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# Assessment Indicators – How to achieve, challenges and solutions

## 5.1 Tsunami Hazard Map – **ASSESS - 1**

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*International Tsunami Information Centre (ITIC)*

# Tsunami Ready Indicators

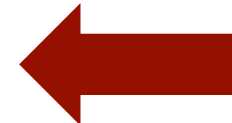


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UNESCO IOC TSUNAMI READY INDICATORS	
<b>I</b>	<b>ASSESSMENT (ASSESS)</b>
1	ASSESS-1. Tsunami hazard zones are mapped and designated
2	ASSESS-2. The number of people at risk in the tsunami hazard zone is estimated
3	ASSESS-3. Economic, infrastructural, political, and social resources are identified
<b>II</b>	<b>PREPAREDNESS (PREP)</b>
4	PREP-1. Easily understood tsunami evacuation maps are approved
5	PREP-2. Tsunami information is publicly displayed
6	PREP-2. Outreach and public awareness and education resources are available and distributed
7	PREP-3. Outreach or educational activities <u>are held at least three times a year</u>
8	PREP-4: A community tsunami exercise is conducted at least every two years
<b>III</b>	<b>RESPONSE (RESP)</b>
9	RESP-1. A community tsunami emergency response plan (ERP) is approved
10	RESP-2. The capacity to manage emergency response operations during a tsunami is in place
11	RESP-3. Redundant and reliable means to timely receive 24-hour official tsunami alerts are in place
12	RESP-4. Redundant and reliable means to timely disseminate 24-hour official tsunami alerts to the public are in place





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# Why is this the first step?

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Tsunami hazard maps are the **basis for planning evacuation routes** and location of tsunami shelters

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Mapping the hazard zone **raises awareness of the tsunami hazard** in the community

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**Prepares the community** for tsunami events

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Helps and **guides the emergency response agencies** on evacuation planning

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**Guides mitigation measures** to minimise the impact of tsunamis

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# Defining tsunami impact at your location



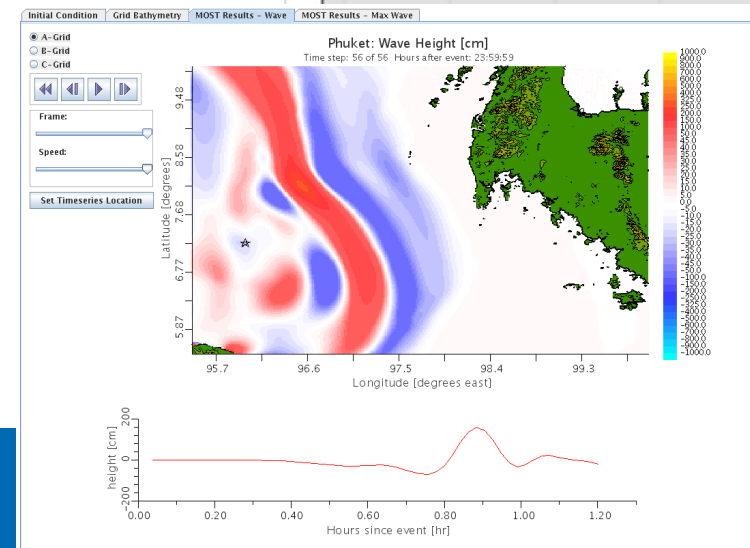
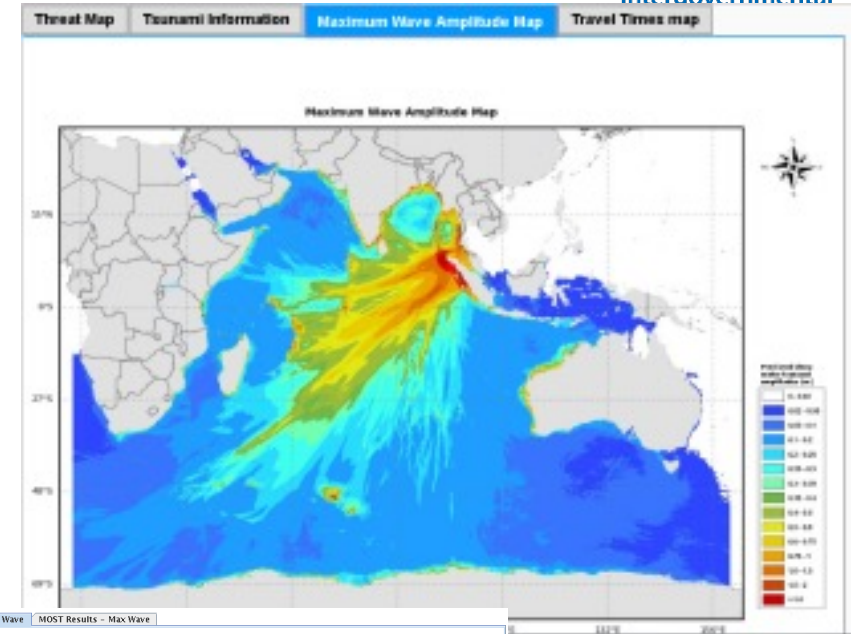
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The impact of a tsunami on the coastline depends on the source location, directivity of the energy moving through the water column, coastal bathymetry and topography

