

# Evacuation approaches, vulnerability assessment, and studies

- **Status of existing and planned work**
  - Short presentations by Wood, Nicolsky, and Allen
  - Necessary areas for future research? Collaborative opportunities?
- **NTHMP Evacuation Resource Webpage**
  - Template to summarize work?
- **MES Evacuation Planning Goals for 2018-2022 Strategic Plan**
  - Current guidelines:
    - MMS – tsunami inundation mapping
    - MES – tsunami evacuation mapping
    - Need for MMS/MES – tsunami evacuation-modeling?
- **Presentation on modeling-results access** (K Henry)

# Categories of evacuation studies

## Agent-based model

- To track individual movement along road network to safe point
- Focus on individuals or cars
- Good for specific scenario and likely congestion



## Least-cost-distance model

- To map travel times to safe zone by calculating “costs” due to varying land
- Focus on evacuation landscape
- Good for overall insight, mixed populations, and varied landscape





# Getting Out of Harm's Way

USGS research on evacuations for tsunami hazards

**Nathan Wood, PhD**

**Jeanne Jones, Jeff Peters, Kevin Henry, Jamie Jones Peter Ng, Matt Jamieson**

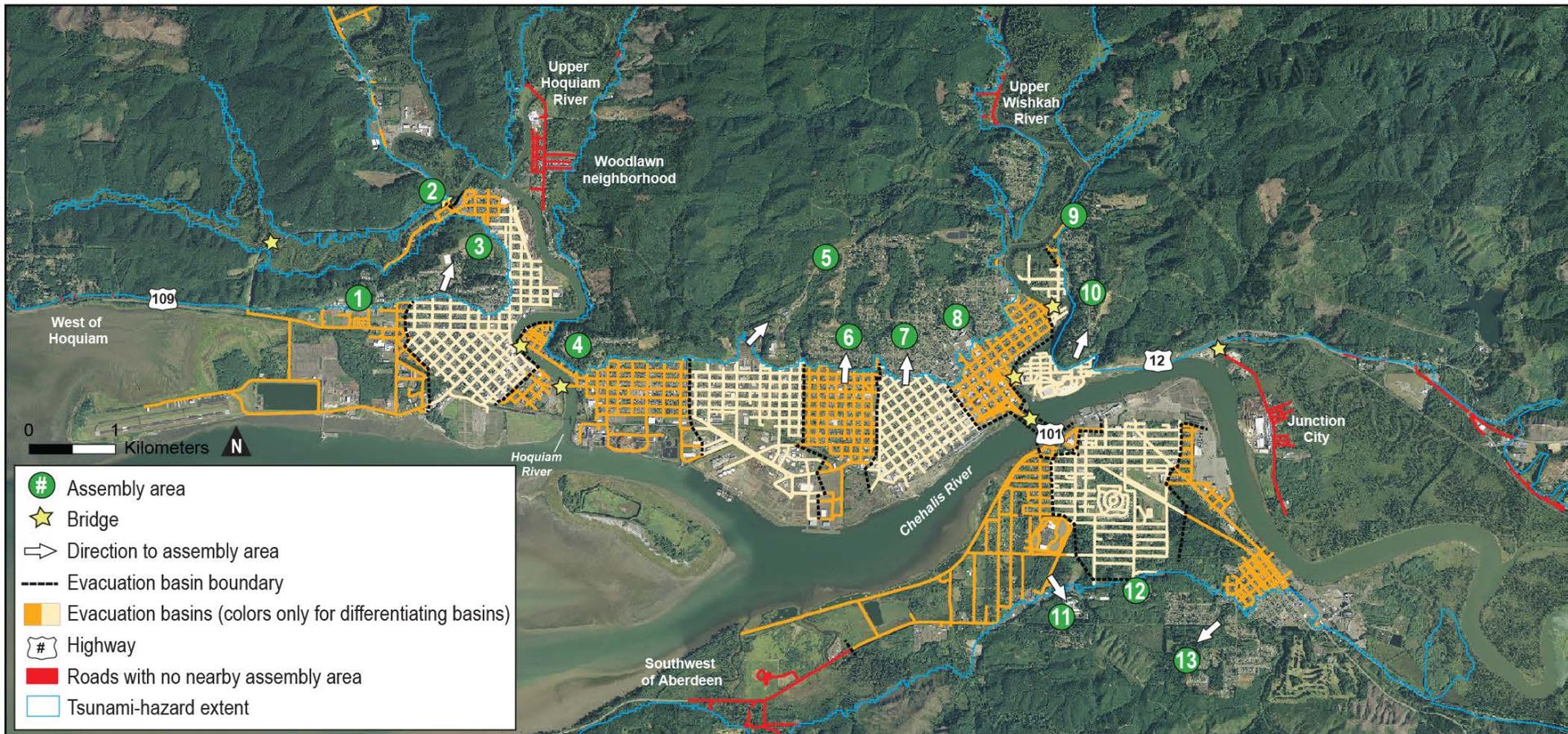
**Western Geographic Science Center**

**nwood@usgs.gov**

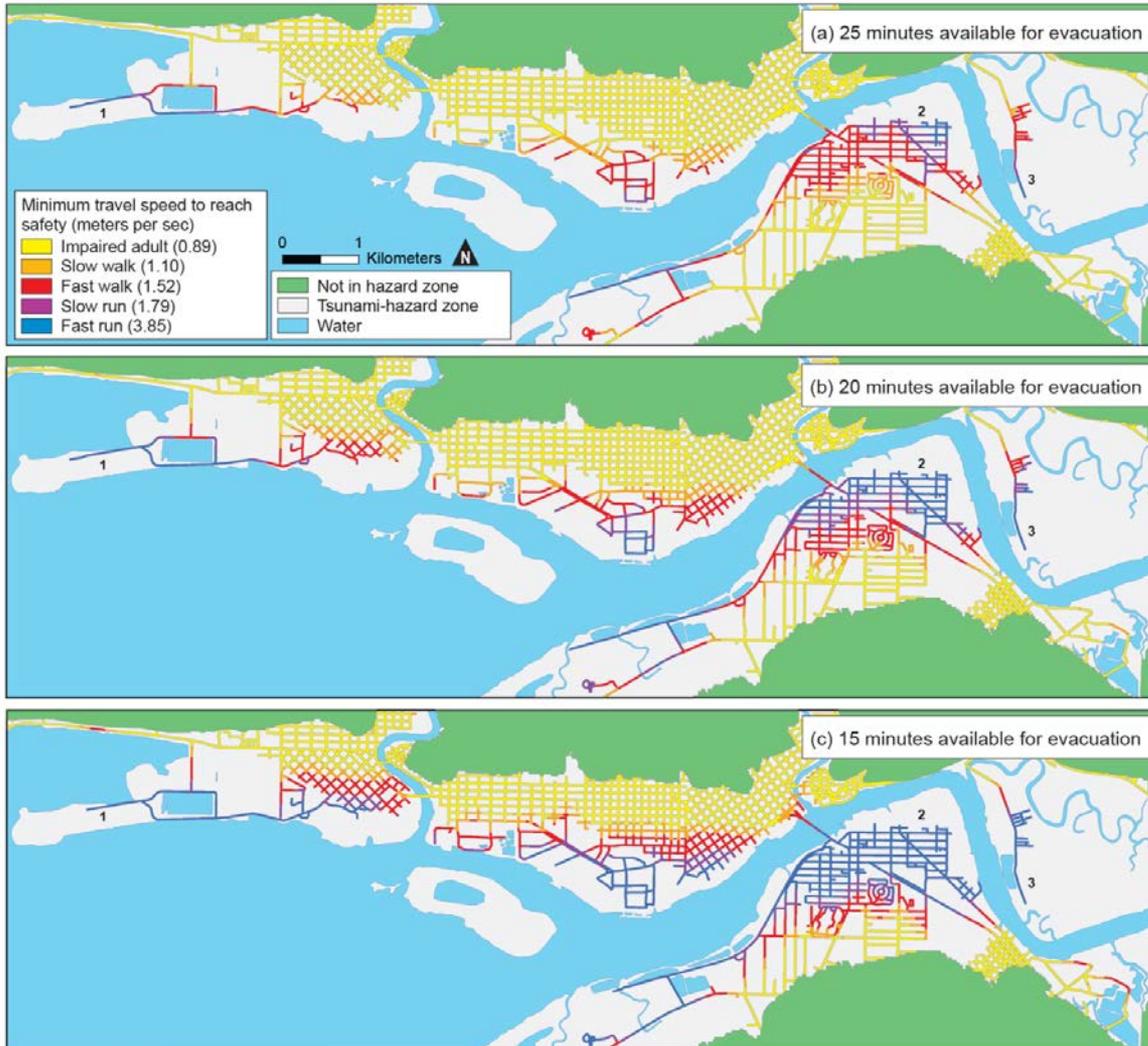
**U.S. Department of the Interior  
U.S. Geological Survey**

# Pedestrian flow-path modeling to support tsunami evacuation and disaster relief planning in the U.S. Pacific Northwest

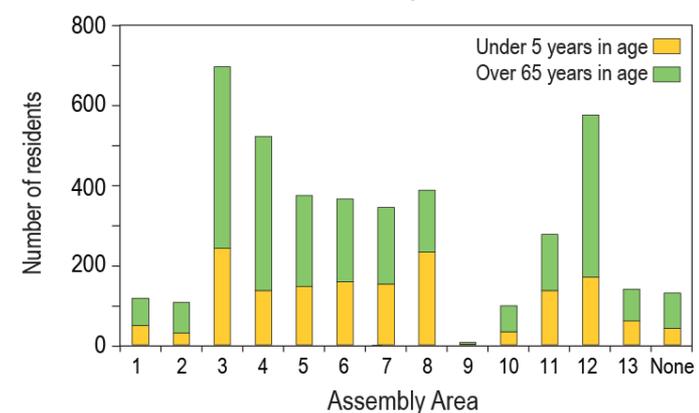
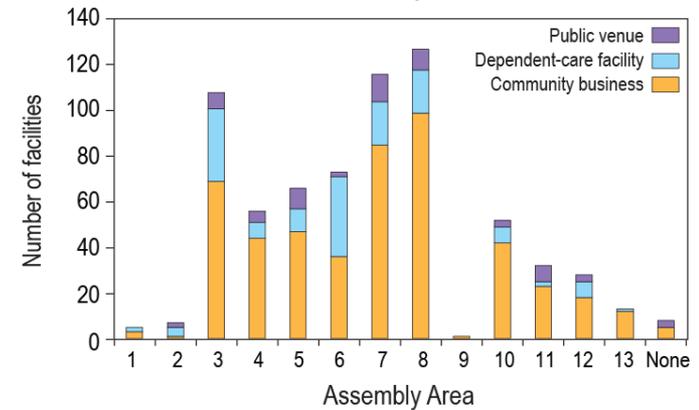
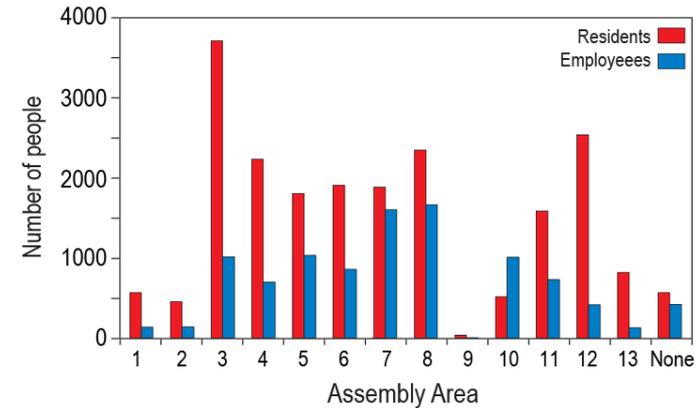
Nathan Wood <sup>a,\*</sup>, Jeanne Jones <sup>b</sup>, Mathew Schmidlein <sup>c</sup>, John Schelling <sup>d</sup>, Tim Frazier <sup>e</sup>



