Tsunami Hazard Assessment

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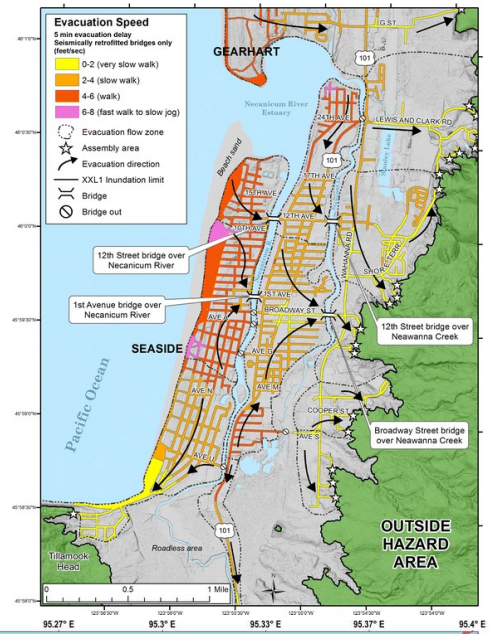
Meeting of

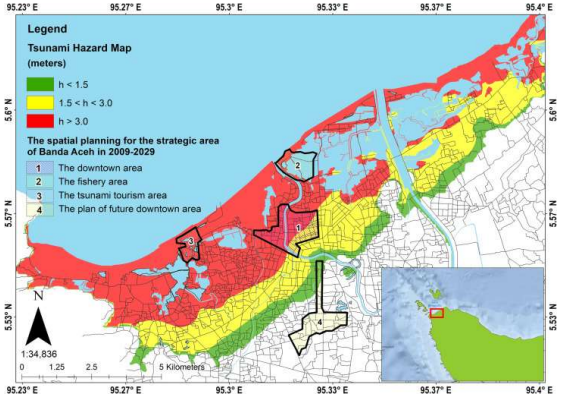
ICG/IOTWMS Working Group-1 on "Tsunami Risk, Community Awareness & Preparedness"

23 July 2025

Why tsunami hazard assessment?

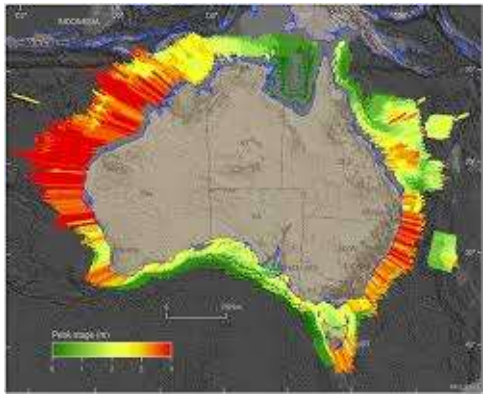
- Assessment of the coastal zones exposed to tsunamis
- Communities and infrastructure vulnerable to Tsunamis
- Coastal zone management
- Development of resilient coastal communities
- Tsunami ready





Advantages of PTHA

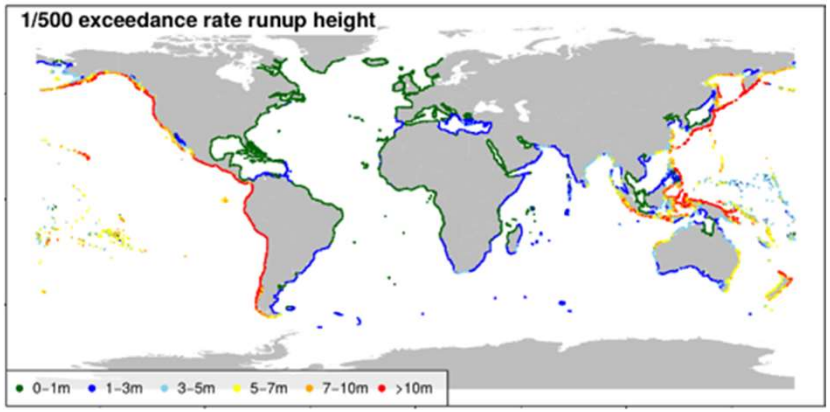
"The PTHA provides evidence-based scientific information to guide the design of earthquake-tsunami scenarios for onshore hazard assessments"