An enclosed bay facing a tsunami source might get higher inundation levels than an open beach tangential to the main directivity of the tsunami, even if both are at the same distance from the tsunami source

An island in the middle of the ocean might have a lower inundation level than a continental open beach, both located equidistant from the tsunami source

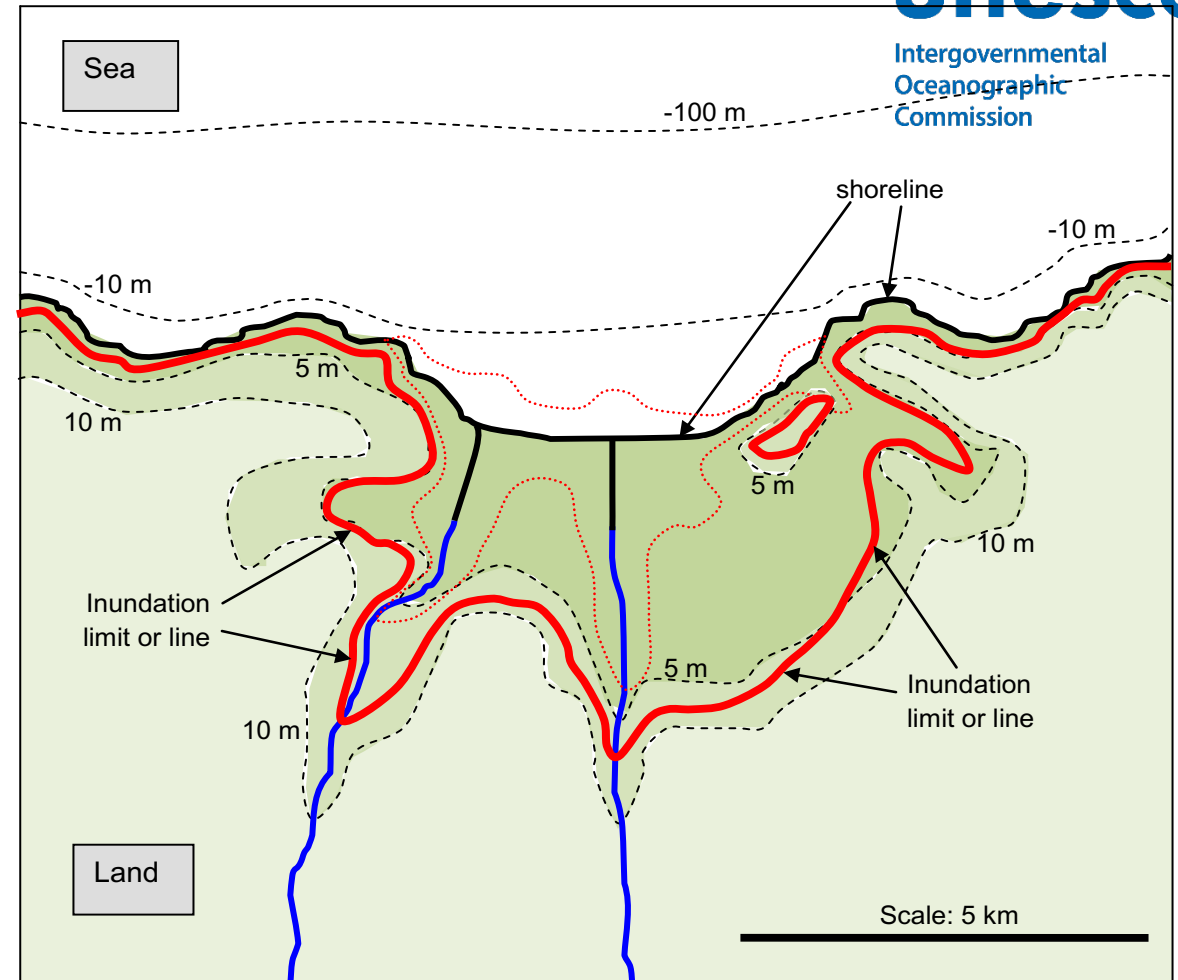


# Define Tsunami hazard zone

Tsunami hazard maps depict the areas that may be flooded by a tsunami usually based on a worst-yet-credible case scenario (the worst tsunami that can impact the area)

The primary source for mapping potential tsunami hazard zones is **inundation modelling**, which illustrates areas expected to be flooded by the tsunami.

