unesco

Intergovernmental
Oceanographic
Commission

IOTWMS Optimal Observing Networks

Seismic, Sea-level and GNSS

Januar Arifin
Januar.Arifin@bmkg.go.id

Yedi Dermadi
yedi.dermadi@bmkg.go.id

Acknowledgements:
S.K. Tummala, Nora Gale, Padmanabham J., Robert Greenwood

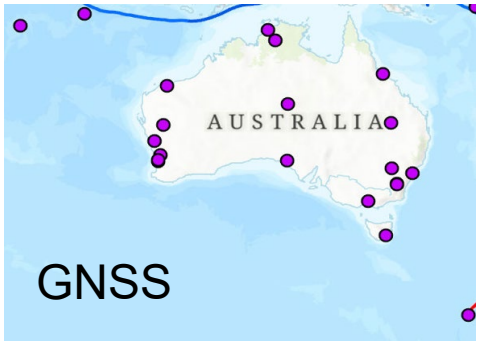
Outline of presentation

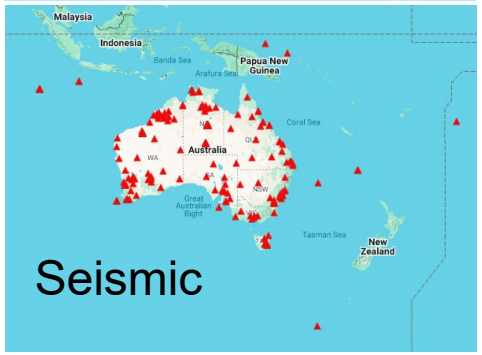
1. IOTWMS Observational Networks-TSPs coverage
2. IOTWMS Seismic Network since 2004
3. IOTWMS Sea-level Network coverage since 2004
4. ODTP Goals , Challenges, Way forward.
5. Discussions?

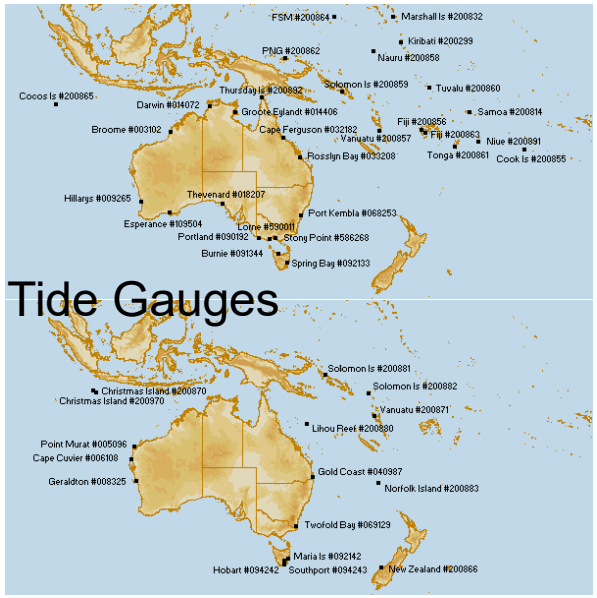
unesco
Intergovernmental
Oceanographic
Commission

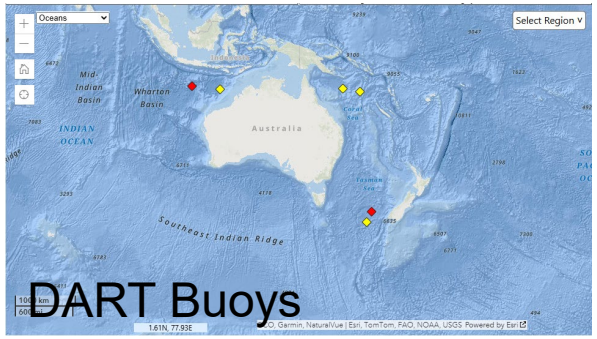
IOTWMS Observational Network – TSPs coverage

