

GEOL 308L: Natural Hazards

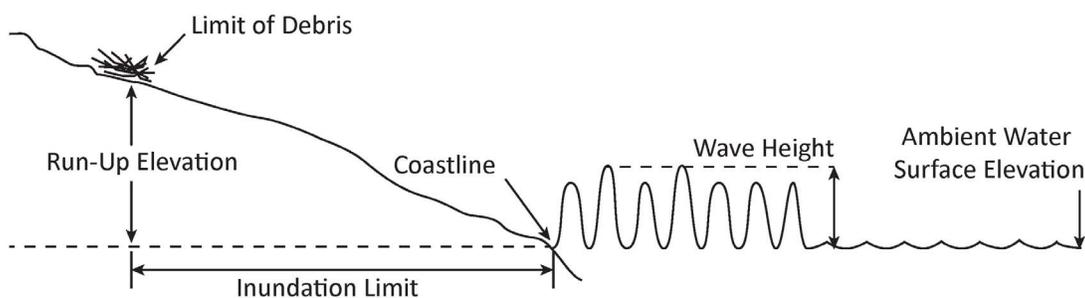
Lab 08: Tsunami Hazards

Background on Tsunami Hazards

Numerical modeling of tsunami run-up elevations is quite costly and time intensive. Tsunami modeling in Oregon took many years. Tsunami modeling in California is following the methods used by the state of Oregon and are still in progress. Prior to these numerical models, we relied on rule-of-thumb approaches to tsunami hazards. In many places, people are still relegated to these rule-of-thumb approaches.

You have been awarded a small grant to prepare some maps for a small community in northern California. There are some existing data from the region that suggest a range of run-up elevations for different types of tsunami. You have been provided a summary of these data from a subject matter expert. There are three levels of hazard for which these data apply: (1) distant tsunami, (2) local tsunami, and (3) local tsunami, worst case scenario. Distant tsunamis are tsunamis from sources at large distance from northern CA. Local tsunamis are tsunamis from sources in close proximity to northern CA (the Cascadia subduction zone). The worst case scenario includes a range of phenomenon that tend to increase tsunami run-up elevations.

Below is a diagram that illustrates the different measures of a tsunami size. Wave Height is the elevation above the ambient water surface elevation at the time of measurement. Run-Up Elevation is the elevation above some vertical datum (typically mean sea level) that which the tsunami reaches during inundation. Inundation Limit refers to the maximum horizontal distance that the tsunami reaches during inundation. Ambient Water Surface Elevation (AWSE) is the elevation above some datum (typically mean sea level) that the water surface is at the time of measurement. This AWSE may be affected by tides, storm surges, river discharge, or other local or regional factors. Numerical models are often calibrated in real time with buoy data relative to wave height, but calibrated to prehistoric tsunami deposits relative to run-up elevation. Run-up elevation and inundation limit are both affected by many factors not yet incorporated into these numerical models (surface roughness, wet vs. dry ground, etc.).



Objectives

The student will learn to:

- Understand and apply a multiple factors that affect tsunami run-up elevations
- Estimate tsunami inundation limits for a range of tsunami types
- Compare a simple tsunami hazard model with numerical estimates of tsunami inundation
- Prepare a tsunami evacuation maps

GEOL 308L: Natural Hazards

Lab 08: Tsunami Hazards

Data Sets:

- 10 m resolution Digital Elevation Model (DEM, Hillshade)
- Road shapefile
- California Geological Survey Tsunami Inundation shapefile

Part I. Raster Analyses

Step 1. Develop hazard-elevation relations

Use the following hazard-elevation relations to develop a regression with which to convert a DEM from elevation units to hazard units. First, enter these data into a spreadsheet. Second, plot these data and place a regression line onto the plot (elevation needs to be on the horizontal axis). Use a polynomial regression. Add the formula for the regression. This is the formula that will form the basis for your raster algebra terms.

Hazard Level	Elevation (m)	Hazard Unit
High	0	0
Medium	3	100
Low	10	200
No	25	300

Step 2. Prepare tsunami hazard surface

Use the raster calculator to convert the DEM from elevation units to hazard units based upon the regression formula. A volunteer from the community that you are helping prepared a DEM that ranges in elevation between 0 and 25 meters, which is the range for which your regression is valid. Save your new raster in your derived folder with a cool name like "GEOL_308L_lab_08_tsunami_regression.tif."

Part II. Visualization

Step 1. Prepare tsunami hazard surface color ramp

Use the legend editor to select colors to represent the different hazards. One may spend considerable time creating a custom color ramp to display tsunami hazard in a gradational manner. Below are the steps to create a custom color ramp from the ESRI website. The steps may be slightly different. Use the help in ArcMap to help determine the best steps to take.

1. In ArcMap, click on the Customize menu, and then click Style Manager.
2. Expand your local profile.
3. Click on the Color Ramps folder.
4. In the right panel, right-click, select New, and click Multi-part Color Ramp.
5. Using the Add > Algorithmic Color Ramp option, add in as many parts/colors as you need.
6. Now double-click on each algorithmic color ramp, and choose the exact color that is needed.
 - a. Under Color 1, click the dropdown to choose the color.
 - b. Once you have chosen the color, click OK on the Edit Color Ramp window.
 - c. Continue to edit each color until you have the desired color ramp.
7. Once you are satisfied with your color ramp, click OK on the Color Ramp window.
8. In the Style Manager, rename your color ramp to a custom name.
9. Click Close on the Style Manager, and now you are ready to use your color ramp with any data.

GEOL 308L: Natural Hazards

Lab 08: Tsunami Hazards

Also, one may use colors for specific ranges of hazard values. Copy and paste the raster layer. Then, edit the colors in the legend editor. Choose hazard ranges for the four levels of hazard and use colors like in the table above (red, orange, yellow, and white).

Step 2. Compare with California Geological Survey Tsunami Inundation data

Visit the Humboldt County GIS data download site. Scroll down and download the tsunami inundation shapefile. Unzip the data and load it into ArcMap. Compare these data with the data that you created. Think about what factors were not incorporated into your raster model. What are these factors? How would they affect tsunami hazards?

Step 3. Prepare tsunami hazard maps

Utilize the GIS data available to prepare two tsunami hazard maps that could be used to educate the public about tsunami hazards. There could be a disclaimer about the source of the data. Don't forget to include the important parts that belong on all maps. Remember about hierarchical composition.

One map will have hazard represented as a gradational change in color from red to orange to yellow to white. The second map will have hazard represented in steps of color as in the table above.

Label geographic locations like towns and major roads and highways. These geographic locations are important for the public to be able to use these maps effectively.

Export the maps as pdfs and email this to the instructor along with the other deliverables.