The result of an inundation modelling study is the tsunami inundation map depicting the tsunami hazard zone



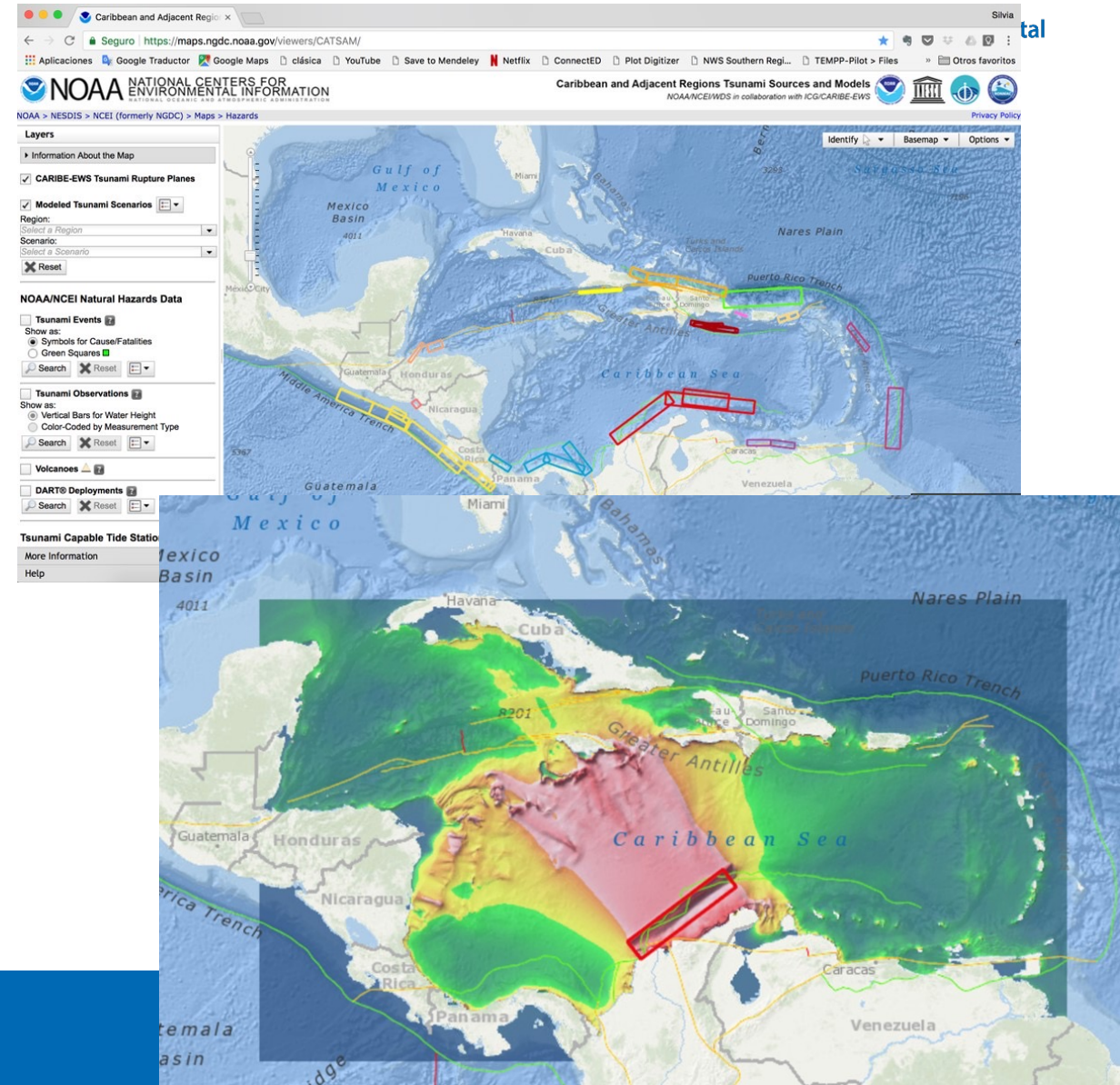
*Inundation mapping (training exercise). The red line marks the maximum horizontal penetration of the tsunami. Source: UNESCO IOC and UNDP, 2009*

