The Creation of High-Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-22 for Higher-Risk Coastal Areas in Maui, Hawaii

Sara Dixon, B.A. in Environmental Science at Colorado College

Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES), University of Washington

Cooperative Institute for CLIMATE, OCEAN & ECOSYSTEM STUDIES

Introduction

Until 2016, the U.S. did not have a national standard for tsunami building design codes. The American Society of Civil Engineers (ASCE) 7 2016 tsunami provisions established the building standards to ensure that coastal infrastructure and buildings are resilient after a tsunami hits [1].

The present project is to create higher resolution Tsunami Design Zone (TDZ) maps that are compatible with the ASCE guidelines to replace previously developed low-resolution TDZ maps for high-risk coastal areas in Maui, Hawaii.

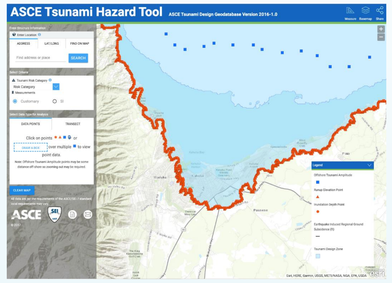

Figure 1: Existing TDZ maps for Kahului in the ASCE geodatabase

This project focuses specifically on buildings of Risk Category III and IV that have a major impact on the economy or civilians and essential facilities [1, 2].

The locations are for the census-designated places (CDP) of Kahului and Kihei-Makena (Figure 2). Both CDPs are highly populated locations which is why these maps are important for new infrastructure and building guidelines.

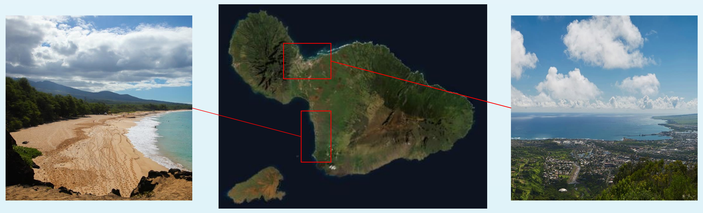

Figure 2: Map of Maui, Hawaii (middle). The two site locations are Makena (left) and Kahului (right).

Objectives

Develop high resolution probabilistic TDZ maps that are compatible with ASCE 7-22 standards for high-risk coastal areas of the island of Maui.

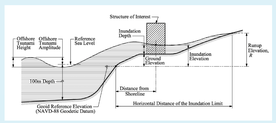

Figure 3: Key definitions in the ASCE tsunami design zone

- Run-up line
- 3-foot flow depth line
- Polygons of the flooding areas
- Wet versus dry zones

Methodology

- The data for the TDZ maps were derived from non-hydrostatic NEOWAVE model results, based on the Probabilistic Tsunami Hazard Assessment (PTHA) method. High quality Digital Elevation Models (DEMs) were also used to create and analyze the TDZ maps.
- The maps were created in ArcGIS Pro 2.8.1. which is a geographic information system application that allows for mapping and analyzing geographic information.

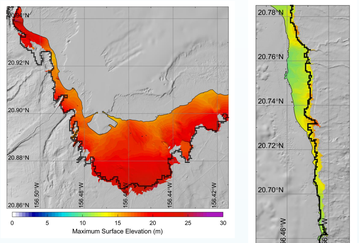

Figure 4: Model-computed TDZ for Kahului (left) and Kihei-Makena (right)

Results

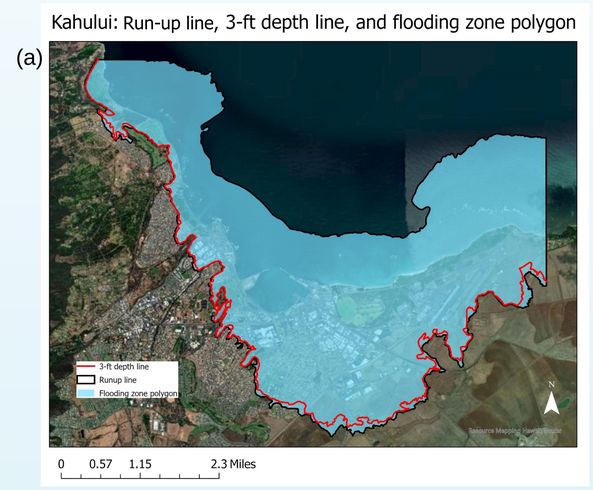

Figure 5: TDZ map products. **(a)** and **(b)** Kahului and Makena run-up line, 3-ft depth, and flooding zone polygon. **(c)** and **(d)** Kahului and Makena wet versus dry zones

Discussion and Future Work

The maps will be included in the new State of Hawaii building codes, the ASCE Tsunami Design Geodatabase Version 2022, and the upcoming ASCE 7-22 and 7-28 standards for future coastal building/infrastructure design in Hawaii [3]. All of which will be useful tools during the design of new and in progress infrastructure and building construction.

The high-resolution maps will play an important role in ensuring the accuracy of possible tsunami flooding. When the 10-m maps are compared to the 60-m maps, there are clear discrepancies with the 60-m maps. Although, the 60-m maps are more conservative in their predictions, it can lead to some areas not within the TDZ when they should be and vice versa.

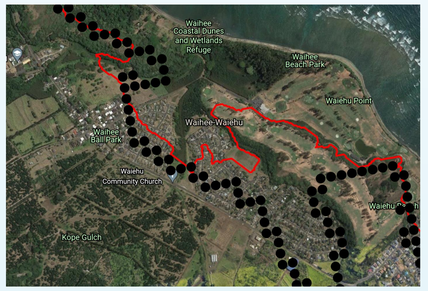

Figure 6: 60-m resolution run-up line (dots) and the 10-m resolution run-up line (red line) in Kahului.

I will be continuing my work on this project for my senior thesis. Possible routes are to look at the impact of these tsunamis on water quality/budgets in the flooded zones or on the reef systems.

Acknowledgements

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References

[1] Chock, G.Y.K., L. Carden, I. Robertson, Y. Wei, R. Wilson, and J. Hooper (2018): Tsunami resilient building design considerations for coastal communities of Washington, Oregon, and California. J. Struct. Eng., 144(8), 04018116, doi: 10.1061/(ASCE)ST.1943-541X.0002068.

[2] Wei Y. (2016), Tsunami probabilistic reference maps for benchmarking Hawaii tsunami design zone maps per the ASCE 7-16 standard, Tech Report submitted to Hawaii Emergency Management Agency, p54.

[3] Robertson, I., Y. Wei, K.F. Cheung, Y. Yamazaki, and P. Lynett (2021),"Development of High-Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-22 for Higher-risk Costal Areas of the Island of Maui – Phase I, State of Hawai'i", Final Informational Meeting, July 16, 2021.