UNESCO/IOC – NOAA ITIC Training Program in Hawaii (ITP-Hawaii)
TSUNAMI EARLY WARNING SYSTEMS
AND THE PACIFIC TSUNAMI WARNING CENTER (PTWC) ENHANCED PRODUCTS
TSUNAMI EVACUATION PLANNING AND UNESCO IOC TSUNAMI READY PROGRAMME
7-18 August 2023, Honolulu, Hawaii USA

Tsunami Hazard Assessment Process and Outcomes

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ITIC Partnership

Presentation Overview

Process

Science

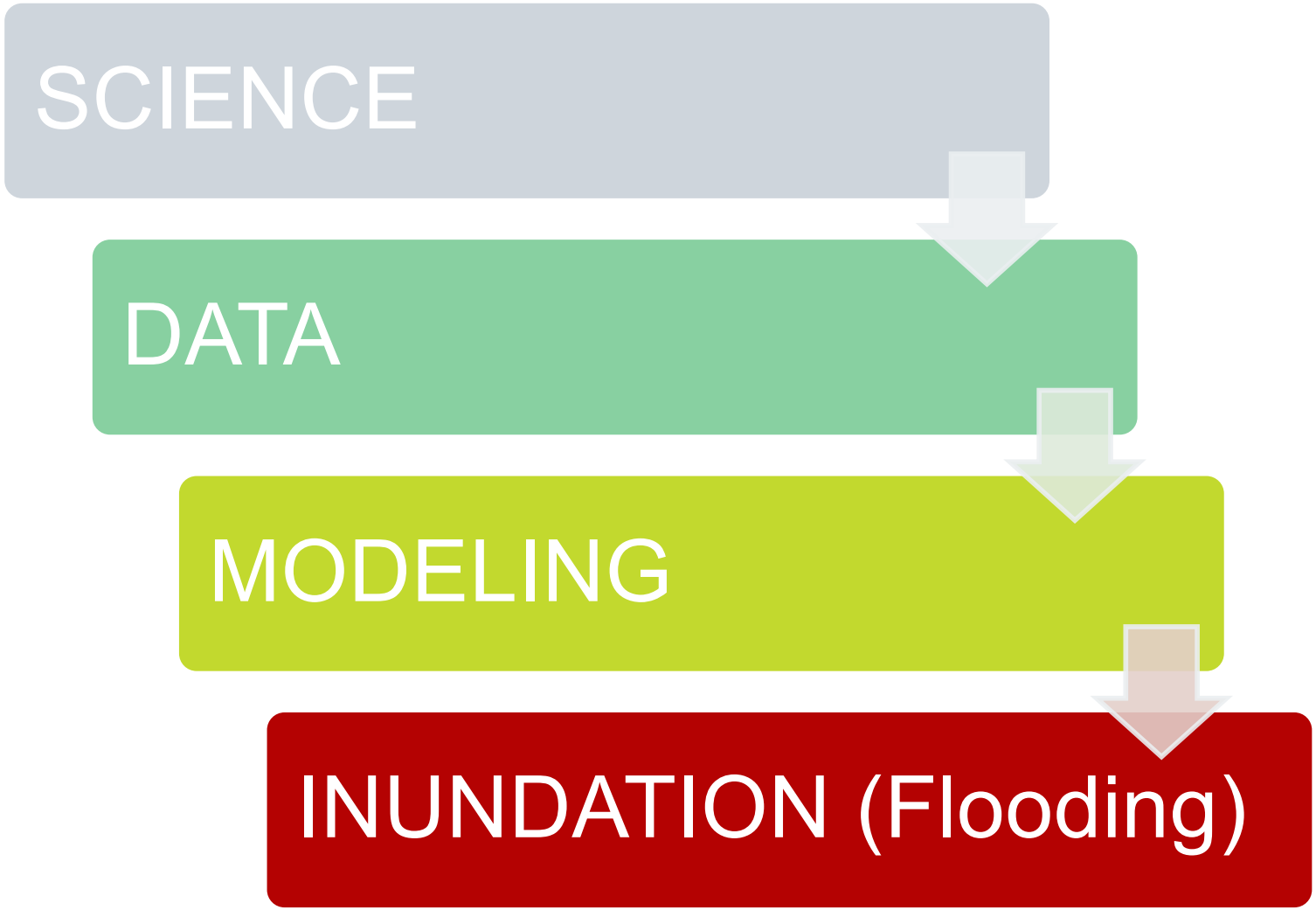
Data

Sensitivity Study

Inundation (Flooding) Modeling

Key Points

Process



Science: What is a Tsunami?

Tsunamis are:

