—DRAFT: Under Review by MMS—

Tsunami Modeling and Mapping: Guidelines and Best Practices

Part III: Tsunami Inundation Determination for Non-Modeled Regions[1]

National Tsunami Hazard Mitigation Program
Mapping and Modeling Subcommittee
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Purpose

This document specifies a set of guidelines and recommended practices for the determination of tsunami inundation zones in areas where there is a low hazard, based on historical occurrence of tsunami; a low risk, due to a low population and infrastructure vulnerability; or that may not have modeled inundation and evacuation maps in the near future and wish to initiate planning and preparedness efforts.

Guiding Principles

The National Tsunami Hazard Mitigation Program (NTHMP) is the nation's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within the United States and its territories at-risk of tsunami impact. The NTHMP strives to reduce loss of life and property damage from tsunamis by developing resilient coastal communities that are informed and prepared for all tsunami hazards to the extent possible. It is the responsibility of the NTHMP, through its Mapping and Modeling Subcommittee, to provide direction and guidance to communities in preparing maps that appropriately portray their tsunami risk. Tsunami inundation maps provide information necessary to support informed decision making, whether they are based on modeling or on estimation of tsunami inundation in the absence of modeling resources. Confidence limits of a map area that will be inundated by a tsunami may be improved later when resources become available.

Intended Audience

These guidelines are intended for government officials and/or community leaders in areas without adequate modeling and mapping capability or areas in which tsunami hazard is low.

Recommended Guidelines

First and foremost, whenever possible, consult with your NTHMP science or emergency management representative (http://nws.weather.gov/nthmp/documents/OfficialDesignees.pdf). Then, following the general guidelines below, the most hazardous areas can be estimated. It is recommended that separate procedures be considered for local (felt events with minutes to evacuate) versus distant (non-felt events

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[1] Formerly titled *Guidelines and Best Practices to Establish Areas of Tsunami Inundation for Non-Modeled or Low-Hazard Regions*

[2] This document was reformatted as part of the "Tsunami Modeling and Mapping: Guidelines and Best Practices" series in September 2016. Notable changes to the content are marked as "New" and in red while this document undergoes review.

with time to evacuate) scenarios. The recommendations provided below are mostly based on *Preparing Your Community for Tsunamis – A Guidebook for Local Advocates* (Samant, Tobin, and Tucker 2008).

- Base your maps on historical inundation information.
  - Where historical events exist, take the maximum runup and add a safety buffer. This can be based on historical events in the area or on geological evidence for past tsunami inundation (http://www.ngdc.noaa.gov/hazard/tsu.shtml).
  - The safety buffer should take into consideration the historical event sources, other known sources of local tsunamis, and local topography.
  - In situations where similar source, tectonic, and coastal regimes exist, interpolating between regional historical events to determine local inundation is reasonable.
- Choose a "reasonable" elevation for the area. Keep in mind the following:
  - The local topography—For most tsunamis, coastal areas, areas along bays, inlets, and rivers that connect to the ocean that are below 10 meters (~33 feet) are at risk. It is possible for very large tsunamis to be destructive even above this elevation, but these are rare.
  - The tectonic setting—Local tsunamis pose additional challenges due to limited time to evacuate and earthquake damage to evacuation routes. Distant tsunamis allow for time to drive from the area without local earthquake or landslide damage to consider. Know if you have local, distant, or both types of potential tsunami sources.
  - The distance from the local shoreline—Most locally generated tsunamis will no longer be destructive by 3 kilometers (~2 miles) inland. Low-lying areas along rivers that connect to the ocean should be designated as tsunami hazard areas for at least three kilometers inland and as far as ten kilometers inland for large, flat coastal rivers. Most tsunamis from distant sources chiefly affect beaches and waterfront areas within ~2 kilometers (1 mile) of the open coast.
- In situations where similar source, tectonic, and coastal environments exist and modeled inundation has been done elsewhere, interpolate inundation based on maximum modeled inundation in nearby/bounding areas.
  - If available, use low-resolution, regional simulations to estimate the relative amplification of tsunamis by offshore bathymetric effects.
  - Interpolation should take into account the behavior of tsunamis of similar size for terrain analogous to that of the target area, even for tsunamis from other parts of the world.
- Extrapolate lower-resolution model data on land to estimate inundation and add a safety factor for both inundation and elevation.
  - Current MMS guidelines for mapping and modeling specify a minimum grid resolution of 90 meter. If regional modeling has been completed at a lower resolution, a first estimate of inundation is to extrapolate the inundation on shore and add a safety factor for both inundation and elevation, since this method typically underestimates flooding.
  - New: Due to significant variability in local tsunami runup heights (due to local bathymetric and topographic effects) and uncertainty in numerical simulations of tsunami inundation, it is recommended that "the design runup elevation to be taken as 1.3 times the predicted maximum runup elevation to envelope the potential variability in the estimates of modeling" (ATC 2012). Hence, the safety factor 1.3 might be appropriate to extrapolate lower-resolution model data on land to estimate the inundation zone.
  - As previously mentioned, extrapolation should take into account the behavior of tsunamis of similar size for terrain analogous to that of the target area, even for tsunamis from other parts of the world.

- Consider using the Green's Law approximation for projecting offshore wave elevations onto a coast with a simplified 2-D method (Mei 1989, Synolakis 1991).

- In the absence of tsunami hazard information, hurricane storm surge maps, where available, may be used in consultation with your NTHMP science representative, for tsunami evacuation planning.

References

Applied Technology Council (ATC). 2012. Guidelines for Design of Structures for Vertical Evacuation from Tsunamis. Second Edition. FEMA P-646. Federal Emergency Management Agency, Washington, DC. http://www.fema.gov/media-library/assets/documents/14708

Mei, C.C. 1989. The Applied Dynamics of Ocean Surface Waves. World Scientific, Singapore.

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This document is part of the "Tsunami Modeling and Mapping: Guidelines and Best Practices" series. All the documents in this series are available on the NTHMP website at http://nws.weather.gov/nthmp/publications.html:

- *Part I: Tsunami Inundation Modeling*
- *Part II: Tsunami Inundation Maps*
- *Part III: Tsunami Inundation Determination for Non-Modeled Regions*
- *Part IV: Tsunami Evacuation Maps*
- *Checklist for Tsunami Modeling and Mapping Reports and/or Metadata*