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Hazard & Inundation Maps

Approaches and Requirements

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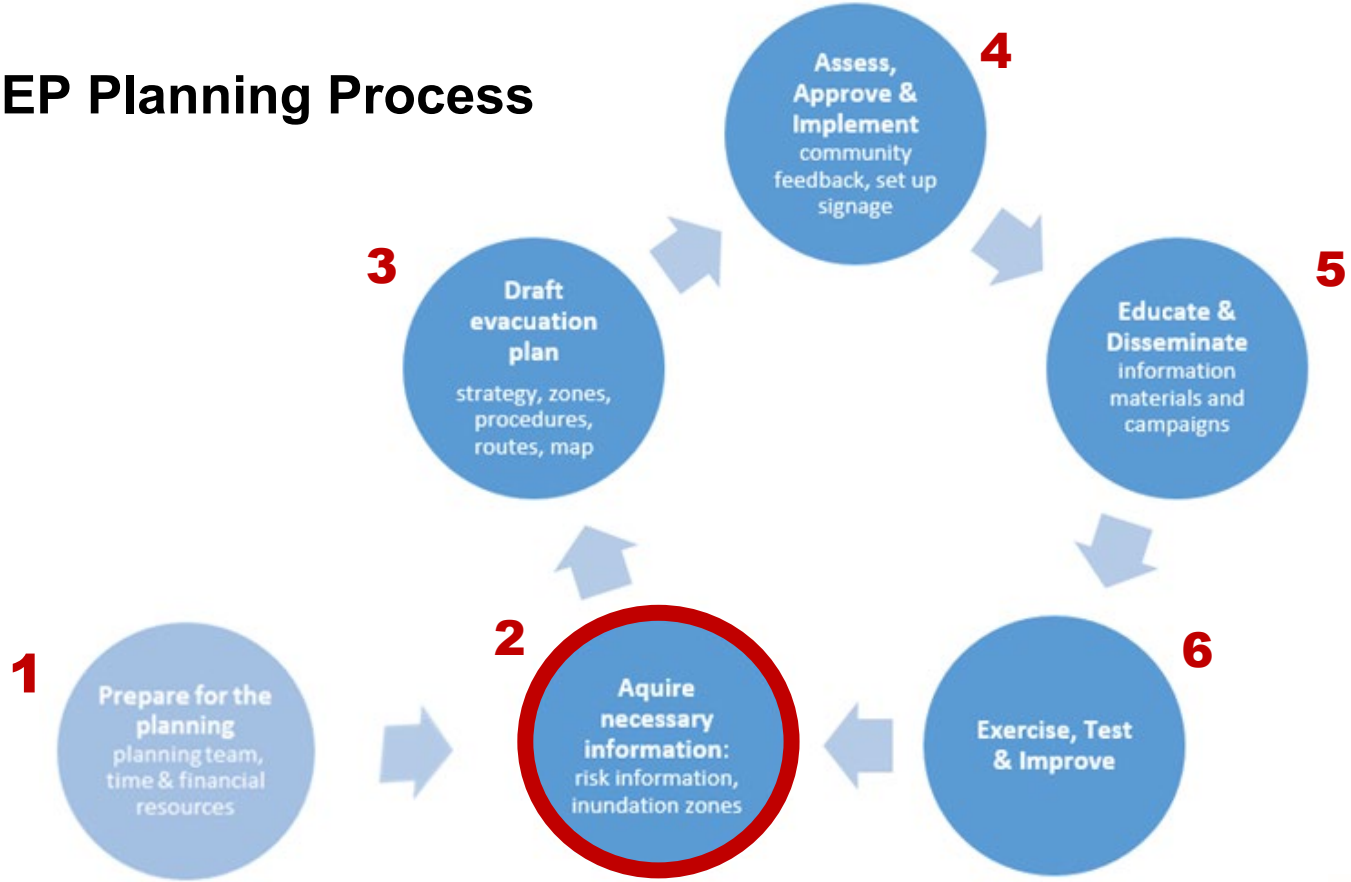
North-West Indian Ocean Regional Workshops on
Tsunami Inundation Mapping and Evacuation Planning
Muscat, 21-25 April 2024

The 6 Steps of a TEP Planning Process



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What we need to know about the Hazard

Where it comes from?

Location of **tsunami source areas** (seismic and non-seismic) which can affect the area

How much time do we have?