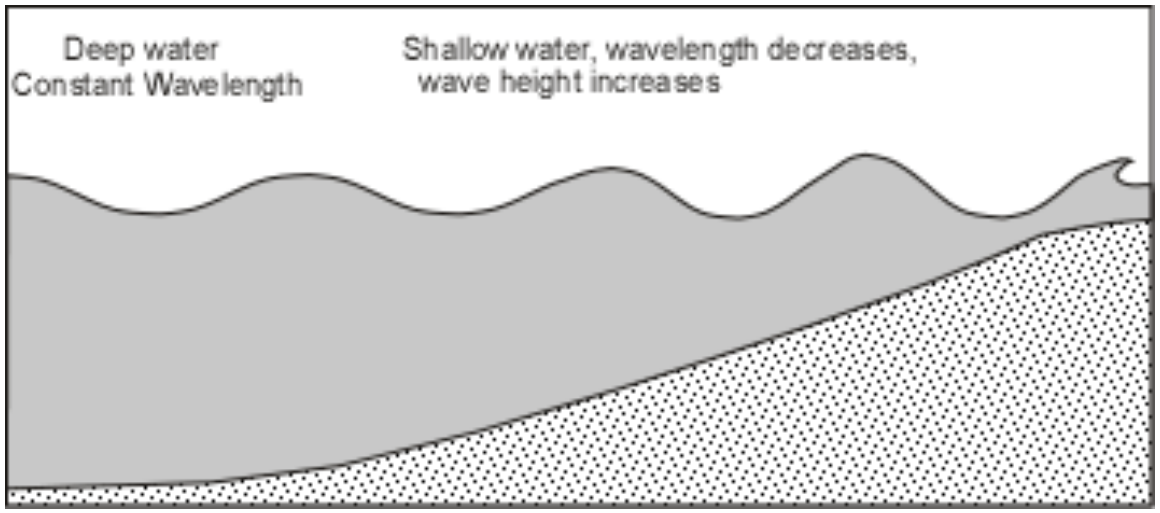
- a series of waves that travel outward from origin. First wave is NOT always the largest
- caused by undersea earthquakes (80%), volcanos (6%), landslides (5% + 7% EQ caused)
- waves that travel across the deep ocean at speeds up to 500 mi/hour (~ speed of a jet)
- more like a bore when they come onshore and NOT like the curling breaking waves in the movies

Can you outrun a tsunami? NO!
If you feel the ground shake,
move away from the water.

Should you run out for fish
if the water goes way out NO!
Move away from the water

Science: Tsunami Behavior

- 'shallow water waves' – In deep water, wave height is low. Wave height increases as waves come ashore. Very long distance between wave crests
- Speed and wave height are determined by water depth



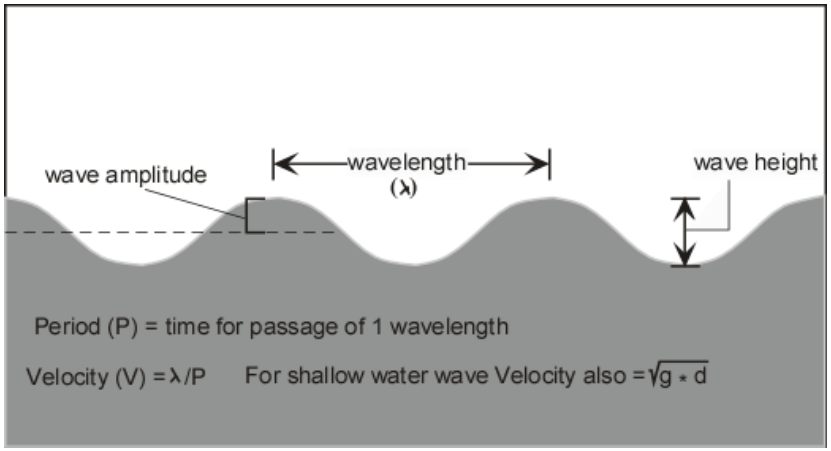
As tsunami waves leave the deep ocean and move into shallow water along coasts:

- wave Speed decreases (speed depends on water depth)
- wave period decreases (as waves slow, the space between them decreases)
- there is no change in the total energy of the tsunami