Earlier works related to PTHA

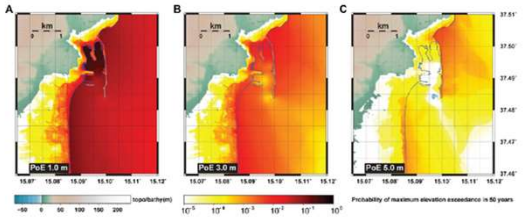
- Previous Global Tsunami Hazard models
- TSUMAPS-NEAM hazard model: **North-eastern Atlantic, the Mediterranean, and connected seas**
- Australian PTHA
- ChEESE1P/Geo-INQUIRE – local hazard workflow
- Global Earthquake Model (GEM) source model?

Davies et al. (2018), Geological Soc London



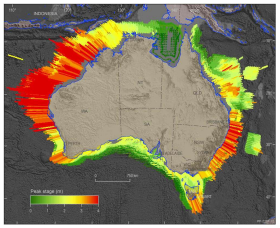
GAR Global Assessment Report on Disaster Risk Reduction 2015

TSUMAPS NEAM Probabilistic TSUnami Hazard MAPS for the NEAM Region



Gibbons et al. (2020), Frontiers Earth Science

OQ OPENQUAKE calculate share explore



Geo-iNQUIRE

UNESCAP Project

Improving risk knowledge through the development of PTHA for NWIO

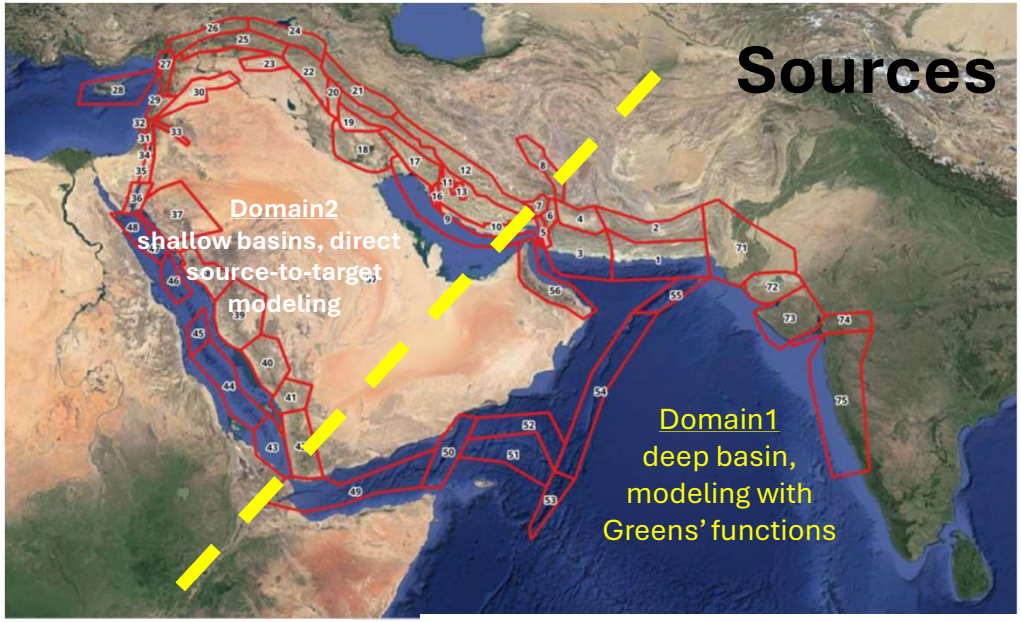
Objectives

- Updated source uncertainty treatment (variable area, stochastic slip, depth-dependent subduction zone properties)
- Higher density output
- Scalable (from global to local) PTHA at any location worldwide
- Integration with OpenQuake
- Plan to include tides, sea-level change