Minimum estimated arrival times (ETA_{min}) for tsunamis of different origins

How bad can it get?

Multiple threat scenarios, including “worst case”, most probable scenario, historical events, paleo-tsunami studies and probabilistic approaches with information on wave height at coast and / or flow depth on land

Which area can be affected?

Area that can be inundated ➔ Inundation Map

Inundation Maps are the foundation for TEP

Detailed maps of future tsunami flooding (inundation) are needed for delineation of evacuation routes and long-term planning in vulnerable coastal communities. Computer models are used to develop the inundation maps used for coastal community planning (from NOAA website).

Modeling of inundation maps is subject to a multitude of uncertainties:

- Tsunami source
- Input data like bathymetry, topography, time-dependant land use
- Uncertainties connected with the model used

Example of the effect of uncertainties on the modeling result

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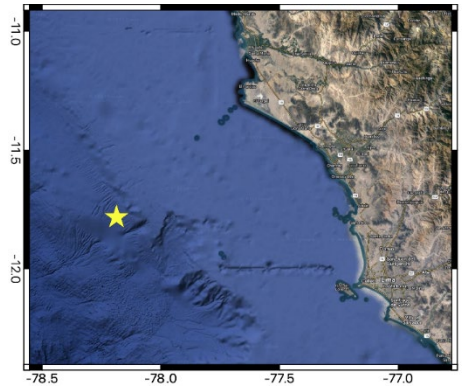
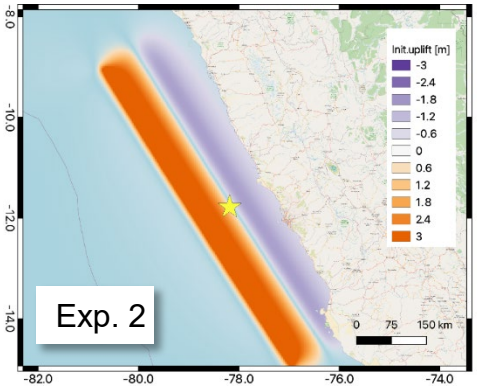
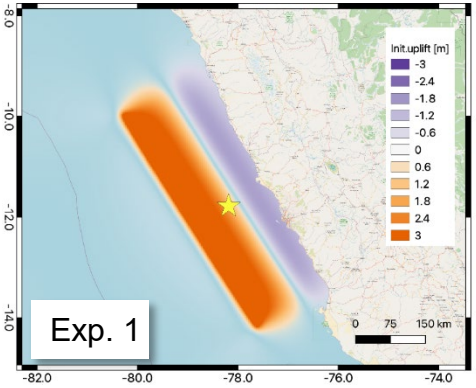
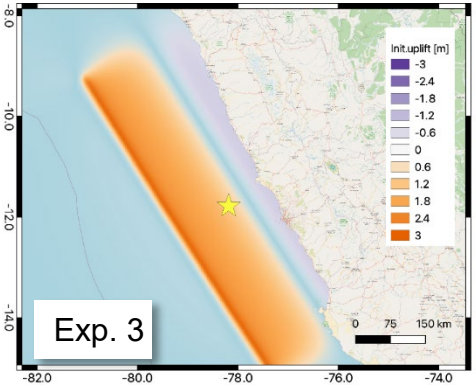
Tsunami sources