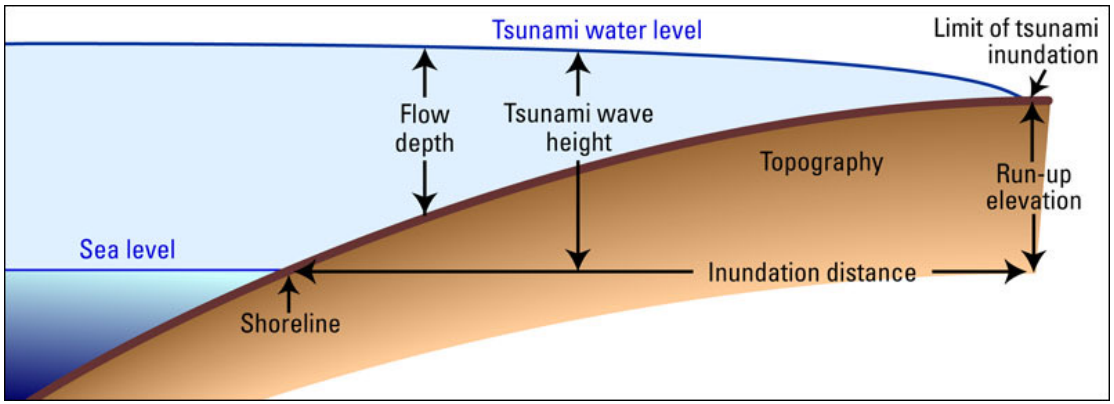
SO

** Wave height increases

Science: Tsunami Terms

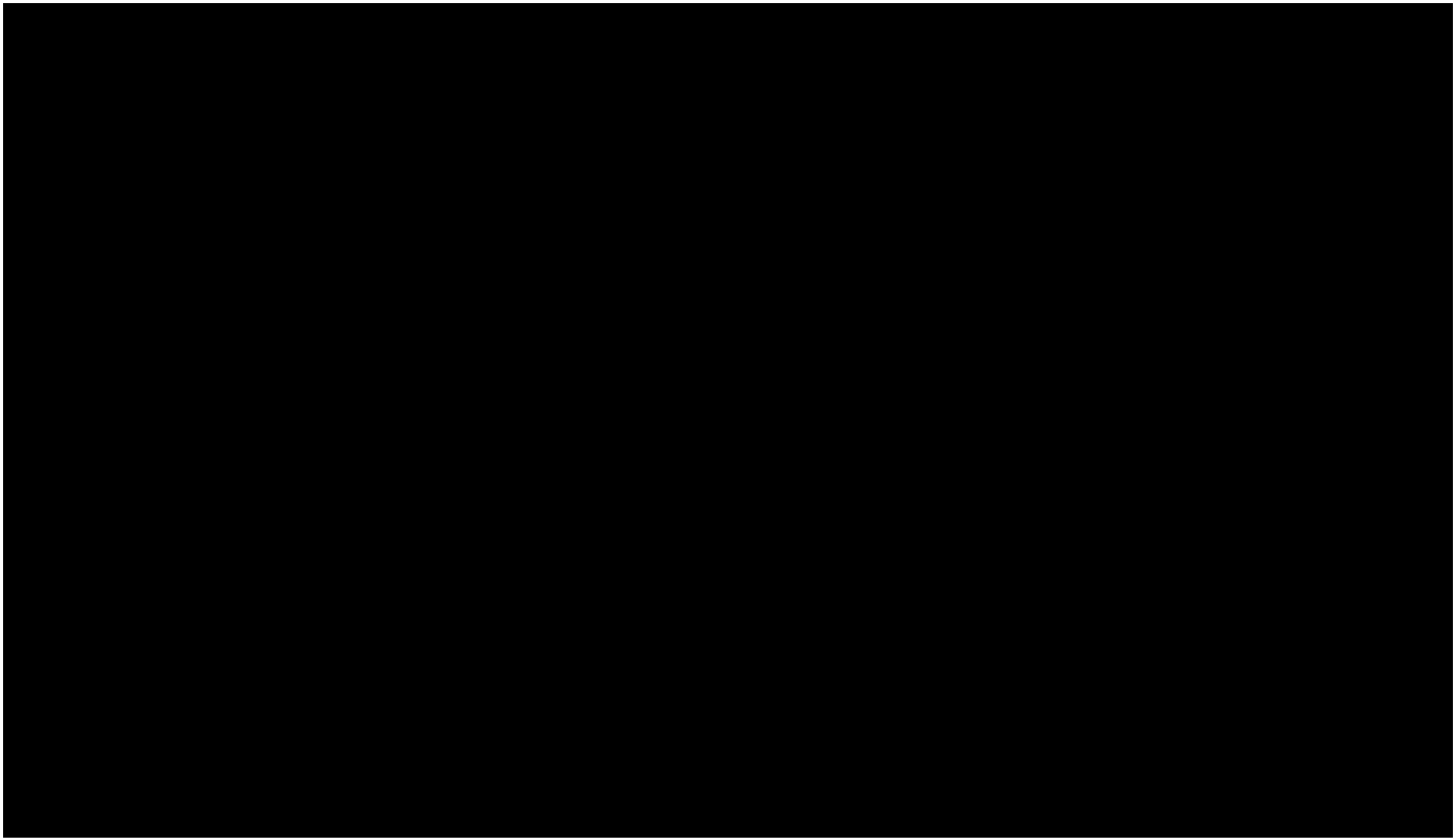


Wavelength – distance between wave crests
Wave Frequency - time it takes for one full wavelength to pass a stationary point.
Wave Speed - speed of the wave. Usual ocean wave speeds are 60 mi/hr; tsunami speeds are up to 600 mi/hr
Wave amplitude – distance from average sea surface to wave crest.
Wave height – distance from wave crest to wave trough
'shallow water wave' – sea surface to sea floor. In deep water, wave height is low. Wave height increases as waves come ashore.



Inundation – furthest extent that water travels from a shoreline
Runup– a measure of vertical or maximum height of tsunami waves above mean sea level at the point of maximum inundation.