TSP-AUSTRALIA







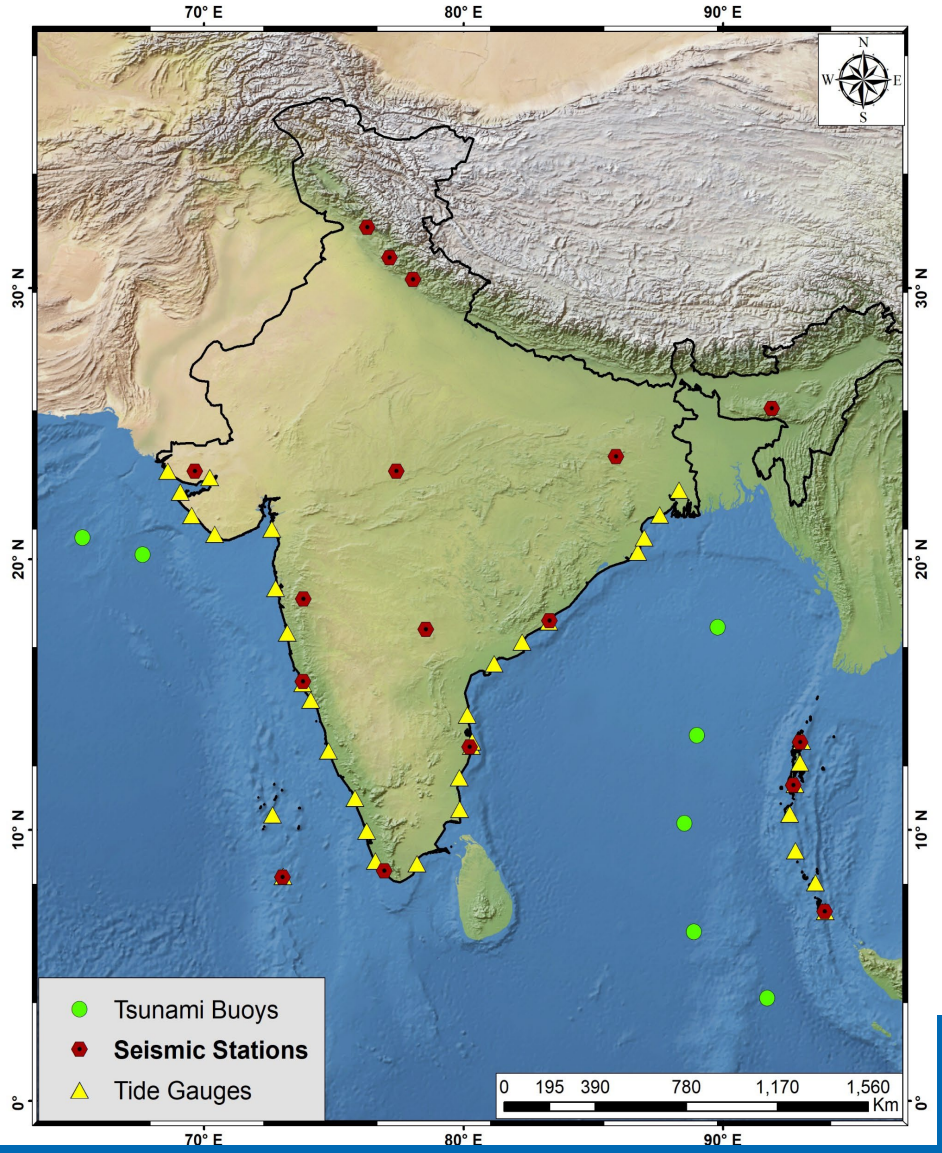


TSP-AUSTRALIA is operated by the **Joint Australian Tsunami Warning Centre (JATWC)**, jointly operated by **Geoscience Australia (GA)**, Canberra and the **Australian Bureau of Meteorology (BOM)**, Melbourne and Brisbane.
The Australian Government shares open, real-time seismic, GNSS and sea level data for the purpose of tsunami monitoring.