Outcomes

- *Seismic sources*: include crustal seismicity out of Makran subduction (smaller Mw but locally dangerous)
- *Geographic Coverage*: consider the entire coast of the Arabian Sea but also, for the first time, Persian Gulf and the Red Sea
- Provide consistent and sustainable database for later use in e.g. inundation modeling
- To make a model under the supervision of the GTM-experts

Wave heights at POIs

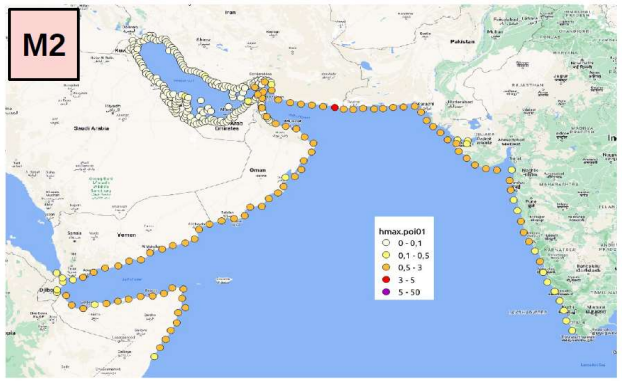


Maximum modeled wave heights (deterministic)

A. Babeyko: PTHA for NWIO

UNESCAP TTF-29 Phase 2, final meeting in Abu-Dhabi, Nov 14-16, 2022

Maximum expected 500 years wave height (probabilistic)



A. Babeyko: PTHA for NWIO

UNESCAP TTF-29 Phase 2, final meeting in Abu-Dhabi, Nov 14-16, 2022

Probability of h>1 meter within next 50 years

A. Babeyko: PTHA for NWIO

UNESCAP TTF-29 Phase 2, final meeting in Abu-Dhabi, Nov 14-16, 2022

Conclusions of the UNESCAP project

- ❑ PTHA incorporates sources besides the Makran subduction: all possible crustal sources along the Arabian and Red Seas and Persian Gulf (following PSHA zonation). ~ 5 000 000 sources
- ❑ Assessment along the entire coast of the Arabian and Red Sea and Persian Gulf with high density of points-of-interest
- ❑ Two alternative probabilistic models: “optimistic” following PSHA and “pessimistic” with upgraded Mmax and unsegmented Makran plate interface
- ❑ Hazard strongly depends on model assumptions. More alternatives should be tested to fairly estimate uncertainties
- ❑ Constraints on focal mechanism are weak (few CMT observations in many zones): may considerably over-weight physically less realistic BS scenarios

This work need to be extended for additional sources that were updated recently

People-Centred Tsunami early Warning for the Indian coastlines (PCTWIN)

To realise the desired objectives and impact, **PCTWIN** is divided into three work packages:

WP1 Knowledge Hub (Lead NGI) will unravel the fundamental physics and processes of earthquake and landslide tsunamis, to improve baseline tsunami hazard, exposure, and risk information (obj#1).