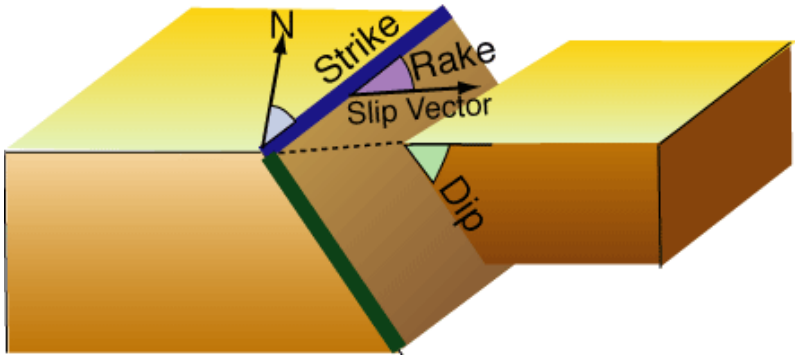
Science: Tsunami Generation

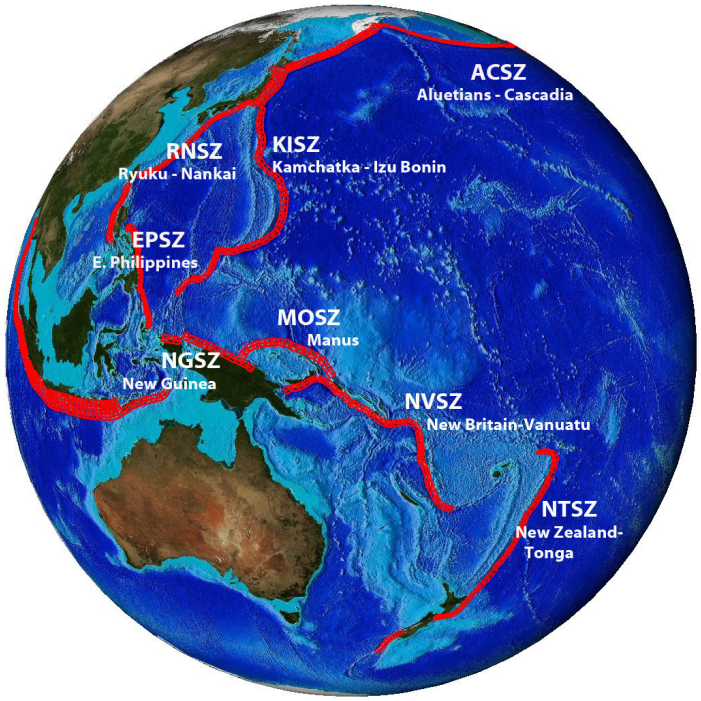


Data: Seismic Sources

Seismic Parameters

- Epicenter
- Length / Width / Depth
- Slip
- Dip / Rake / Strike [deg]
- Moment Magnitude



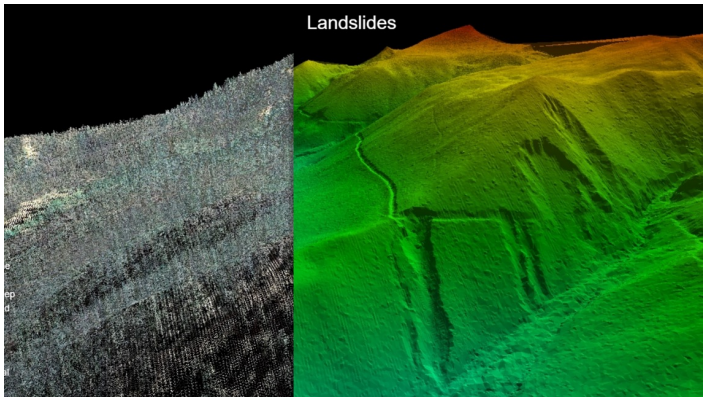


Ex. Pre-computed unit sources for Pacific Basin

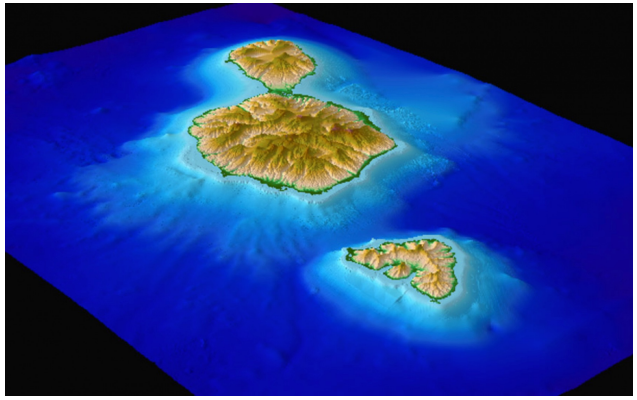
Data: Bathymetry & Topography

Method

Tsunami inundation is modeled by simulating scenarios then passing the generated waves over a digital elevation model (a representation of seafloor features and bare earth topography put together from survey data)
*Bare earth excludes trees, buildings, and all other surface objects on land.



USGS Public Domain data and image



DEM of French Polynesia Society Island constructed by NCEI in 2017

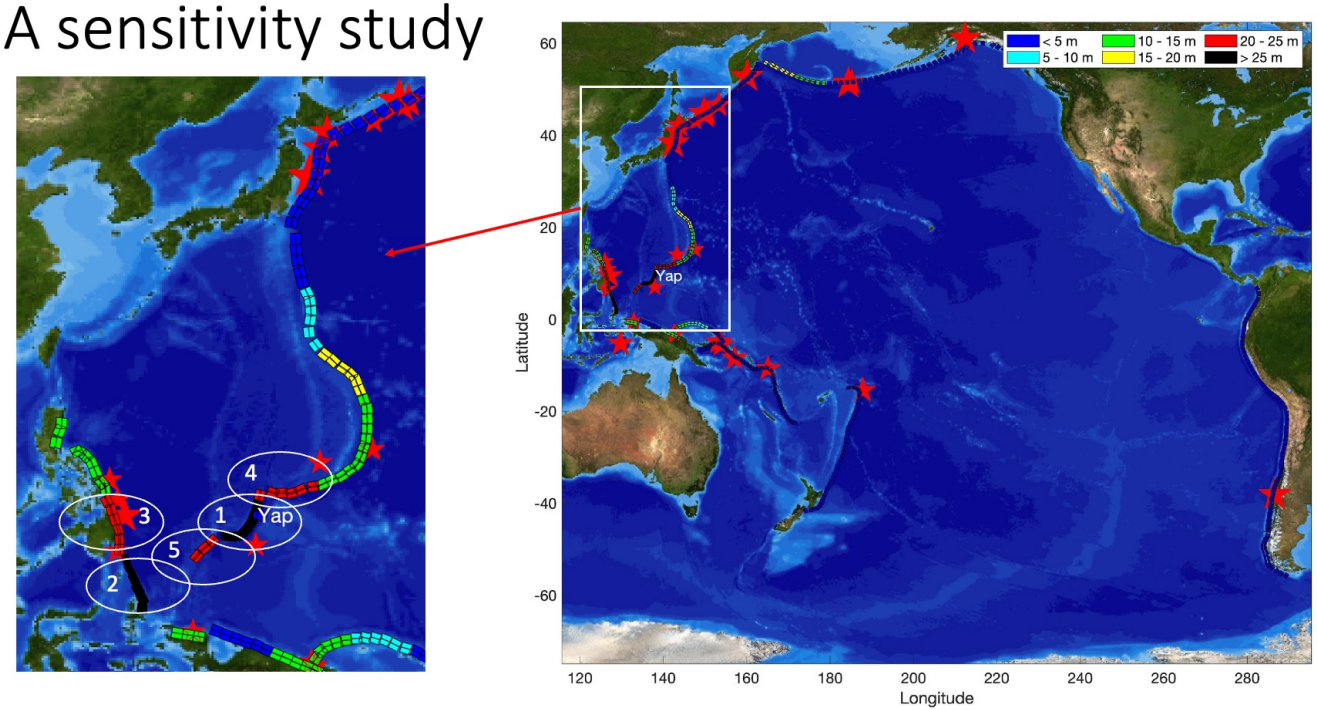
Data are Critical!