- GA operates seismic and GNSS networks.
  - 90 broadband seismic stations, including stations on Niue, Manus, Rabaul, Lord Howe Is., Norfolk Is., Christmas Is., Cocos (Keeling) Is., and Macquarie Is. – **all shared via IRIS/Earthscope**
  - 20 GNSS stations – **all shared via IGS**
- BOM operates tide gauge and tsunameters (DART).
  - 46 Tide gauges – **Shared 44 stations data to IOC Sea level**
  - 6 Tsunami Buoys – **shared all buoys data to NDBC portal and IOC Sea level**

IOTWMS Observational Network – TSPs coverage

TSP-INDIA

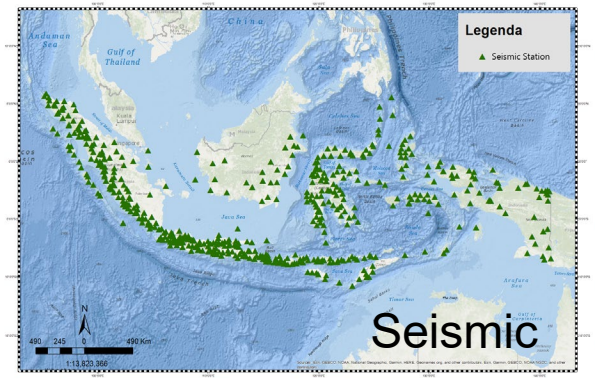


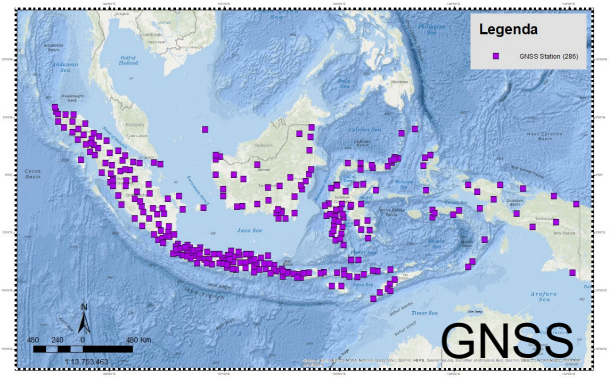
TSP-INDIA is operated by **Indian Tsunami Early Warning center** located at **INCOIS**, Hyderabad.

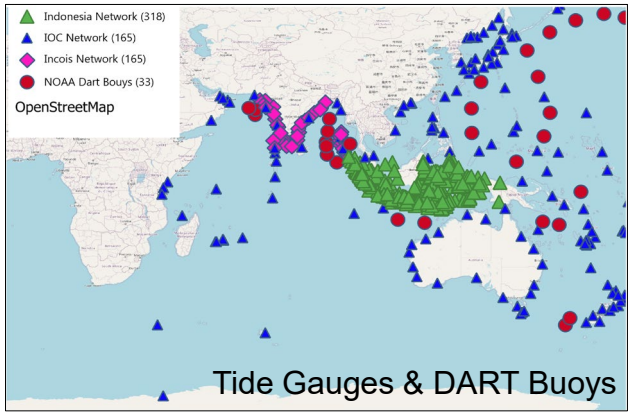
- INCOIS receives openly available Seismic (IRIS, GEOFON), Sea level data (GLOSS/IOC Sea-level/NDBC) sources for the purpose of tsunami monitoring.
- As NTWC, they operate Seismic, Tide Guage Network, Tsunami Buoys and GNSS networks.
- 17 broadband seismic stations– **Shared 4 broadband seismic stations**
- 35 Tide gauges – **Shared 8 stations data to IOC Sea level**
- 5 Tsunami Buoys – **shared all buoys data to NDBC portal**
- 35 GNSS & SMA stations of Andaman & Nicobar Islands