# Data requirements for inundation modelling

## 1. Tsunamigenic earthquake source information

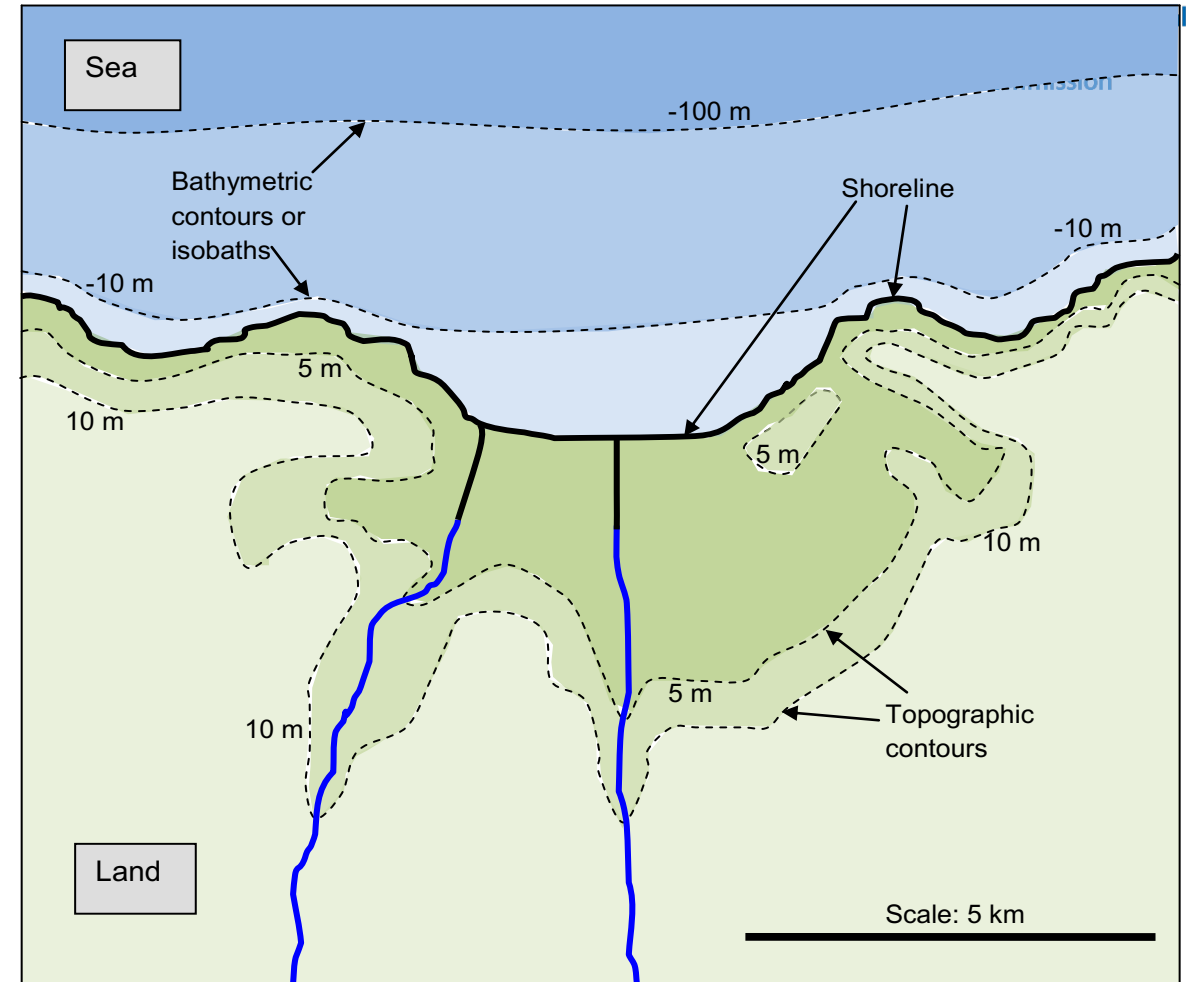
- Sources: historical archives, tsunami researchers, seismologists at local universities
- If no credible earthquake source information available, worst-case scenarios need to be estimated

## 2. Detailed topographic and bathymetric data



# Topography and bathymetry

**Inundation modelling requires detailed coastal topography and near shore bathymetry data ideally combined in a Digital Elevation Model (DEM)**



*Bathymetry and topography (training exercise). Source: UNESCO IOC and UNDP, 2009*

# Topographic and Bathymetric Data

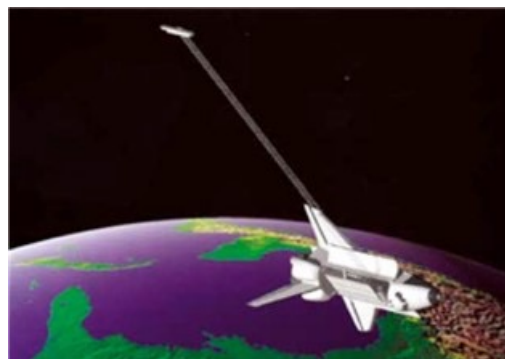
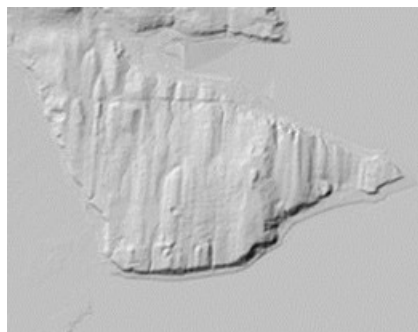


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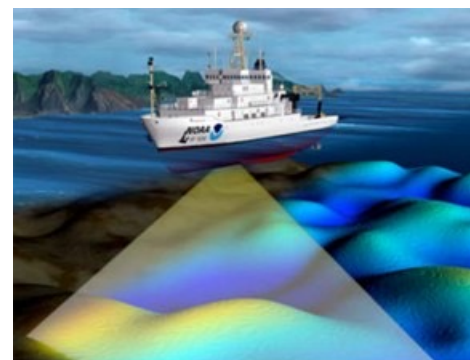
## Topographic Survey

- **Photogrammetry**
- **Topographic LiDAR**  
(Light Detection and Ranging)
- **Space-based Radar (SRTM)**  
(Shuttle Radar Topography Mission)