Data that goes into construction of DEM governs how good results really are. Data from all available sources are quality checked and converted to the same datum then merged. Topographic features are stripped out (left).

Sensitivity Study

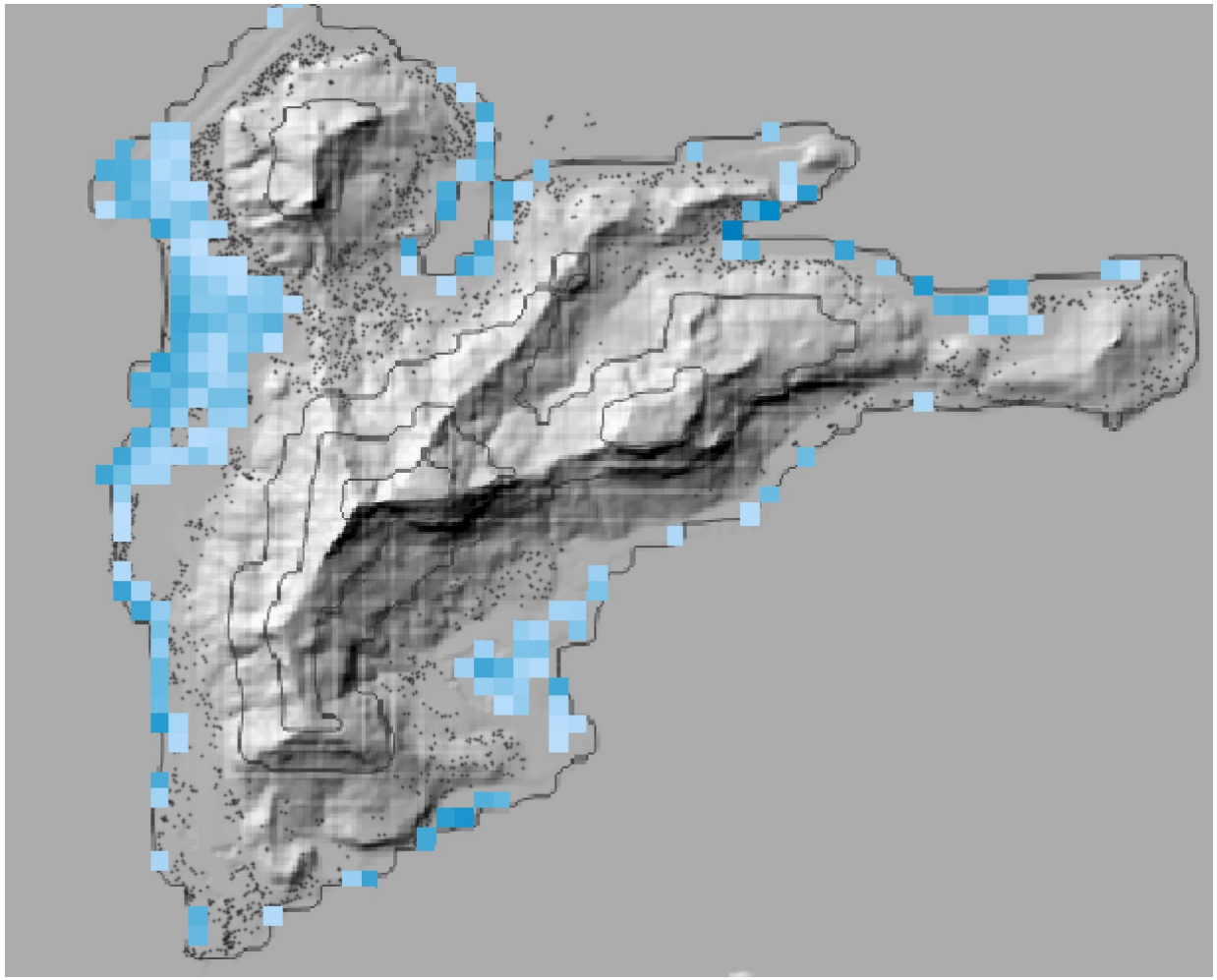
- Historical events are compiled (US NOAA Historical Tsunami Database)
- Tsunamis are generated from earthquake scenarios from all subduction zones in ocean basin of concern.
  Ex. Pacific Ocean “the Ring of Fire sources for Hawaii

A sensitivity study



Ex. Sensitivity study conducted for Yap State, Federated States of Micronesia

Data: Low- vs High-Resolution DEM

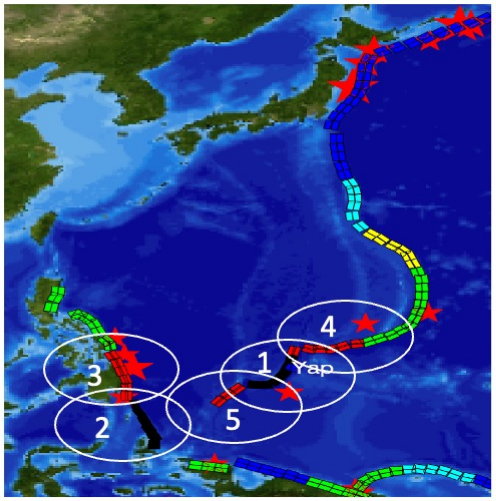


Data resolutions
Nearest shore, at 50-m
3-arcSec (90m)