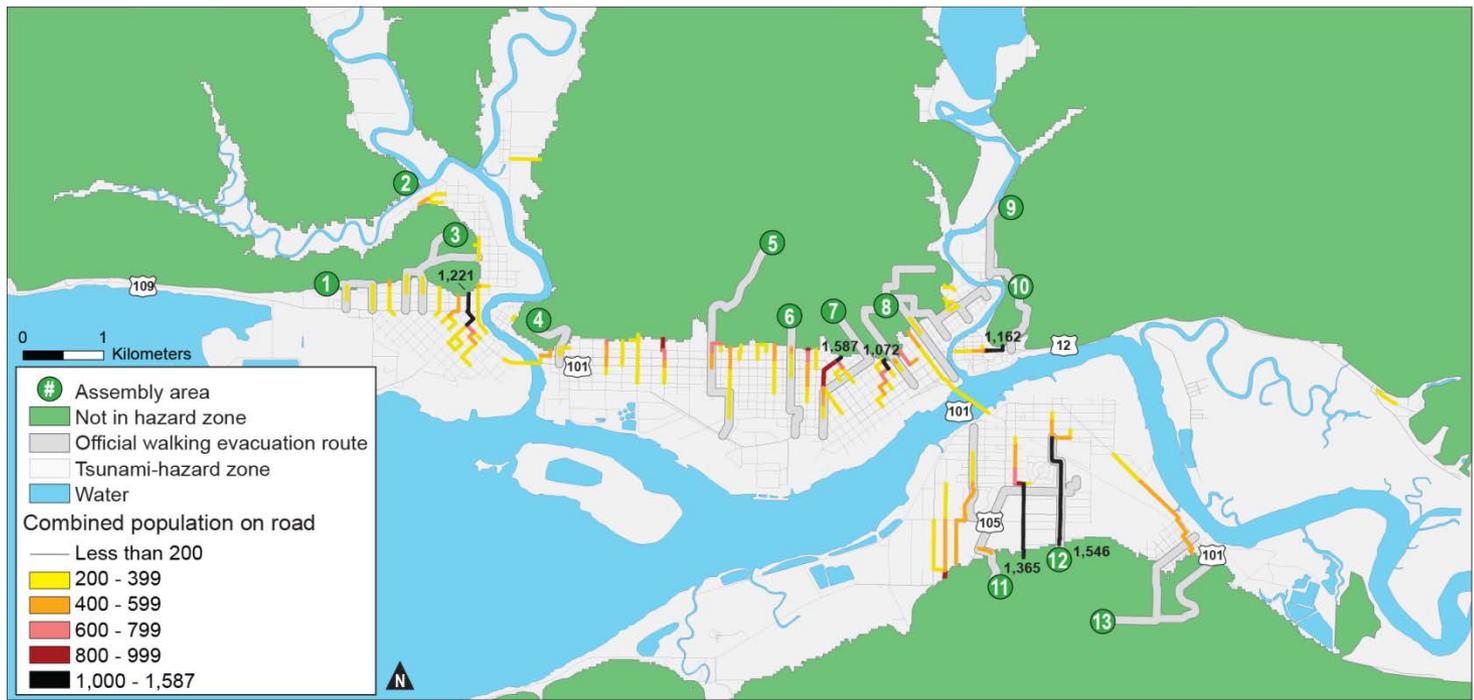
# Effect of departure delay on travel speeds



