-MMAF (now part of BRIN) and The Indonesian Tsunami Expert Society (IATSI). Since the firsts installation of 2 IDSL in the Sunda Strait in early 2019, there are now 9 IDSL installed in Indonesia: West Sumatera (2 units), South of Java (4 units) and the Sunda Strait (3 units), including the latest one in Rakata Island of Krakatau. IDSL data and alerts have been incorporated into the BMKG system as the sole authority of tsunami warning in Indonesia (InaTEWS). In the last three years, the installation and the operation of IDSL have been supported by many institutions and universities in Indonesia: Kemenkomarves-RI, BIG, BPPT (now part of BRIN), LIPI (now part of BRIN), Kemenhub-RI, PVMBG-ESDM-RI, Kominfo-RI, BKSDA-KLHK-RI, UNILA Lampung, UNTIRTA Banten, UNSYIAH Aceh, UNIB Bengkulu, Tel-U Bandung, ITB Bandung, IOTIC-IOC-UNESCO Jakarta, Fisheries ports of MMAF, Balawista Pantai Carita, and the Local authorities.

Links:

- Reference: https://webcritech.jrc.ec.europa.eu/TAD_server/Data/Documents/IDSL%20Description.pdf
- The level in real time on IDSL-309: https://webcritech.jrc.ec.europa.eu/TAD_server/Device/634
- The latest webcam image: https://webcritech.jrc.ec.europa.eu/TAD_server/api/Device/IDSL-309/Webcam/Latest
- The latest timelapse: https://webcritech.jrc.ec.europa.eu/TAD_server/api/Device/IDSL-309/webcam/TimeLapse/

Fig. 3: One of the images of the webcam taken by the IDSL-309 device