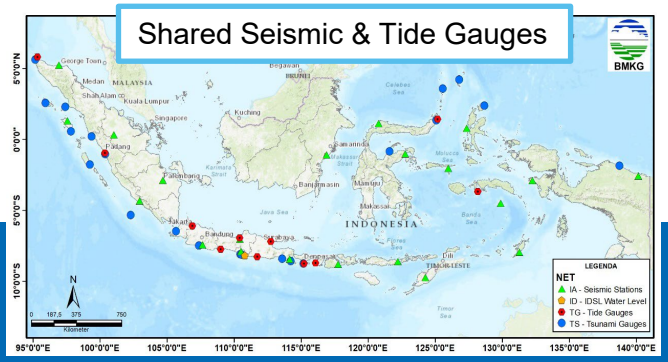
IOTWMS Observational Network – TSPs coverage

TSP-INDONESIA







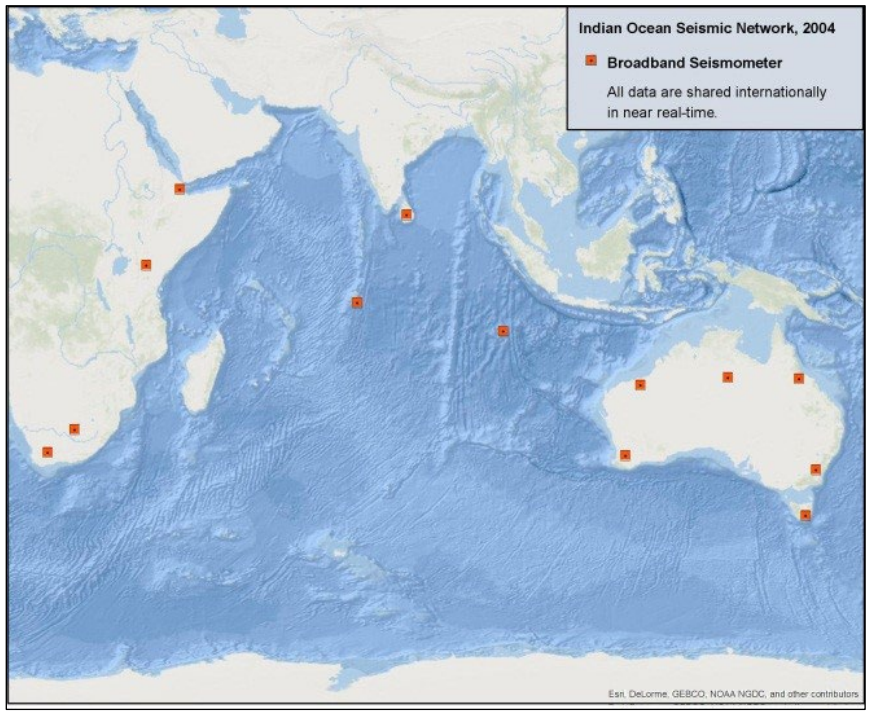


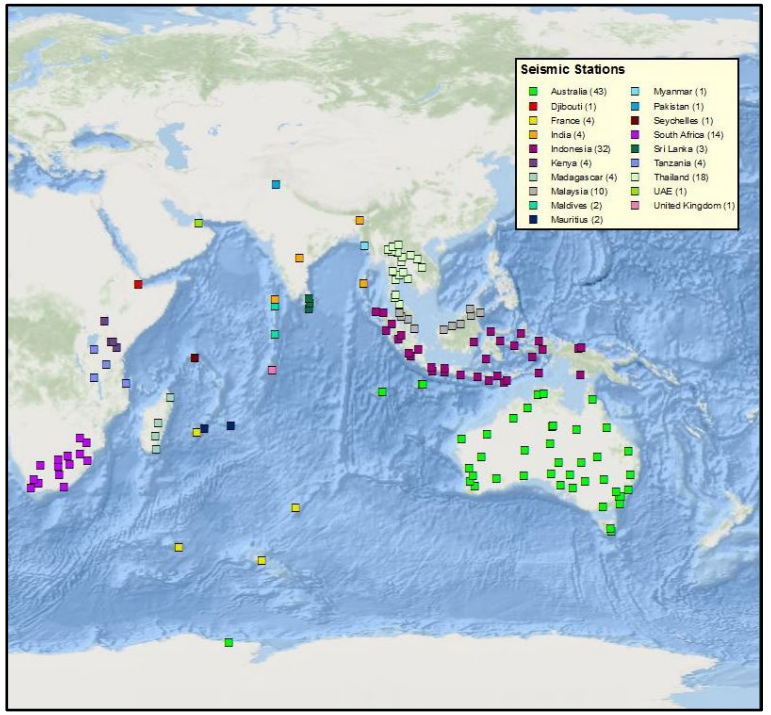
TSP-INDONESIA is operated by **Indonesia Tsunami Early Warning (InaTEWS)** located at **BMKG**, Jakarta.