## Bathymetric Survey

- **Single-beam survey**
- **Multi-beam surveys**
- **Bathymetric LiDAR**





# Digital Elevation Model (DEM)



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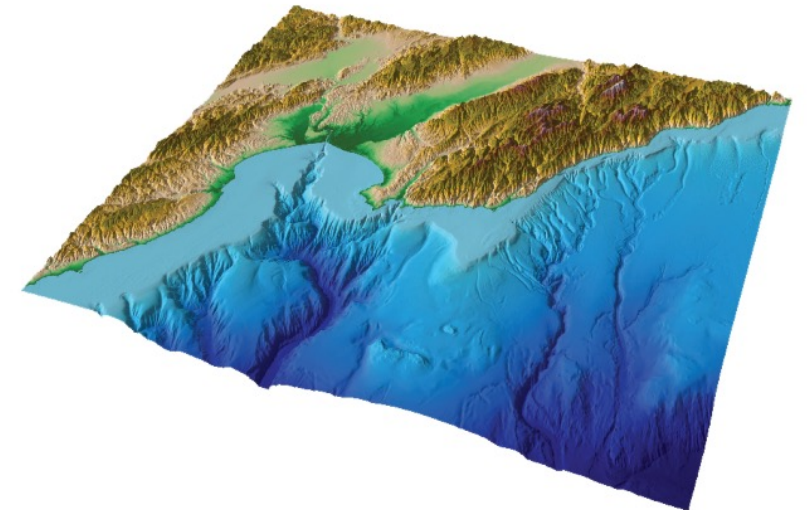
*A coastal DEM depicts Earth's land surface and ocean bottom. It is constructed from land and seafloor elevation data collected by federal, state and local governments, universities and private companies.*



# How are DEMs used?

*DEMs help to plan, prepare for, and better understand ocean processes. Uses include:*

- Real-time tsunami and storm-surge forecasting and warning
- **Hazard mitigation and community preparedness**
- Ecosystem management and habitat research
- Coastal change and terrain analysis
- Pollution monitoring and contaminant dispersal
- Map creation and Earth visualization
- Long-term planning



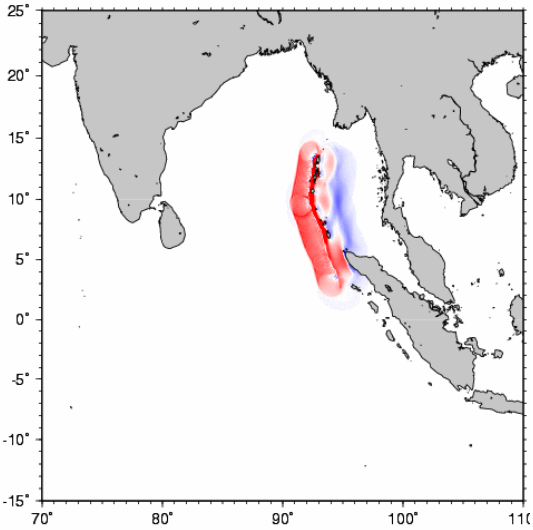
Tsunami inundation grid, Monterey Bay, California (upper) and perspective view from the southwest of Monterey (lower.) NOAA PMEL, 2012

# Numerical models

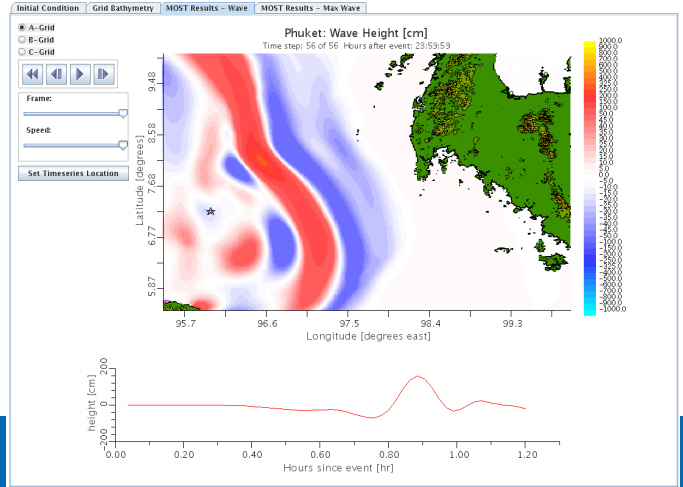
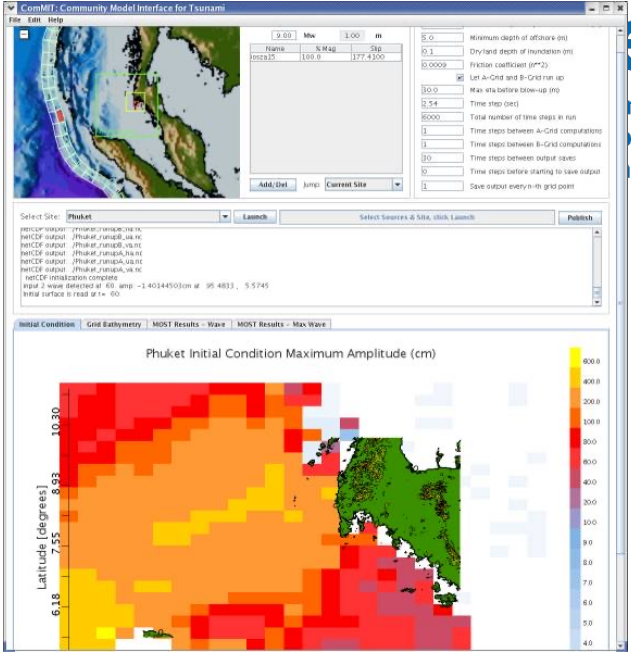
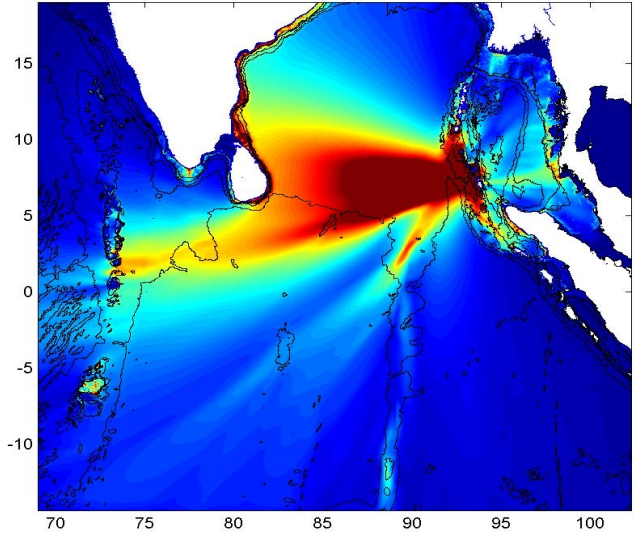
*Propagation models model the movement of tsunami waves from their source across the ocean to the coastal zone (linear models)*