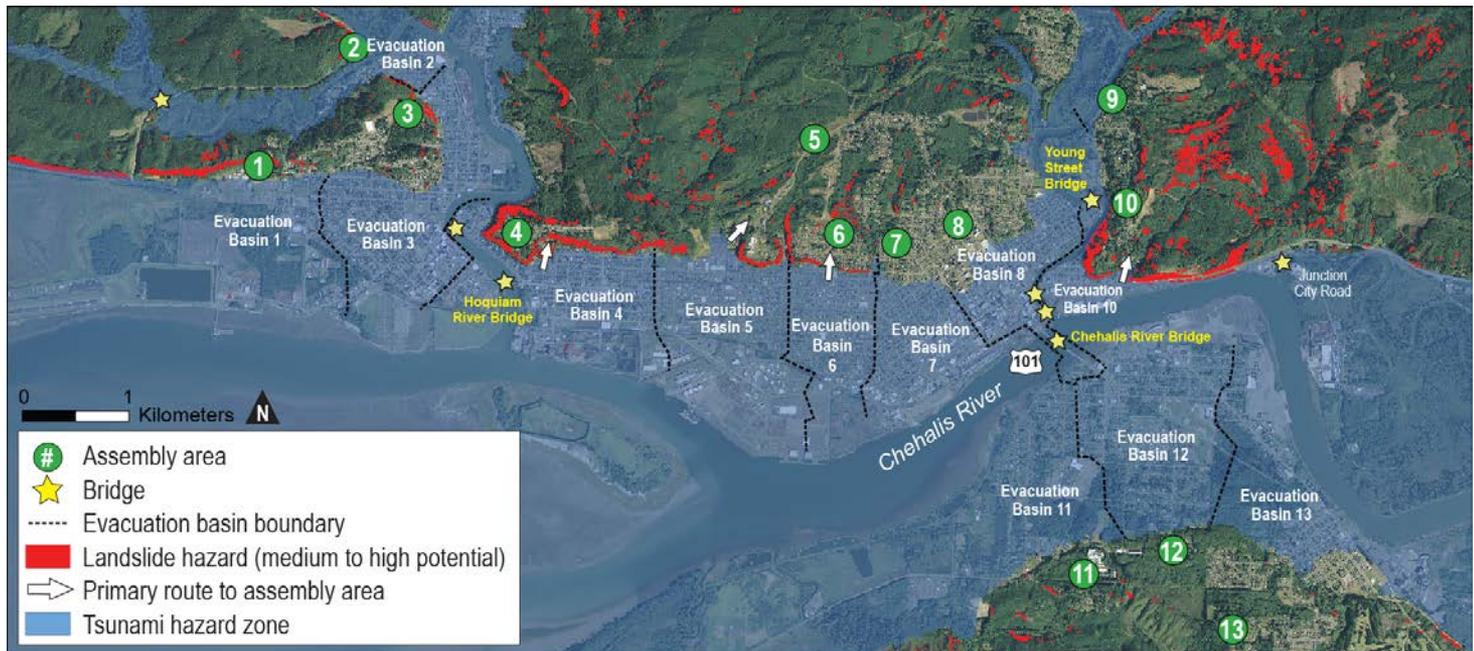
# Population demand at assembly areas



# Population on major pathways



# Potential for blocked routes due to landslides

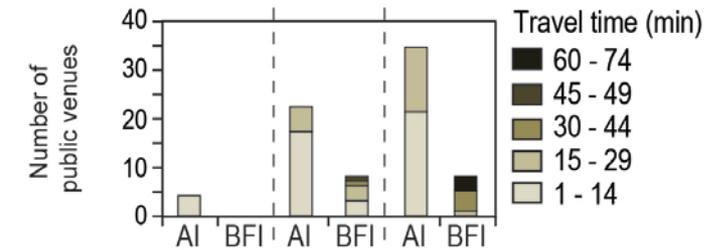
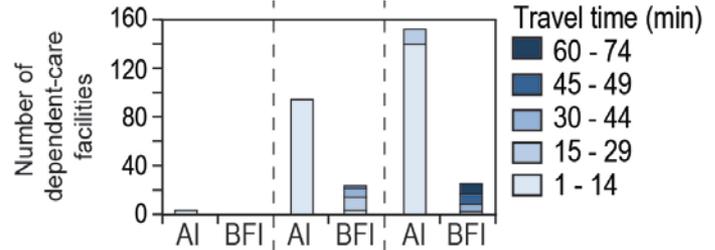
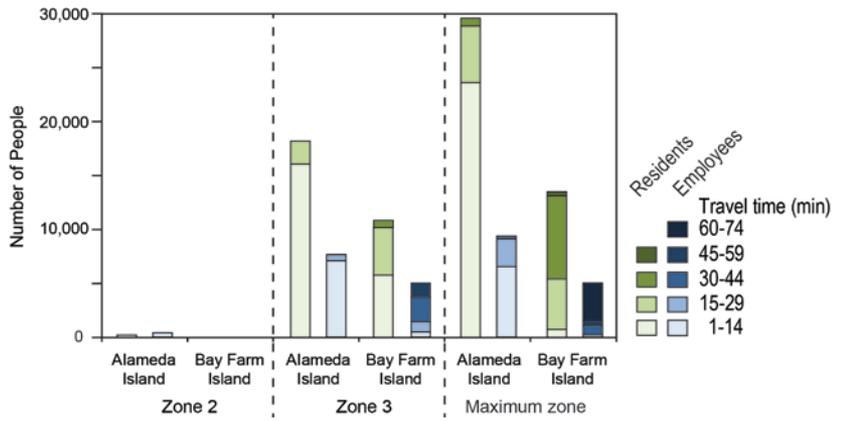
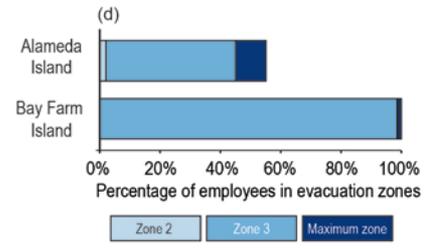
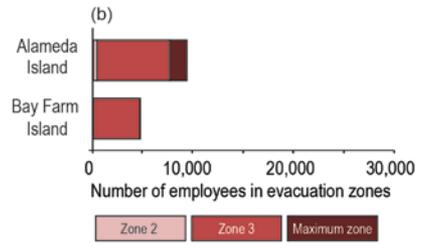
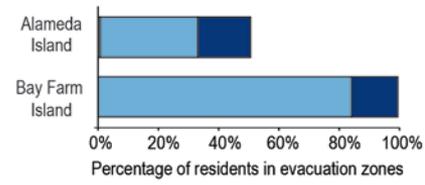
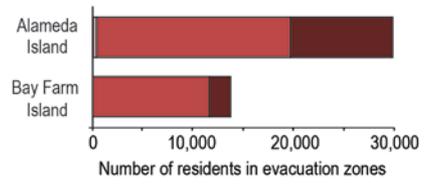




