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Michale Scott Dixon

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Assessing Socio-Economic Risk of Affected Populations in the Path of Lahars Flows from Mount Rainier

Michael Scott Dixon- Urban Studies & Geographic Information System Certificate Program 2012

UNIVERSITY of WASHINGTON
TACOMA

Purpose

The Puget Sound region has experienced increased growth over the past ten years. What this means is that more people are attracted to the area because of the region's job climate, and its natural outdoor activities.

What strikes as a major concern is that cities in the Puget Sound region live in the shadows of Mount Rainier. The combination of having great populations living in close proximity and downstream, from a dormant volcano can result into catastrophe. An event like this was seen with the 1991 eruption of Mount Pinatubo. (U.S.G.S Fact Sheet 113-97) In this instance, the volcano affected the lives of 3 million people within the region of Mt. Pinatubo. Mount Rainier has the potential characteristics of what can happen during an eruption. The Puget Sound Region has 3,690,900 people living and working amid the dormant volcano. (US Census, 2012)

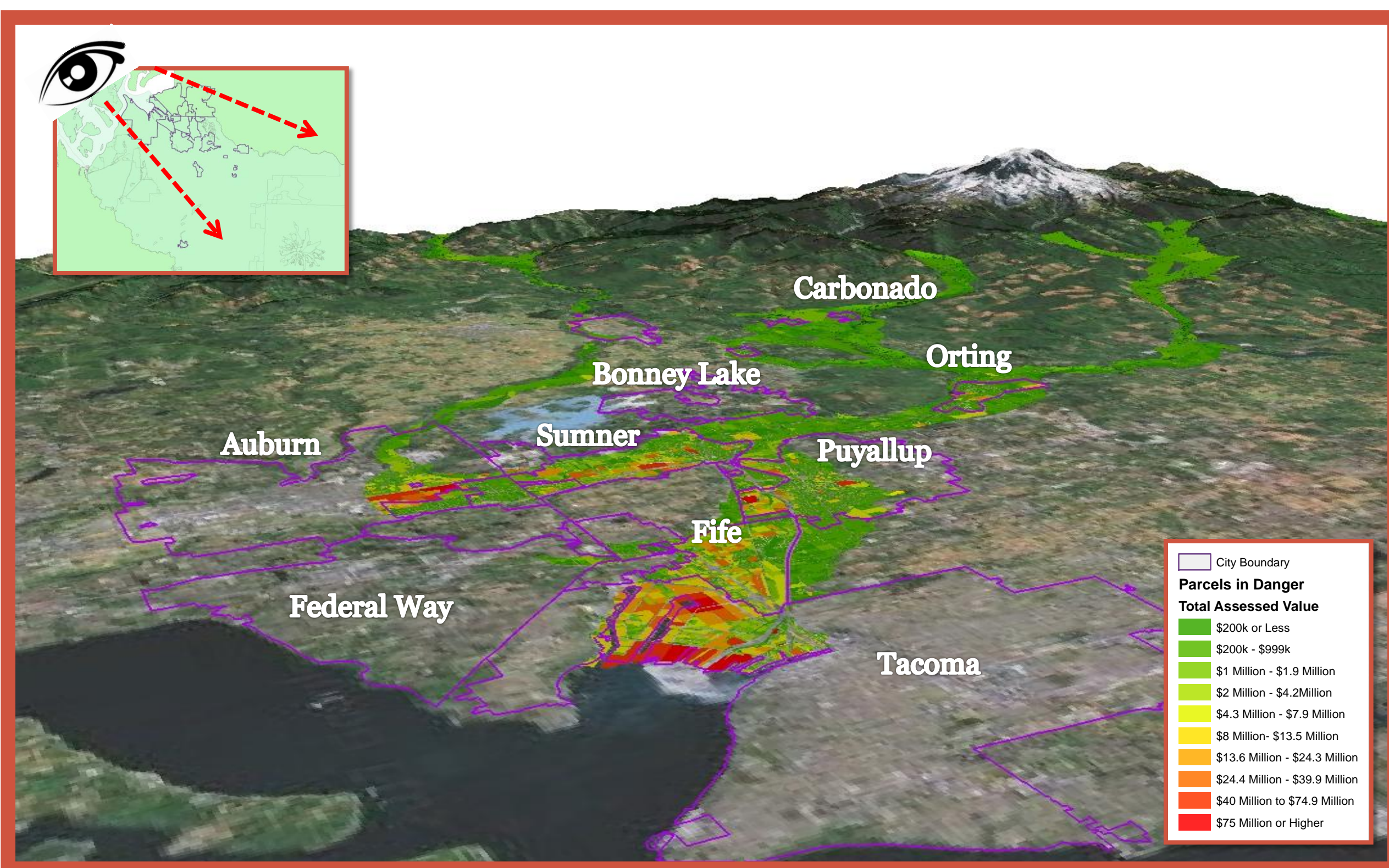


Figure 2. 3-Dimension map analysis of parcels within catastrophic lahar flows also visualizing assessed land values