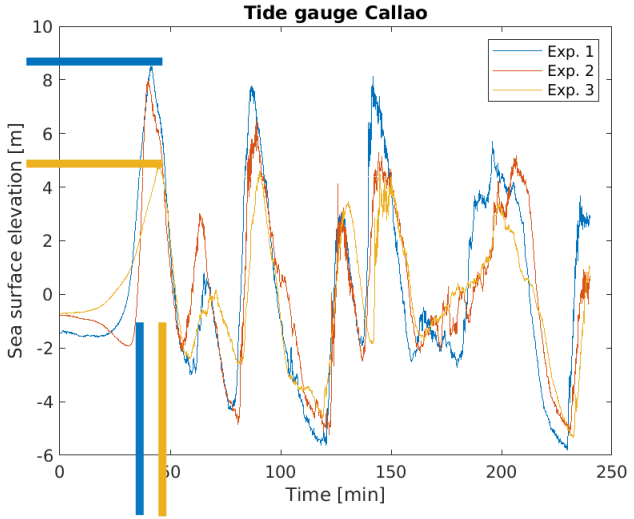


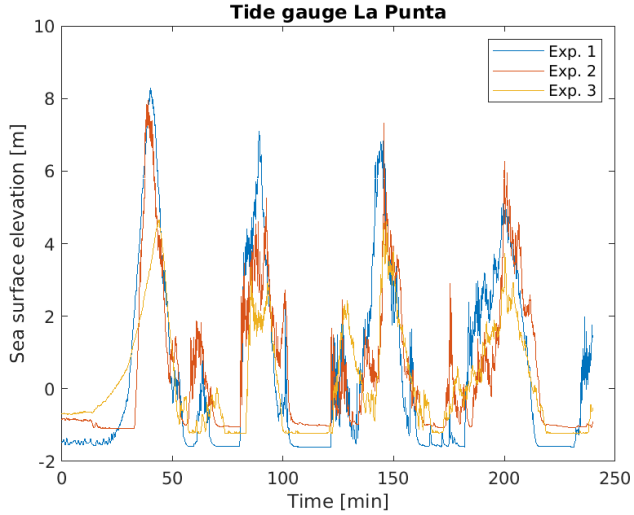
- Three experiments with the same Mw and epicenter, but
- Variations of
  - Length and Width
  - Slip value

	Exp. 1	Exp. 2	Exp. 3
L [km]	550	770	770
W [km]	140	100	200
Slip [m]	11.5	11.5	5.75

Tide gauge records

- Simulated tide gauge records provide estimates of arrival time (ETA) and wave amplitude (EWA)
- General waveform similar for experiments
- **Considerable differences ETA and EWA**