*Inundation models model how the waves interact with the coastal bathymetry and topography as they arrive at the coastal zone (non-linear models)*

2004 Sumatra Earthquake 010 min



Wave Energy





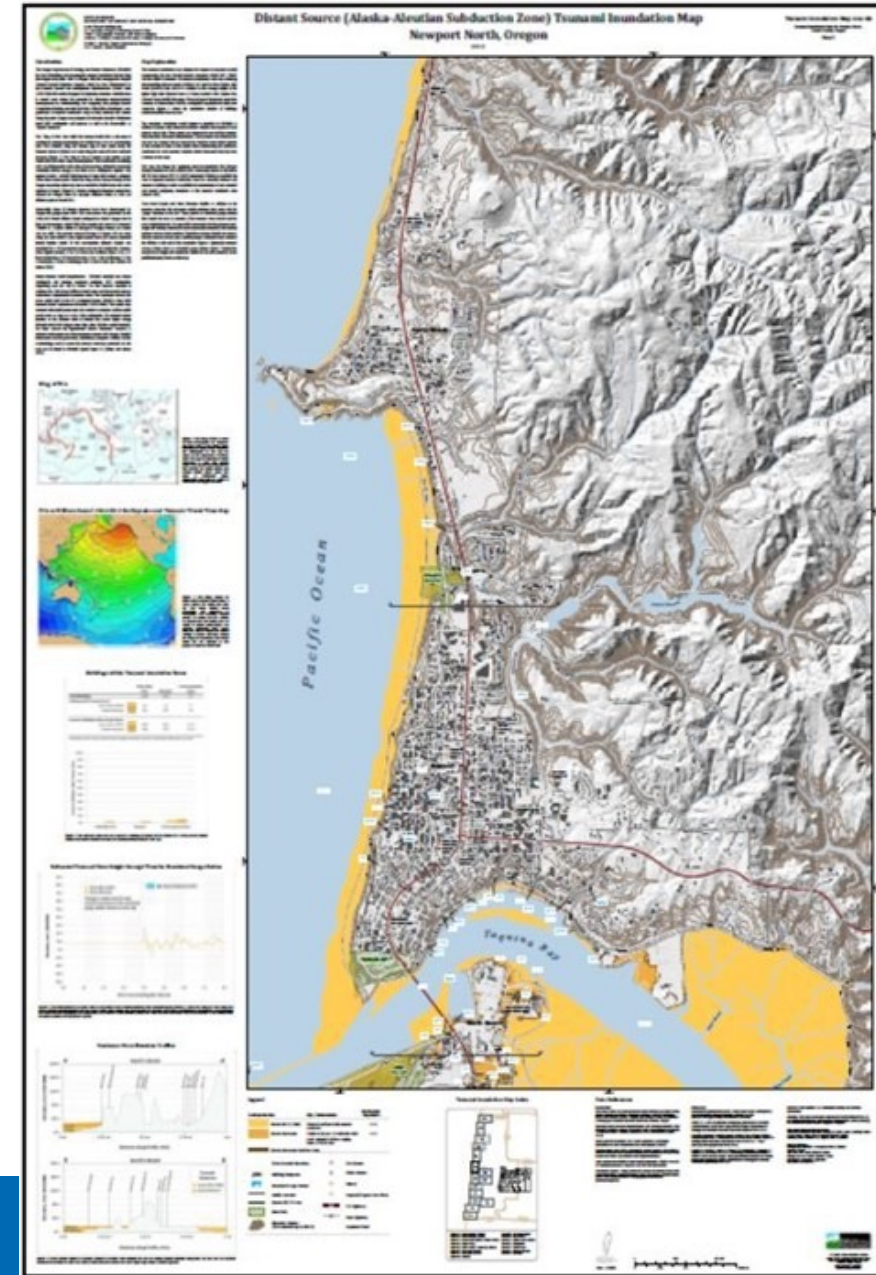
# Tsunami Inundation Maps

## Inundation maps should:

- Be developed using best available data for area of coverage (e.g., use highest resolution LiDAR data, best bathymetry, current deformation models, best geologic seismic data).
- Use of alternative information should be explained in documentation.