# Intra-community implications of implementing multiple tsunami-evacuation zones in Alameda, California

Jeff Peters<sup>1</sup> · Nathan Wood<sup>2</sup> · Rick Wilson<sup>3</sup> · Kevin Miller<sup>4</sup>





Prepared in cooperation with the Hawai'i Emergency Management Agency

## Community Exposure to Tsunami Hazards in Hawai'i

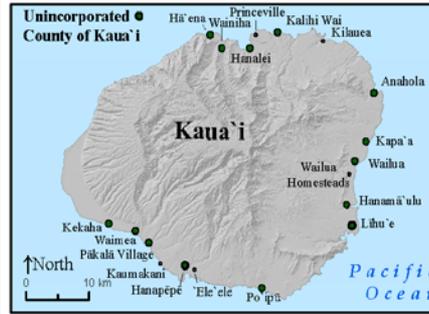


Scientific Investigations Report 2016–5053

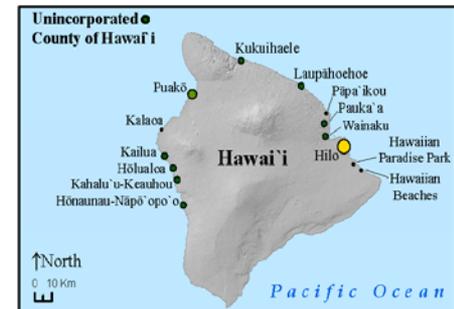
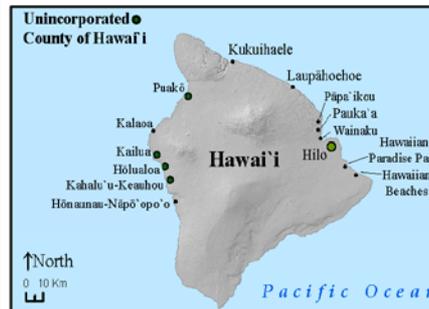
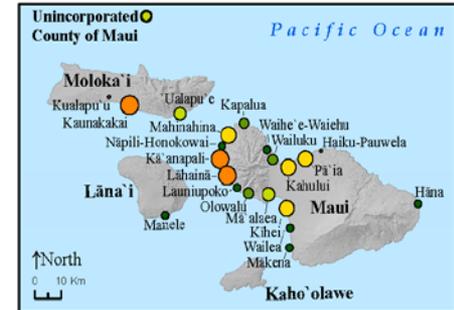
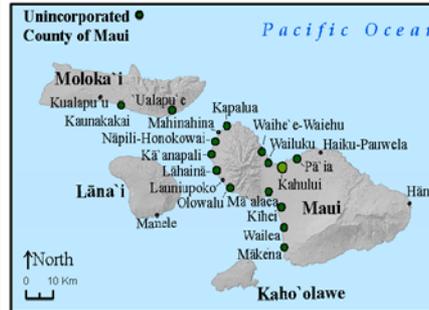
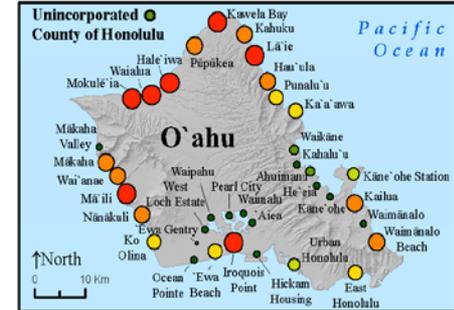
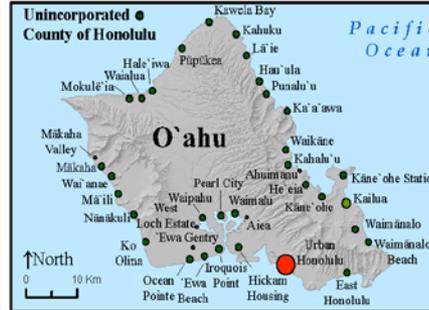
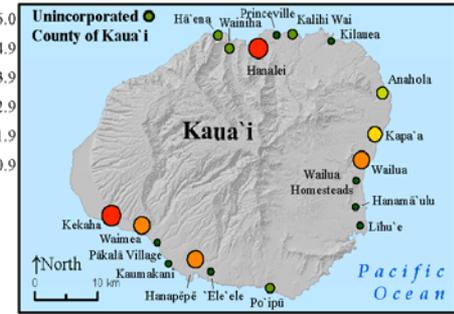
U.S. Department of the Interior  
U.S. Geological Survey

- Land cover
- Residents, employees
- Community-support businesses
- Dependent-care facilities
- Public venues
- Critical facilities