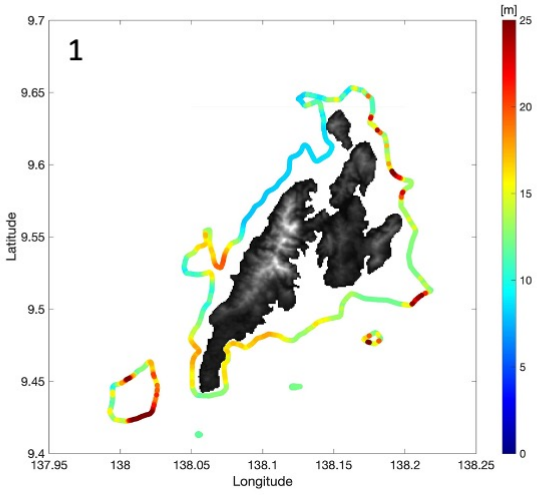
Offshore 30-ArcSec [1km]
GEBCO 2014

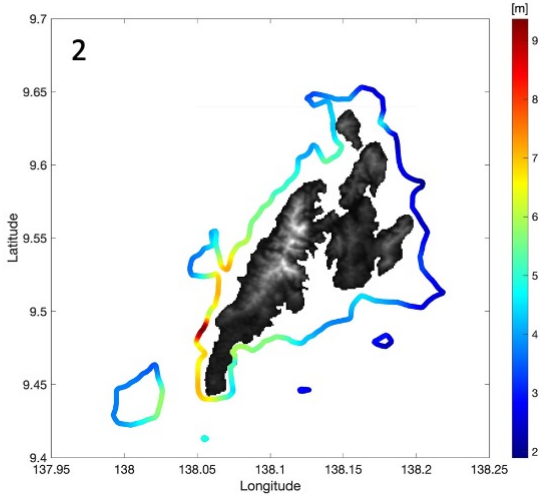
Topography
CGIAR SRTM 90 m

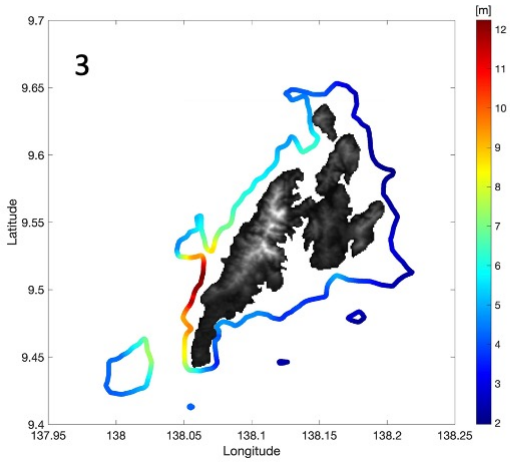
Modeling Low-Resolution Modeling

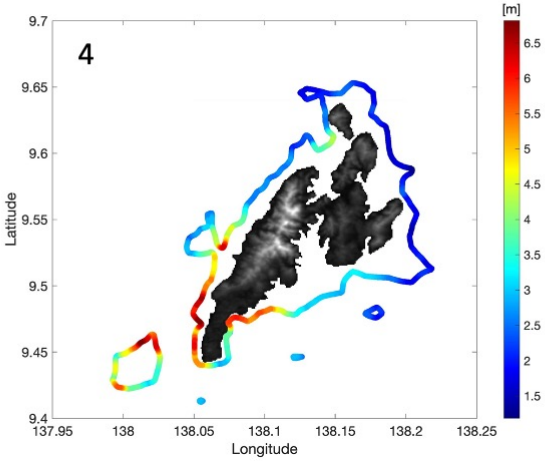


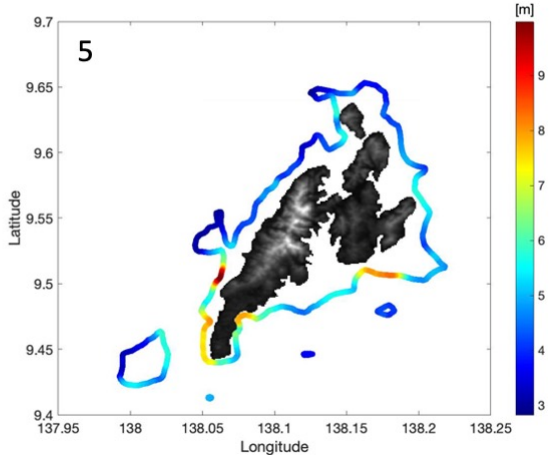
Maximum amplitude at 50 m isoline



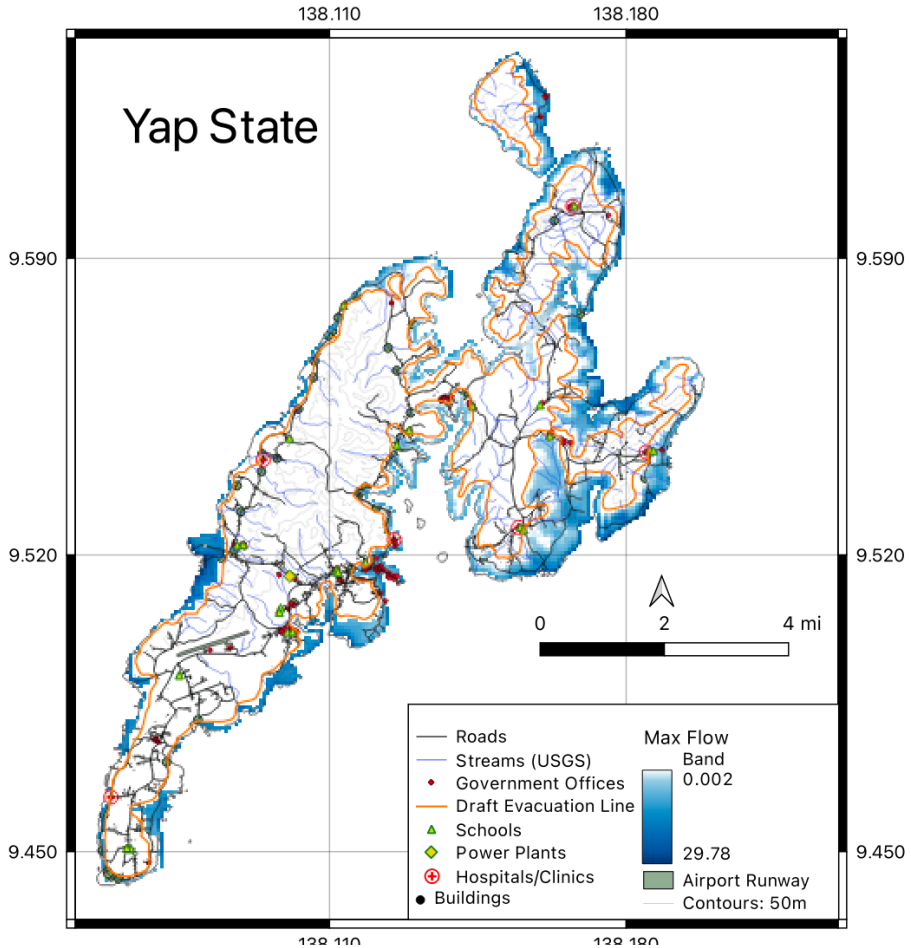


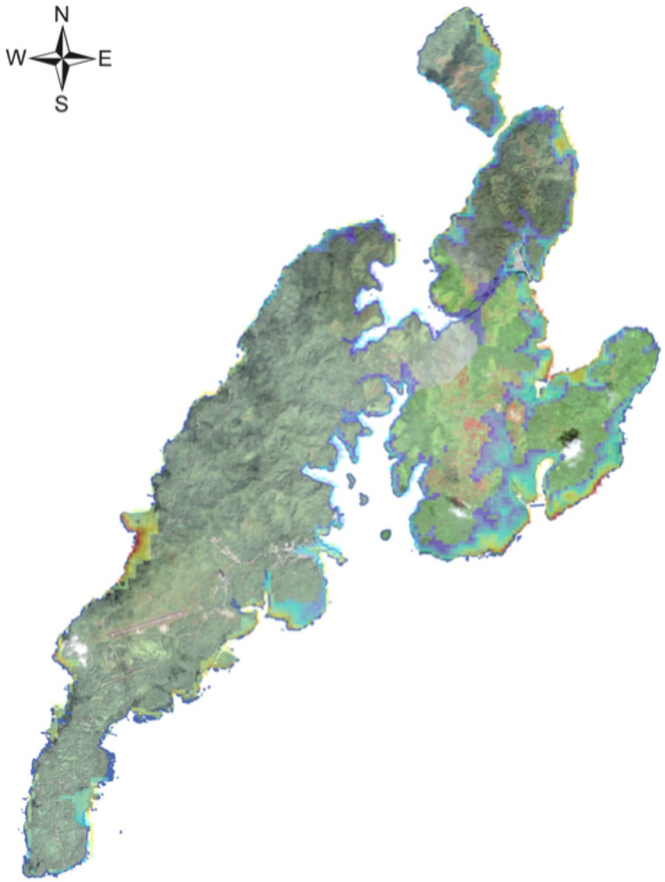