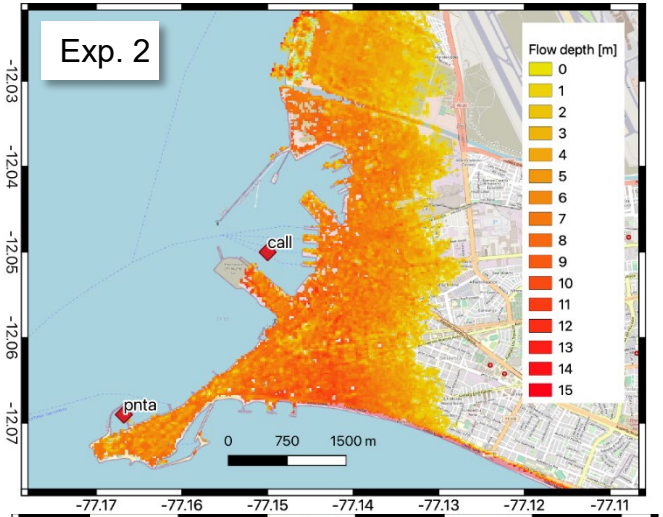


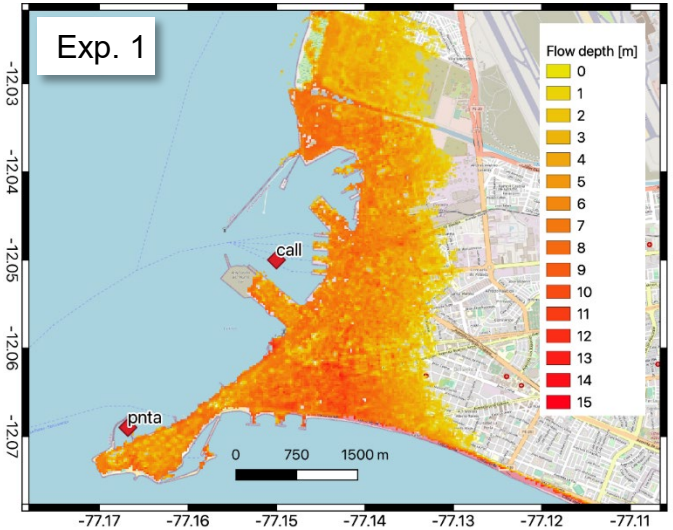


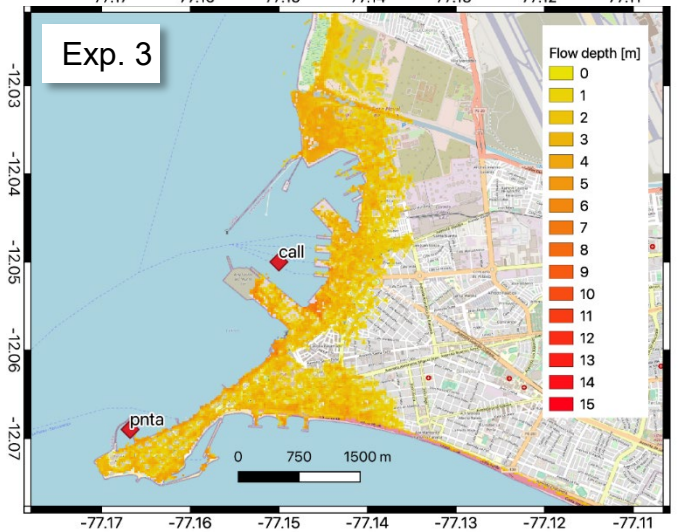
Inundation

- Also inundation extent varies considerably for the different experiments
- Exp. 1 and Exp. 2 with identical slip values are more similar

Source parameters may have strong influence on warning products and the estimates of the tsunami impact







Inputs for Inundation Mapping

Important input for inundation modeling is:

a) Hazard information (in form of Tsunami height or flow depth at the coastline):

PTHA, single scenario i.e. worst case scenario, historic information (Tsunamis of 1945, 2004),

a) Data (bathymetry and topography (resolution), land use)

b) Computing capacity

Approaches for Inundation Mapping

Source selection

- Single scenario approach - most credible/worst case/historic
- Probabilistic Tsunami Hazard Assessment

Mapping method

- “Bathtub” Model - based on topography only.
- Modeling using analytical functions, i.e. using amplification factors
- Full hydrodynamic continuous model

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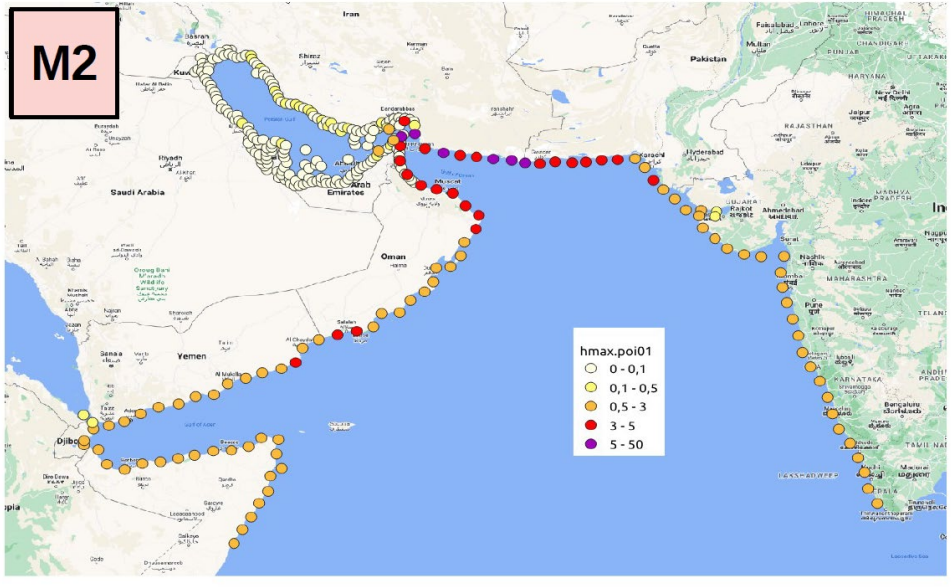
Outcome of yesterday's meeting

At yesterday's meeting of the regional tsunami inundation modeling and mapping working group, we discussed a roadmap for transitioning from the existing **PTHA 1.0 to a regional seismic consensus model**. This will be a joint effort of the regional group and the scientists involved in ICG/NEAMTWS. This regional model, which incorporates regional knowledge, can be used as input for inundation mapping along the entire coastline of the NWIO.

Maximum expected 2500 years wave height (probabilistic)



A. Babeyko: PTHA for NWIO

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

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Approaches for Inundation Mapping

The question what inundation mapping approach shall be used may be dependant on the risk in the coastal region in question. For high risk regions (e.g. cities, places with critical infrastructure) a fully hydrodynamic modeling approach with a high resolution grid should be chosen (very computationally expensive). For low-risk regions (e.g. sparsely populated coastal regions without critical infrastructure), a purely topography-based approach, which can be tackled with simple GIS tools, may be the tool of choice.

The choice of approach should be discussed between policy makers, local disaster managers and scientists and then decided upon.

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