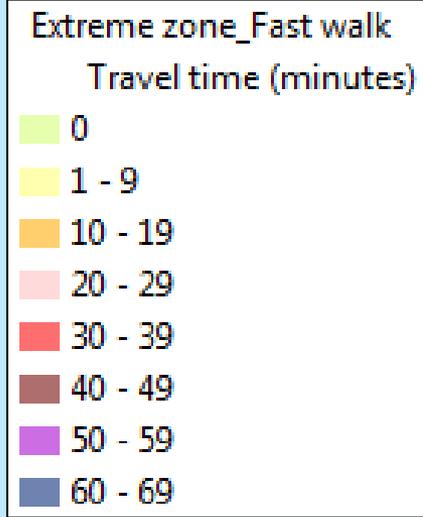
Composite Amount Index



Composite Percentage Index



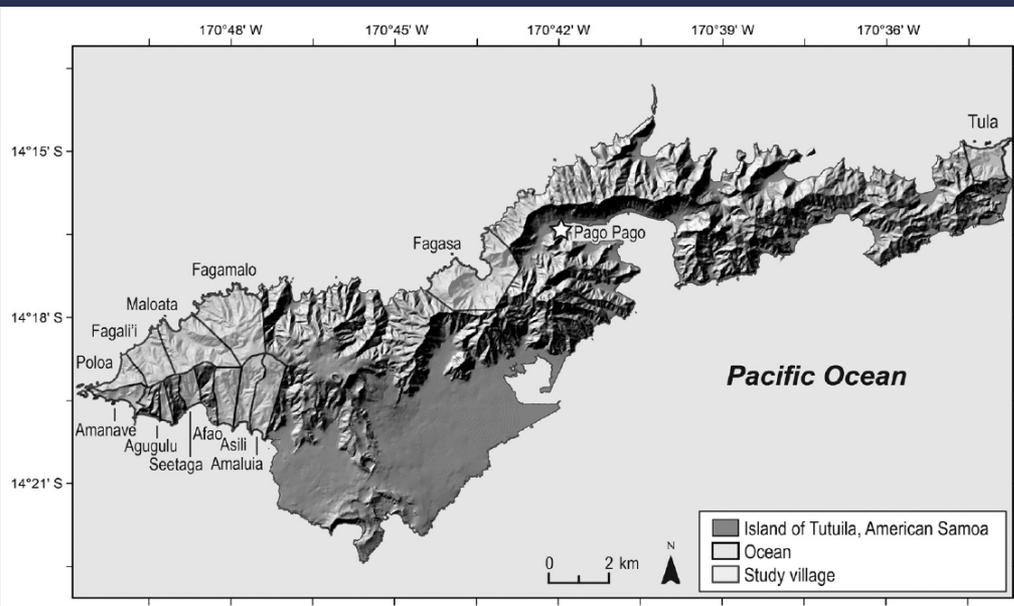
# Multi-modal evacuation modeling for Oahu



# American Samoa

## Modeling landscape changes to improve pedestrian evacuation potential

- Pedestrian-evacuation modeling with current landcover and then hypothetical cuts into the forests up to safety
- Focusing on where to possibly create new evacuation pathways

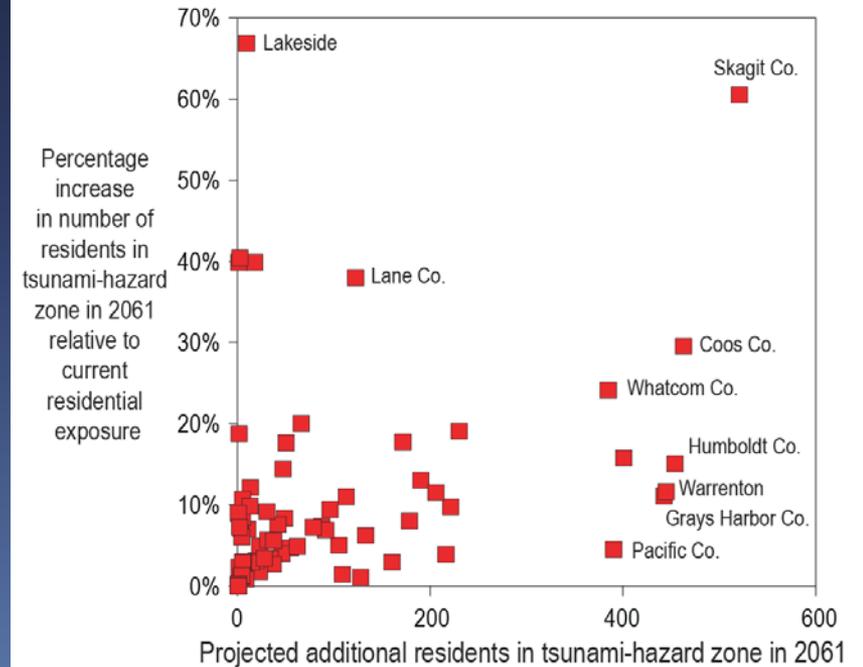
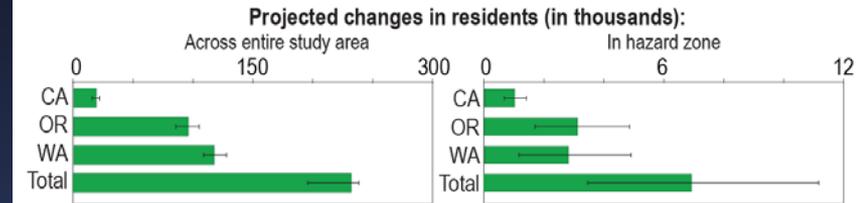
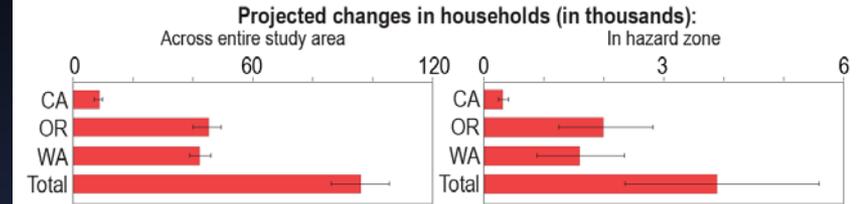
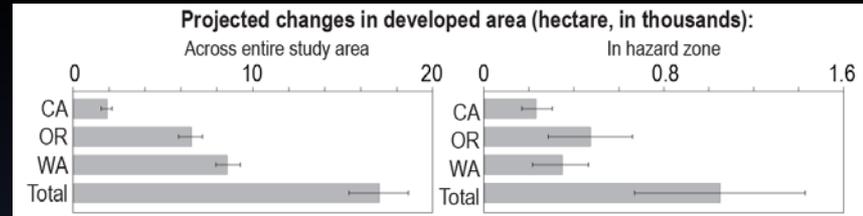