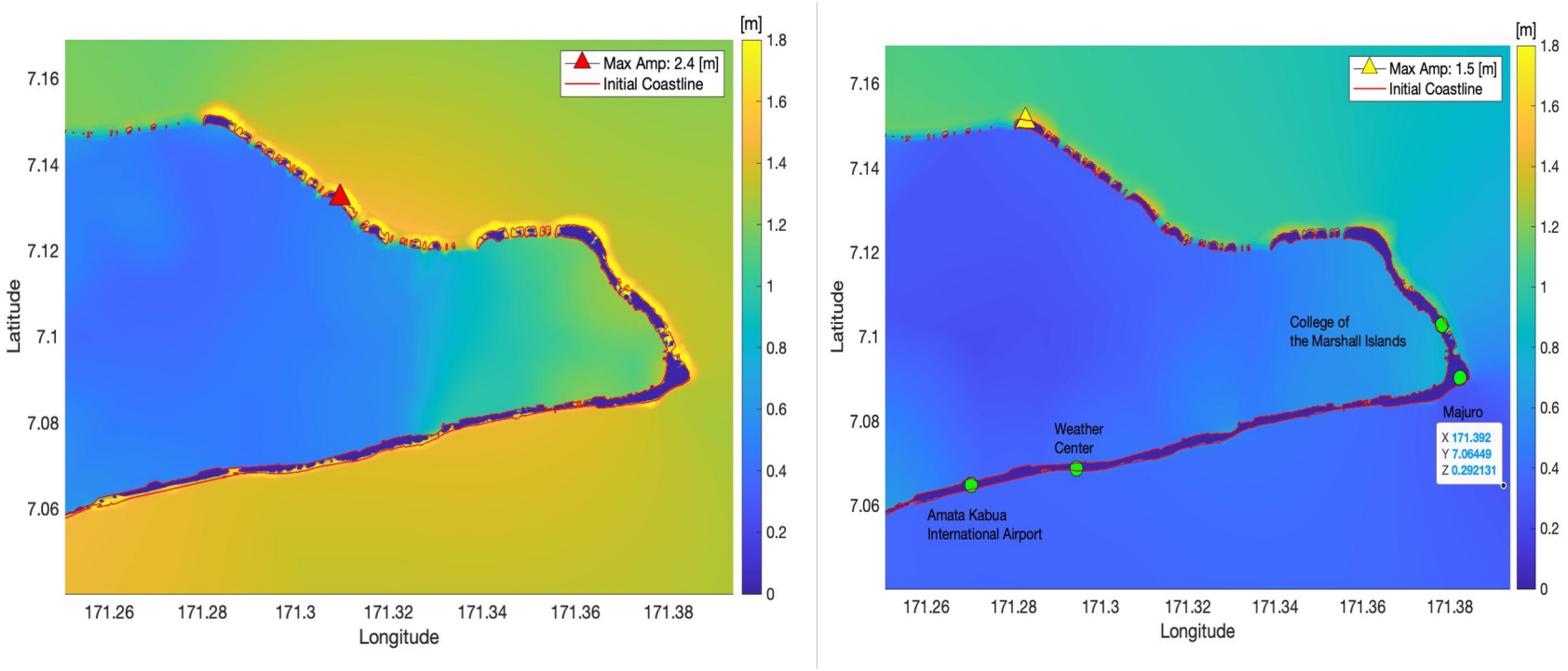


Modeling: Inundation





Data: Low- vs High-Resolution DEM

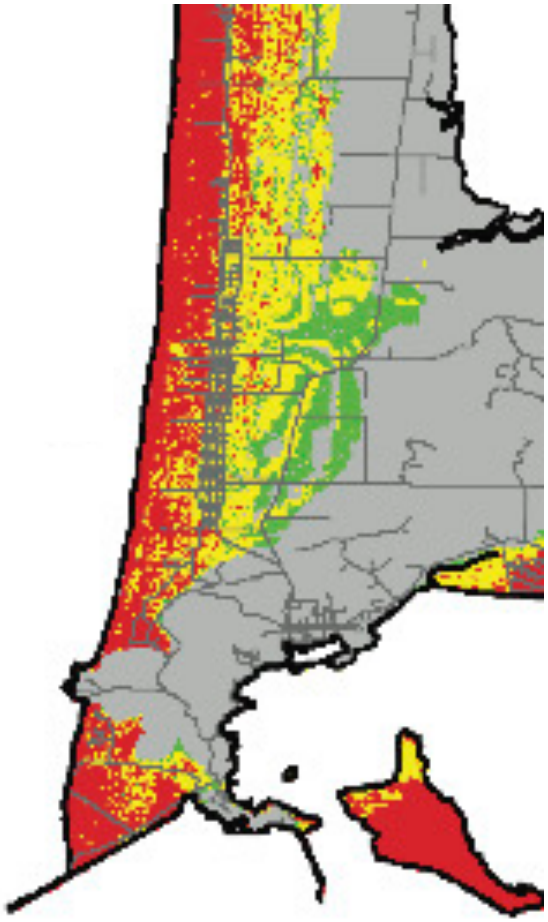


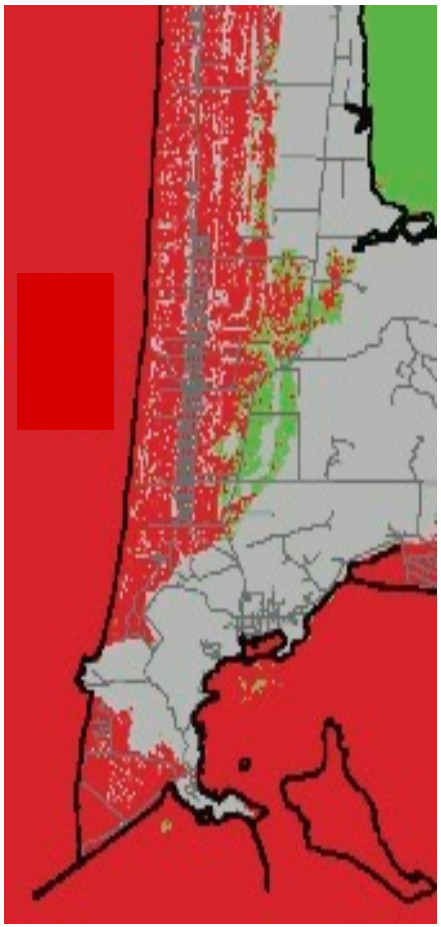
EX. Inundation of Majuro Atoll, Marshall Islands, from sources along the South American Andean and Japan subduction zones.

LiDAR (Light Detection and Radar) data provided a grid resolution of 1/3 arcSec [10 m]

Outcomes: Inundation to Evacuation Map

Max Inundation + Currents → Evacuation map





Long Beach, Washington (NOAA, WA EMD)

Key Points

Process

- Collect Data
- Identify scenarios to consider
- Determine sensitivity of impact area
- Compute inundation
- Develop composite of all solutions
- Document

Outcome --> Evacuation Map to prepare, plan for, and raise public awareness.

Thank You !

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