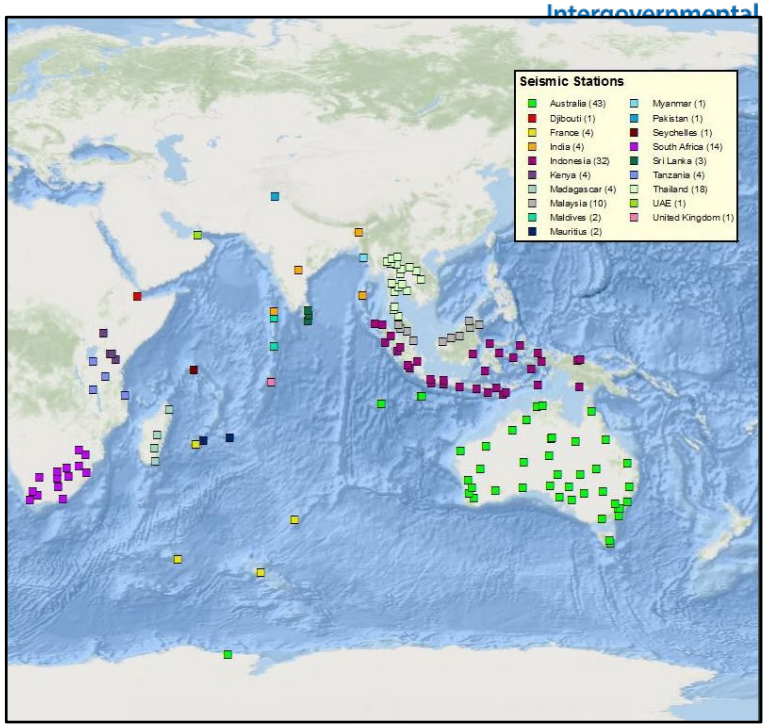
- InaTEWS-BMKG retrieves shared global seismic data (GEOFON, IRIS), and sea level data (GLOSS-IOC, NOAA, JRC, INCOIS) for the purpose of tsunami monitoring.

- BMKG operates:
  - 533 broadband & short period seismic stations– **Shared 21 broadband seismic stations**
  - 106 Tsunami Gauges – **Shared 21 stations data to IOC Sea level**
  - 35 Maritime Automatic Weather Station (AWS) as auxililary water level stations
- As supported members of **InaTEWS**, **BIG** contributes 258 Tide Gauges & 286 GNSS; **BRIN** 7 InaBuoys, 1 InaCBT and 11 IDSL.
- In 2025, BMKG successfully installed 100 Tsunami Gauge Stations, specifically designed to detect both seismic and non-seismic tsunamis through high-frequency real-time data, supplemented with CCTV and real-time air pressure sensors for volcanic meteotsunami detection.
- BMKG consolidated all sea level observations into a single monitoring platform, InaTNT, enabling streamlined access and rapid analysis.
- Encouraging member states to build capacity for generating and sharing sea level data, fostering regional cooperation in tsunami monitoring and early warning systems