*Tsunami Inundation Map  
Newport North, Oregon*

Earthquake Size	Slip / Deformation	Earthquake Magnitude
 Alaska M9.2 (1964)	Vertical seafloor deformation estimate.	~9.2
 Alaska Maximum	Uniform slip on 12 subfaults with each assigned values ranging from 49 to 98 feet.	~9.2



# Tsunami inundation maps should include:



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**Title**

Local Source (Cascadia Subduction Zone) Tsunami Inundation Map  
Newport North, Oregon  
2013

**Appropriate explanatory information.**

**Geographic location (coordinates)**

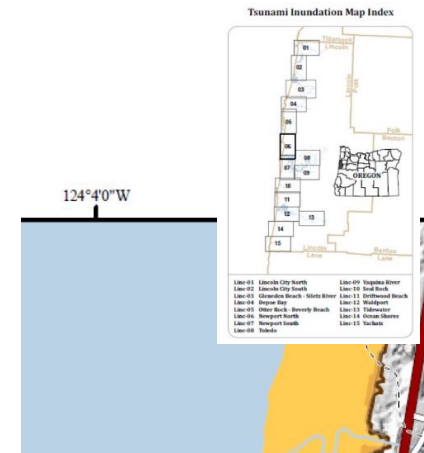
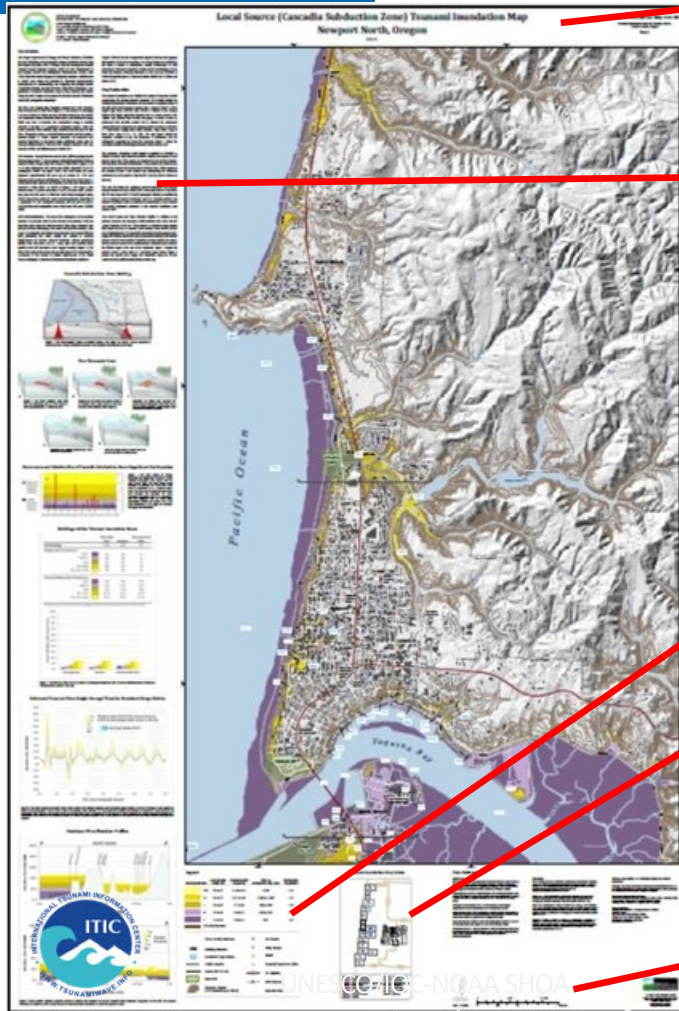
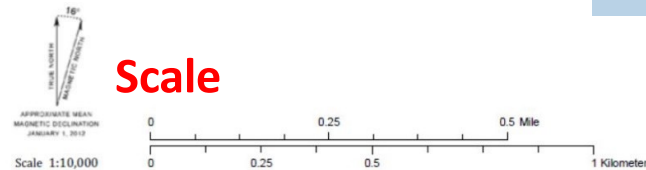
**Legend**

Earthquake Size	Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
XXL	59 to 72	118 to 144	1,200	-9.1
XL	56 to 72	115 to 144	1,050 to 1,200	-9.1
L	36 to 49	72 to 98	650 to 800	-9.0
M	23 to 30	46 to 62	425 to 525	-8.9
S	13 to 16	30 to 36	300	-8.7

Urban Growth Boundary	Fire Station
Building Footprint	Police Station
Simulated Gauge Station	School
Profile Location	Hospital/Urgent Care Clinic
Senate Bill 379 Line	U.S. Highway
State Park	Gravel Blanket