Objectives

In the recent disaster of Hurricane Katrina, it highlighted the direct linkages between the ability to evacuate with the standing of socio-economic status. Where people of lower socio-economic status did not have the ability to leave the impacted area and so they were more at risk to the inevitable outcomes. The purpose of this project is to analyze the "geography of risk" of the population in order to determine the characteristics and demographics of the lay of the land. This project seeks to find in the event of a major eruption of Mt Rainier will it have the same implications of socio-economic risk in comparison to the characteristics of Hurricane Katrina?

What this project seeks to measure is the socio-economic risk by doing a calculation of different socio-economic factors that will deem a census tract as either high or low risk of people needing help to evacuate. The factors are: Median Income, Children under 18 population, Population without vehicles, Population below poverty, Disabled population, and Median House Values. With these values, the project will seek to create an analysis of what areas and populations will need help in the evacuation process.

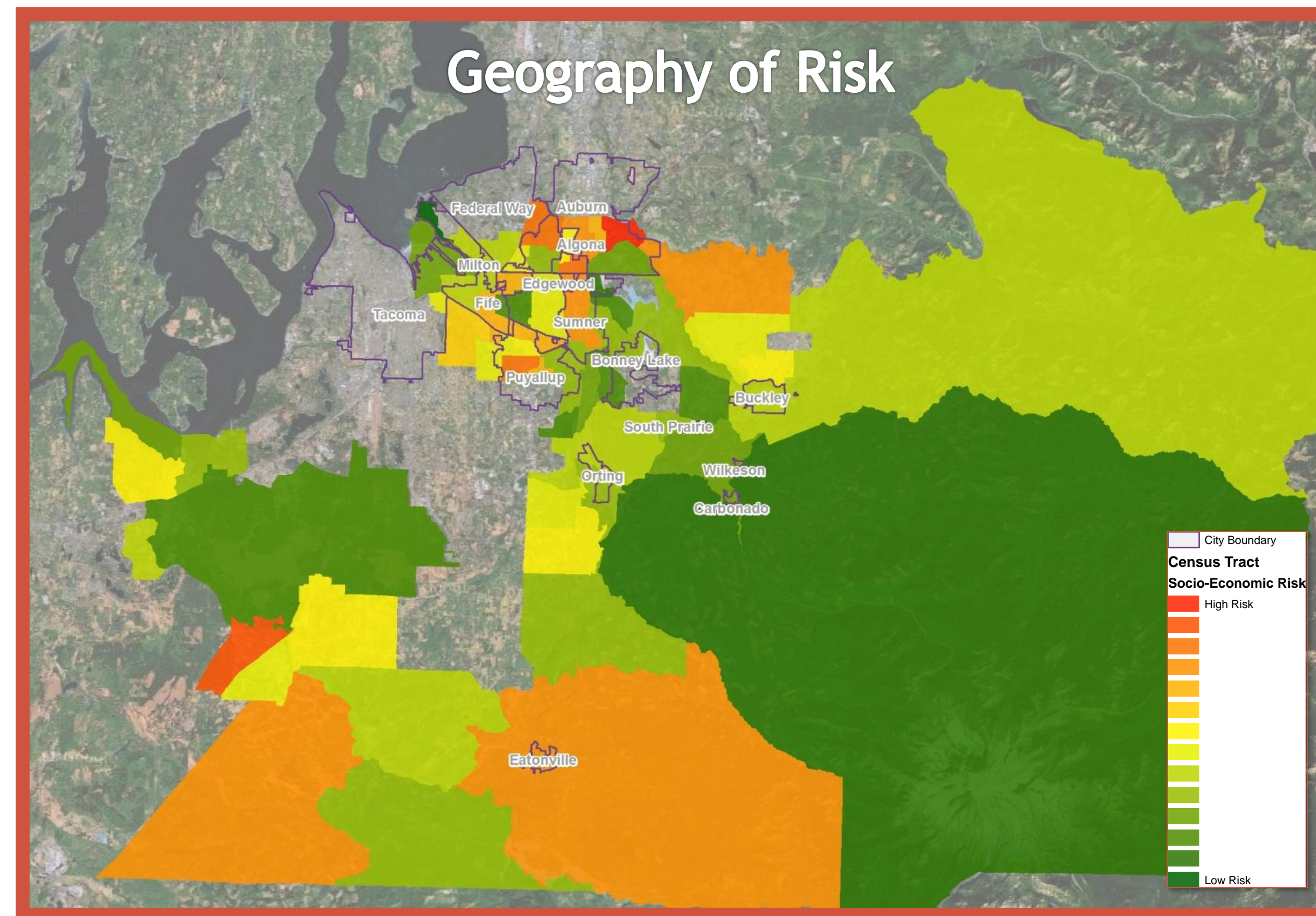


Figure 1. This map shows the affected Census Tracts using a socio-economic index to locate populations most at risk

Methods

To attain the necessary data for the project the US Census provided all the variables at the census tract level to complete the research. Once collected on a single table it was exported to the file geodatabase and spatially joined to the corresponding Census Tracts polygon shapefile.