IOTWMS Seismic Network



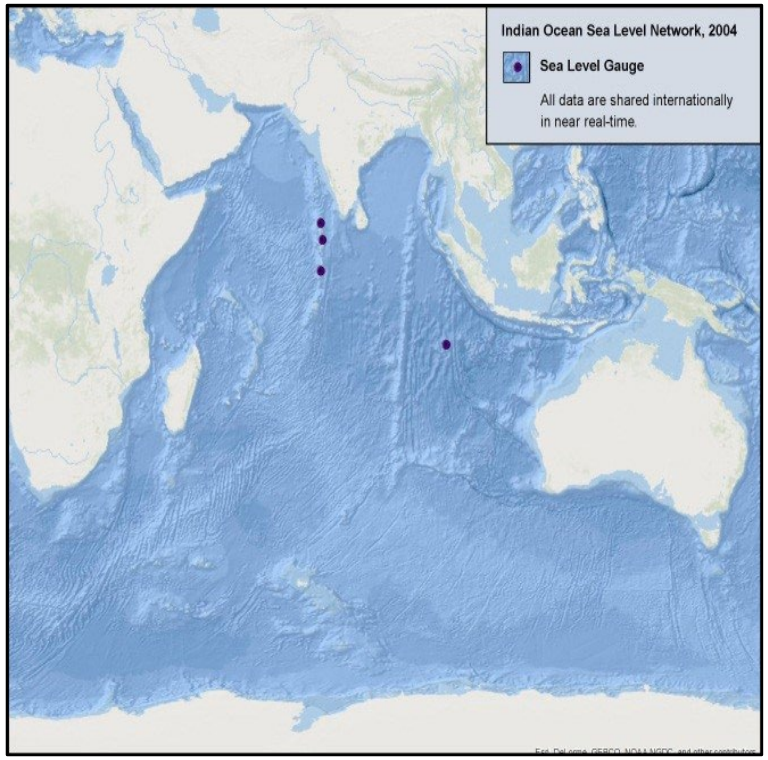




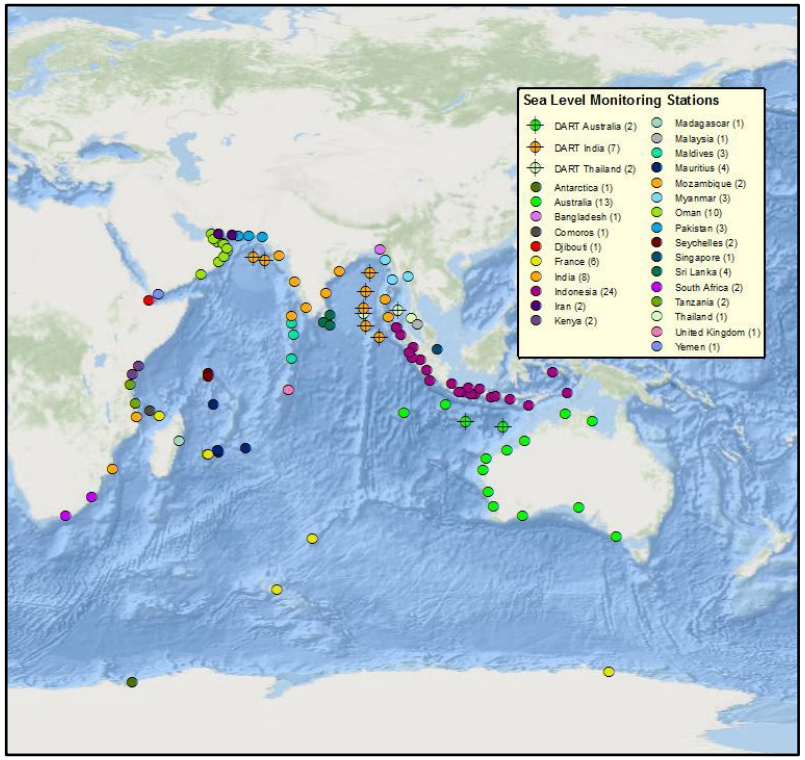
2004 **2017** **Same as 2017**

- Seismic stations are essential for rapid detection of tsunami-genic earthquakes.
- The current network is not sufficient to fully meet IOTWMS requirements.
- Improved data sharing in NWIO and SWIO regions is critical to reduce detection time.
- GNSS data may be needed to be shared in the IOTWMS AOS region