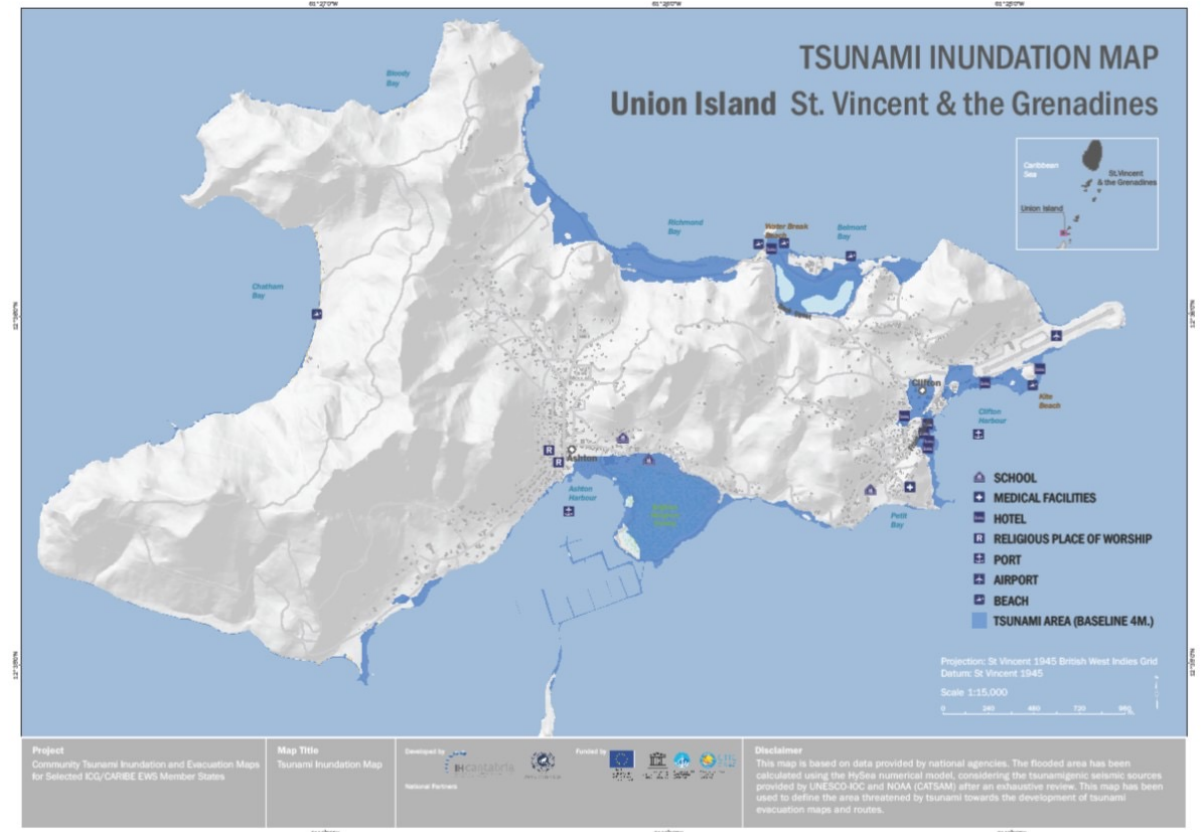
**Scale**



# What if DEM data and inundation models are not available?

*A community may not have access to high resolution digital bathymetry and/or topographic data and may not have the necessary skills to set up and run numerical inundation models.*

- A “Bathtub” model approach can be used. This assumes that an **area with an elevation less than a projected runup level will be flooded like a “bathtub”**. A basic topographic map will still be required to map out inundation areas.
- Alternatively, external experts (DMOs, universities, academics, researchers and consultants) can assist in establishing the tsunami hazard zone.
- The guidelines in **Supplement 1 of MG82** can be used. These were adapted for global use from the 2011 guidelines developed by the US National Tsunami Hazard Mitigation Program (NTHMP) Mapping and Modelling Subcommittee.



# Summary of ASSESS-1

- ✓ Mapping and designation of tsunami hazard zones provides the **basis for planning evacuation routes and locations for tsunami safe zones and shelters**
- ✓ Tsunami hazard maps depict the **areas that may be flooded** by a tsunami and are usually based on a **“worst-yet-credible case” scenario**
- ✓ The primary source for mapping tsunami hazard zones is **inundation modelling which requires specialist technical expertise** available at universities, scientific institutions and/or government agencies
- ✓ The **data requirements** for inundation modelling are **tsunamigenic earthquake source information and detailed topographic and bathymetric data**, preferably in Digital Elevation Model (DEM) format.
- ✓ **Numerical models are used** to predict the propagation of tsunami waves from their source **across the ocean to the coastal zone (linear models)** and the interaction of tsunami waves with coastal bathymetry and topography in the **coastal zone (non-linear models)**
- ✓ **If DEM data and/or inundation modelling expertise is not available**, a **“bathtub” model** approach can be used in which it is assumed that an area of elevation less than the projected runup level will be flooded. **Alternatively**, experts can assist in establishing the tsunami hazard zone **based on historical and geological records**



# THANK YOU

# Vinaka Vaka Levu

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