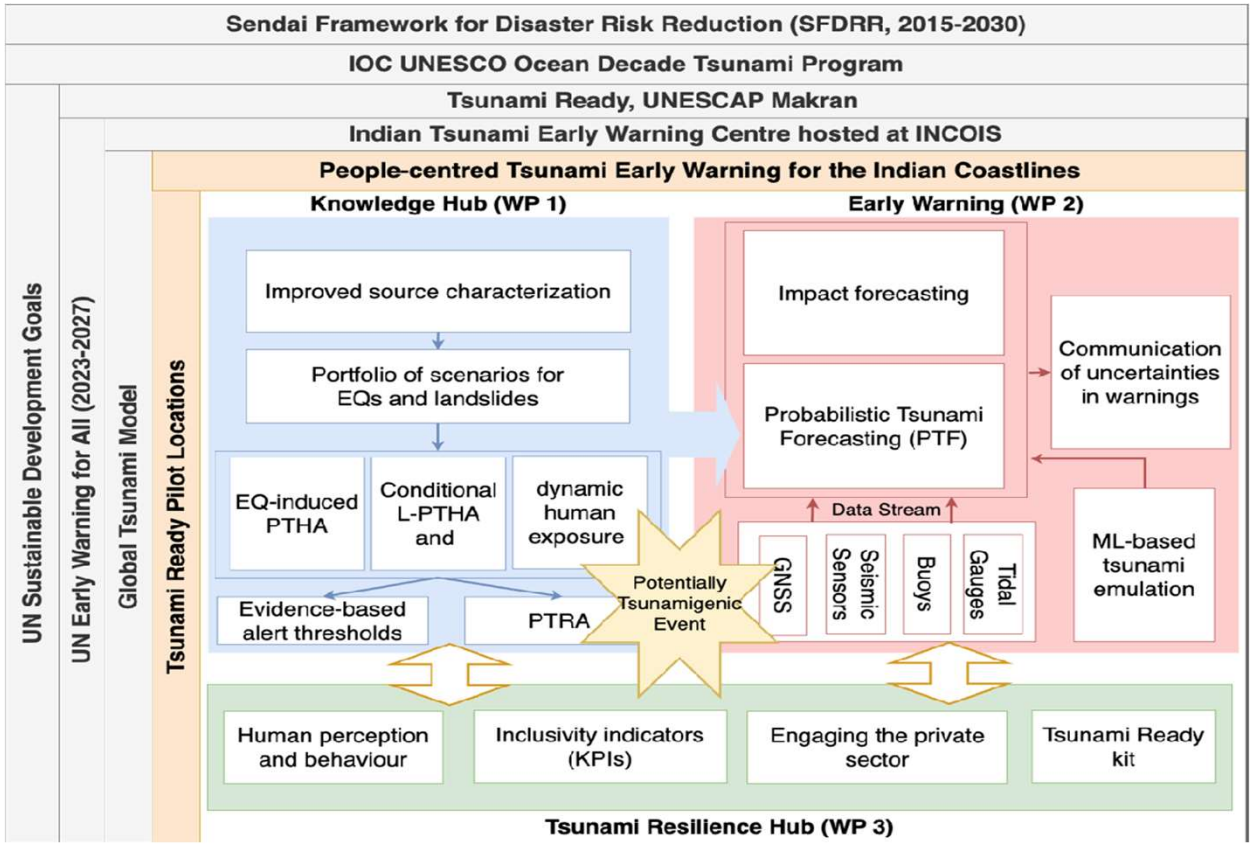
WP2 Early Warning (lead INCOIS) is the operational core of the project. It aims to improve and boost the technical and operational capabilities of ITEWC at the national level and the IOTWMS at the regional level (***obj#2***).

WP3 Resilience Hub (Lead UCL) focuses on participatory activities aiming at increasing public awareness and the level of preparedness of communities to respond to tsunamis (***obj#3***).

PCTWIN Framework

WP-1 Objectives

- Develop tsunamigenic source models for use in hazard and risk analysis
- Carry out tsunami simulations for the source portfolio
- Probabilistic analysis – aggregate probabilities
- Exposure and risk analysis
  - Integrate PTHA outputs
- Local and regional analysis



Overview of tasks

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T1.1 Fundamentals of Earthquake Physics (**UE**, INCOIS, ISR, EOS)

- Understanding locking potential and coupling of Sumatra Andaman from GNSS data

•T1.2 Tsunamigenic seismic sources and scenarios (**ISR**, UE)

- Provide an earthquake tsunami source portfolio relevant for India
- Focus on lesser known tsunamigenic zones

•T1.3 Tsunamigenic landslide Sources and scenarios (**NGI**, INCOIS, IOC-UNESCO)

- Describe past events
- Provide a portfolio of tsunamigenic landslide sources

•T1.4 Probabilistic tsunami hazard analysis (**INCOIS**, ISR, NGI, UMA, GFZ, IOC-UNESCO)

- National level PTHA map – earthquakes
- High resolution at selected locations
- Screening of hazard potential / conditional probabilities – landslide tsunamis

•T1.5 Exposure mapping (**UCL**, INCOIS, NGI)