# Pedestrian evacuation potential for the California coast

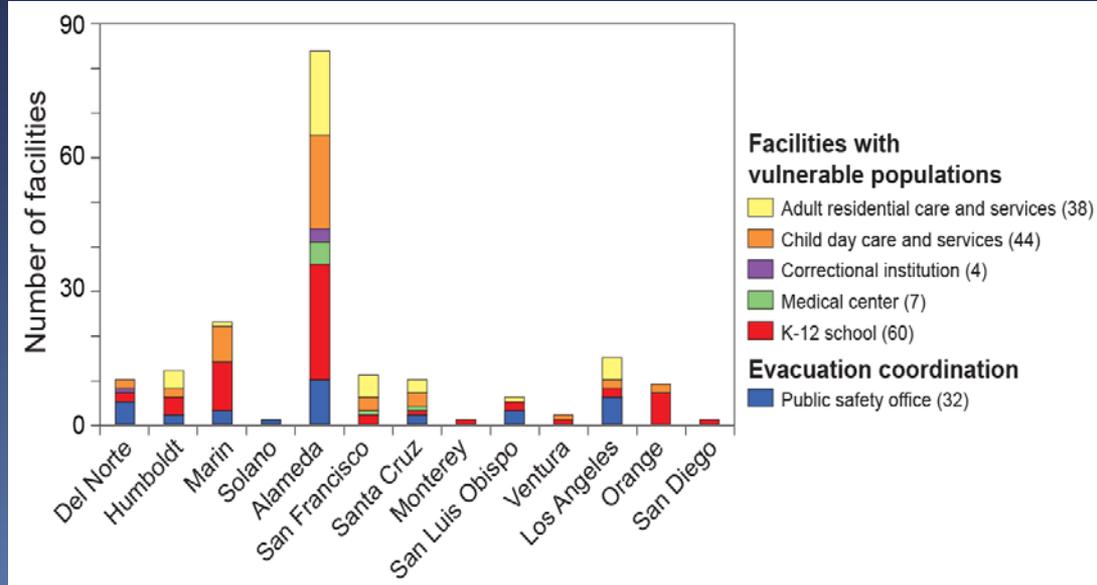
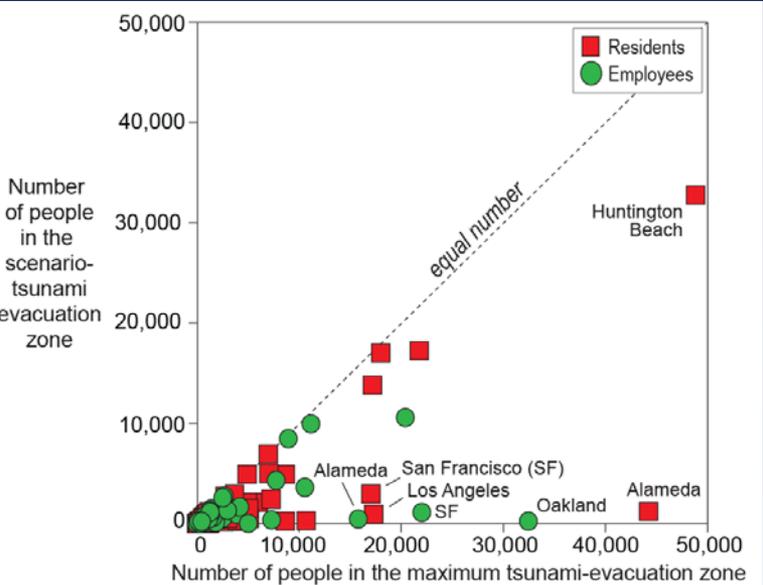
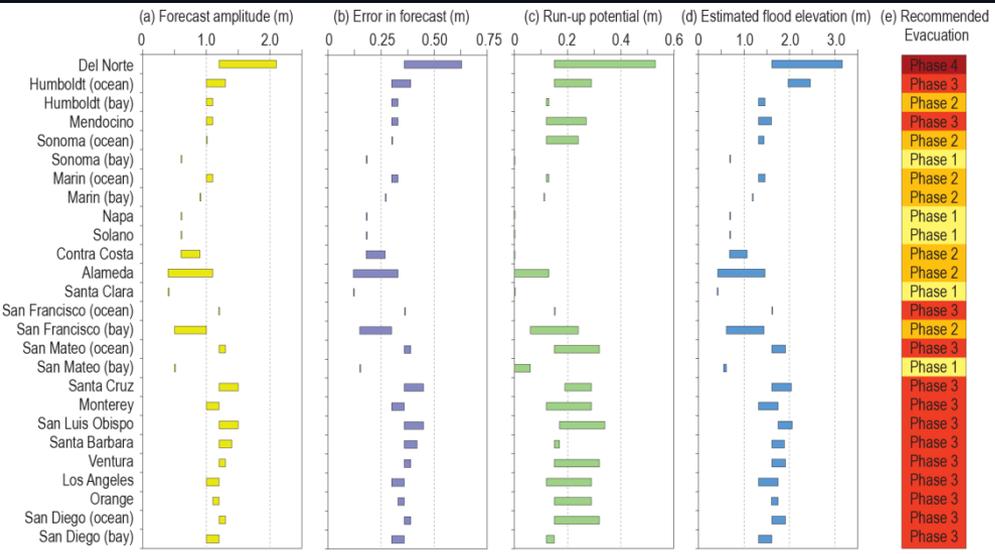
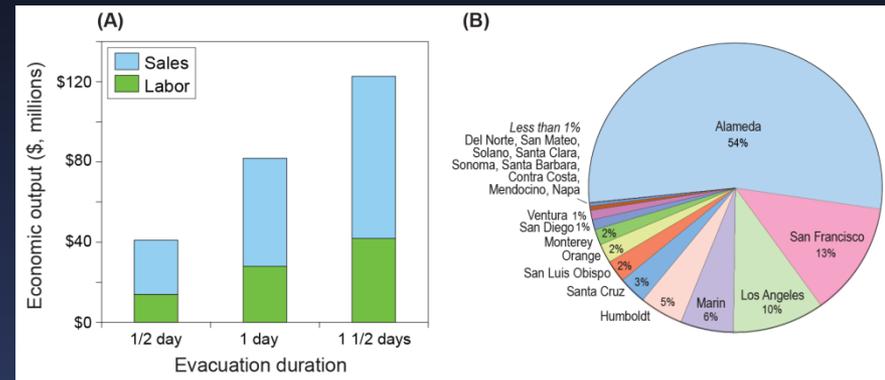
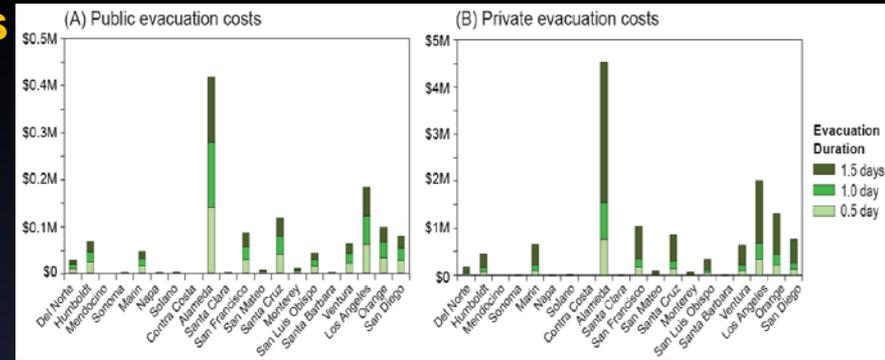
- Winter 2017
- Supports CGS with Seismic Hazard Mapping Act
- Likely to be roads-only
- Funding from USGS SAFRR