To standardize the variables to index the next step was to use the attribute tables. To do this in my attribute table I used the statistics tool to get the MEAN and STANDARD DEVIATION for each of the variables and recorded these numbers down. I created a new field (type Double) to correspond with each SES variable. I named them "Zpoverty, ZIncome, ZChildren, ZNoCar, ZElderly, ZMedianVal, ZDisabled" to refer to the statistics to calculate. A standard score is a z-score and within these new Z fields I performed the calculation: $((\text{VariableField} - \text{MEAN}) / \text{STANDARD DEVIATION})$. What this calculation does is subtracts the mean poverty rate from each Census Tract's SES variable and then divides the outcome by the standard deviation of the entire set. Each z-score equals the variation from the mean. From this data the indexing was now ready.

The next step is to create a new class from these scores. To classify z-scores: 1) Select all cases in which the z-score is less than or equal to negative 2. Keeping those selected, enter "-2" in the new Z-Class field; 2) Now select all cases with a z-score is greater than -2 but less than .5. Enter "-1" in the ZClass field for these cases in the Z-Class; 3) Select cases with poverty z-score between -.5 and positive .5. Classify these as "0"; 4) Select cases with poverty z-score greater than .5 and less than 2. Classy as "1"; and 5) Select cases with poverty z-score greater than or equal to 2. Classify as "2".

This procedure was now done across all of the Socio-Economic variables. Once completed the last step was to create a last field which was labeled as "GeoRiskIndex" which used the formula:

$$[\text{ZIncomeClass}] + [\text{ZChildrenClass}] + [\text{ZNoCarClass}] + [\text{ZPovertyClass}] + [\text{ZElderlyClass}] + [\text{ZMedianValClass}] + [\text{ZDisabled}]$$

This added all of the classifications where the resulting number indicated the risk of each Census Tract. The lower the classification numbers the higher the risk and vice versa. To represent this on the map the use of a red to green color ramp was attached to the corresponding numbers. The results correspond to Figure 1.

Results

What the findings show is that 26 of the 67 Census Tracts assessed have a "Low Risk" calculation of socio-economic factors where populations who do have the ability to evacuate can do so with less assistance. 24 of the 67 have a "Moderate Risk" where more efforts would be needed to evacuated in the event of a lahar. 17 of 67 Census Tracts have a "High Risk" of socio-economic factors where populations do not have the ability to evacuate or will need greater help to evacuate. These populations are more located in the urban centers of the Puget Sound such as cities of Auburn, Kent, Puyallup, Edgewood, Federal Way and outlying Eatonville.

Surprisingly, the analysis indicates that more people higher socio-economic factors are living within the path of Mount Rainier that is why the map is depicting a "Low Risk" score because these populations have the ability to evacuate, then the ones measured. What the data shows is that people in lower socio-economic standing are not being placed in an environmental unjust location as with Katrina. Here environmental injustice is focused on populations with higher socio-economic standing where they choose to live with a potentially hazardous area.



Figure 3. Digitized evacuation routes within the Puyallup River Valley

Citations & Acknowledgements

- N. Wood and C. Soulard "Variations in Population exposure and sensitivity to lahar hazards from Mount Rainier, Washington" (2009). Journal of Volcanology and Geothermal Research. Pp376-378
- Janda et al. "Assessment and Response to Lahar Hazard around Mount Pinatubo, 1991 to 1993" (2006) USGS <http://pubs.usgs.gov/pinatubo/janda/>
- K. Scott and J. "Valance History of Landslides and Debris Flows at Mount Rainier, Washington" (1993)
- U.S. Department of the Interior, USGS "Mount Rainier- Living safely with a volcano in your backyard" (2008)
- Special Thanks to my fellow GISers and Matthew Kelley to help steer this project into fruition! It was greatly appreciated.
- For my full report please follow the link: <https://sites.google.com/site/gisportfoliomichaeldixon/home/mt-rainier-lahar-gis-final-project>

Disclaimer: This analysis measures factors based on specific characteristics of Census Tract populations. It should be noted that *all populations are at risk* in the event of an eruption. Please follow all evacuation procedures by your local governments