- Dynamic exposure, new data sources for diverse set of assets (e.g. schools, hospitals)

•T1.6 Probabilistic tsunami risk analysis (**UCL**, INCOIS)

- Integrating national PTHA with exposure data

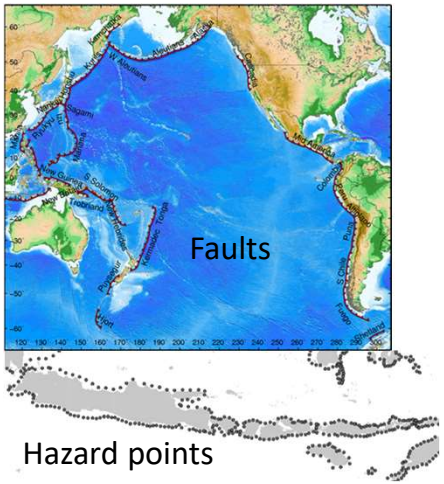
The aim of the WP – provide inputs to hazard and risk analysis
Tsunami hazard and risk analysis methods in a nutshell

Probabilistic hazard analysis - PTHA

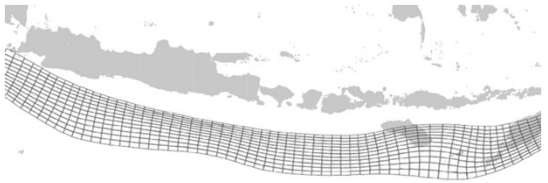
- Define sources and events probabilities
- Create events with associated rates
- Define hazard Points of Interest (POIs)
- Simulate the wave propagation (and inundation)
- Associate tsunami heights at the POIs with event probability and quantify the hazard

Risk and impact

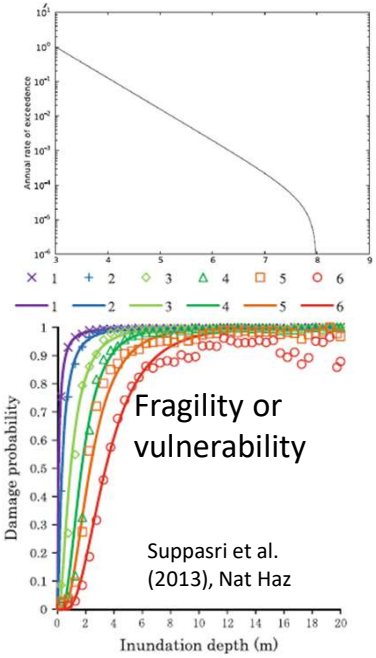
- Integrate inundation area with exposure
- Assign vulnerability to each exposed asset
- Compute Loss and risk metrics

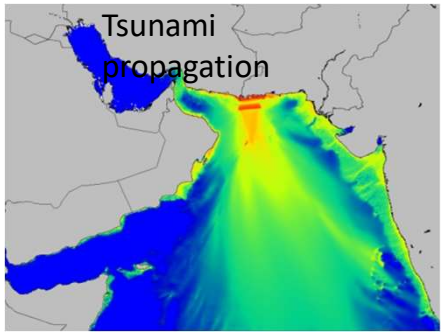


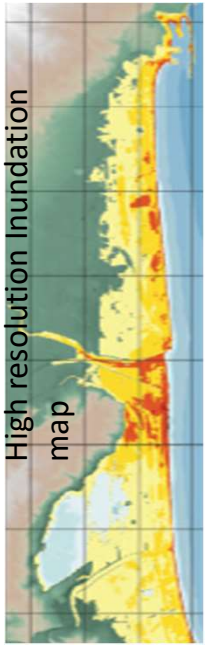
Unit sources



Hazard curves







Courtesy – Geoscience Australia

Way forward

- Hazard assessment for IO member states (leverage on PCTWIN)
- Prioritize member states or study sites in Phase-1
- Extent of modelling domain to be considered
- Sharing of results with member states
- Resource mobilization in the selected member states
- Capacity Building on hazard assessment

Thank you