# Projected changes in community exposure to tsunami hazards in the U.S. Pacific Northwest based on a future development scenario



# Community disruptions and business costs for distant-tsunami evacuations using maximum versus scenario-based zones



# USGS tsunami-evacuation modeling to date

## Completed

- U.S. Pacific Northwest coast (Cascadia)
- California – Alameda (published), Balboa Island (in review)
- Bay Farm Island (vehicular) – in review
- Some Alaskan communities (Cordova, Kodiak, Seward, Valdez, Whittier)
- Statewide analysis of community impacts related to playbooks (in review)

## Underway

- Oahu (initial modeling complete, vehicular underway)
- Projected changes in community exposure to Cascadia tsunamis (in prep)

## 2017 plans

- American Samoa – opportunities for nature-based mitigation
- California coast – regional assessment of evacuation potential
- Optimization research for VE siting

# Group discussion

- Necessary areas for future research?
- NTHMP Evacuation Resource Webpage
  - Template to summarize work?
- MES Evacuation Planning Goals for 2018-2022 Strategic Plan
  - Current guidelines:
    - MMS – tsunami inundation mapping
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    - Need for MMS/MES – tsunami evacuation-modeling?
- Presentation on modeling-results access (K Henry)
- Where do we go from here?

# Suggested Guidelines and Resources for Tsunami Evacuation Modeling

## Introduction and Purpose

**Types of approaches** – community based, least cost distance, agent-based

## Modeling guidance

- Model data sensitivity
- Populations – types, distributions, scenarios
- Mode – pedestrian, vehicular, shuttle
- Travel speed
- Evacuation landscape - roads only vs. full landcover
- Barriers – fences, water bodies, ground failures
- Wave arrival considerations – single time, variable
- Evacuation delays (eq, human behavior)
- Vertical-evacuation siting
- Approaches to model verification

## Mapping guidance

- Maps
  - Travel time to safety?
  - Minimum travel speeds?
  - Evacuation basins?
  - Potential VE sites?
- Graphs
  - Distribution of people as a function of travel time to safety
  - Population demand at assembly areas
- Cartographic considerations
- Communicating limitations and disclaimers

## Use of modeling and mapping results

## Conclusions

## Appendix A. Case studies of recent tsunami-evacuation analyses