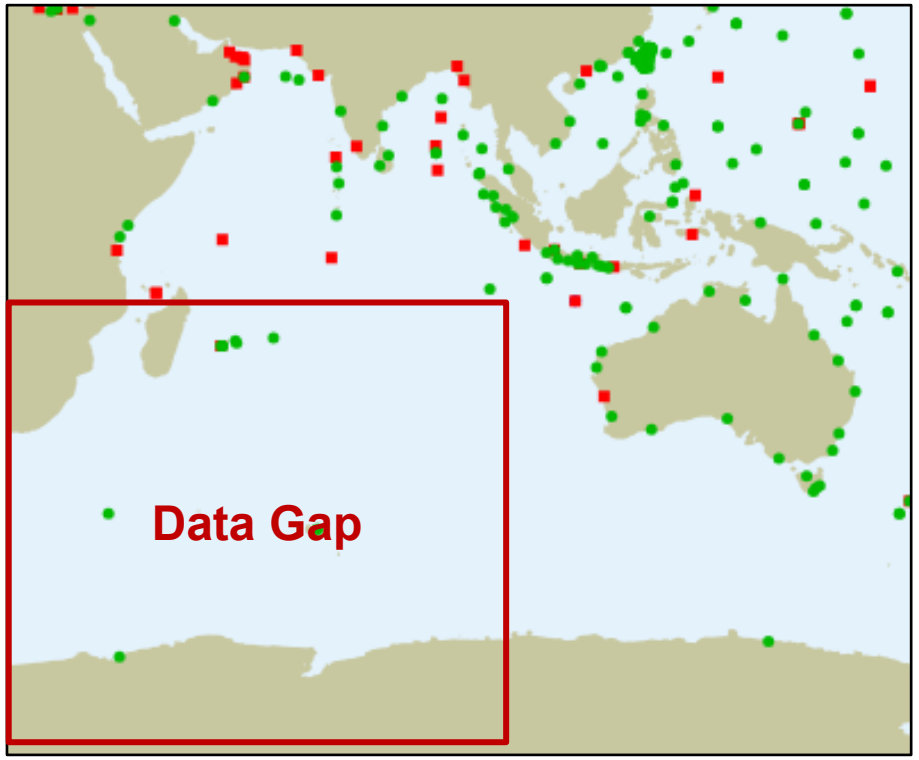
IOTWMS Sea-level Observational Network



2004



2017



IOC Sea Level Monitoring Facility what it currently shows for IOTWMS region.

- Sea-level stations are critical for rapid tsunami detection and confirmation.
- The current network is insufficient to meet the ODTP goal of confirming threats within 10 minutes.
- Greater data sharing from IOTWMS Member States is essential to strengthen monitoring.
- Upgrading sampling rates from 1-minute to 15/30 seconds is needed for faster detection and reporting.

ODTP – Ocean Decade Tsunami Program- Goals- NETWORKS

unesco
Intergovernmental Oceanographic Commission

The ODTP aims to deliver confirmed, actionable tsunami warnings to all at-risk coasts within 10 minutes of origin.

Why is the 10-Minute Target Challenging?

- **Proximity of Sources:** Tsunami-genic earthquakes often occur close to coastlines, leaving only minutes to act.
- **Sensor Gaps:** Sparse coverage of tide gauges and deep-ocean sensors.
- **Data Latency:** Transmission, validation, and processing delays.
- **Modeling Limits:** Rapid, reliable forecasts need high-quality real-time inputs.

Solution : *To design the Optimal Notional Network Solution for 10-Minute Tsunami Warning in Indian Ocean Region*

- **Dense Sensor Network:** Strategically deploy near-shore, deep-ocean, and coastal detectors using optimization algorithms to cover high-risk seismic zones.
- **Real-Time Data Sharing:** Enable direct, automated exchange between national and regional centers with interoperable protocols.
- **New Technologies:** Use SMART subsea cables, GNSS stations, and machine learning for rapid detection and modeling.
- **Targeted Investments:** Identify and fill gaps in coverage; sustain regional collaboration under ICG/IOTWMS.

unesco
Intergovernmental
Oceanographic
Commission

THANK YOU