Michael Dixon
TGIS415
UWT

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

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.

As a state, there have been measures to channel growth in to certain areas as a means to manage where populations can go. Each municipality must have a growth management plan to help mitigate and plan for growth. This is a great way to evaluate and anticipate development. What strikes as 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 as well as shutting key U.S. military installations. 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 as well as military, ports and interstates. (US Census) There is a hazard response plan for Mt Rainier that states the history, monitoring, warning system, and evacuation routes for cities that are downstream from debris coming from Mt.

Rainier. With cities' continued growth and plans in place, it raised the issue of looking at the characteristics of the populations to see if there were any vulnerable populations in the path of the lahar. This raised the question of socio-economic standing with a different disaster that pointed out environmental injustices to a population.

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?

Planning

To analyze this question I would comprise my research by first collecting the essential data that I needed in order to create geography of risk analysis. This would include: The geographic extent, the audience of the project, and who is at risk. Figuring out the extent of the project was the first information that was critical to finding the geography of risk. The geographic extent would be within Pierce County but also looking the lahar flows that affect municipalities and other businesses in the Puyallup River

Valley. This extent would be sufficient because of this valley being the most populated where the most damage can occur structurally.

The audience of this project would the population of Pierce County at large. This includes residents of Orting, Puyallup, Fife, Tacoma, Milton, business owners, and other parties doing operations within the valley. The project has the potential to update the Pierce County Emergency Management. Under the PCEM includes agencies like Red Cross, JBLM, Puyallup Tribe, USGS, WSDOT, WSP, US Corps of Engineers and elected officials. Another interested party would be the Port of Tacoma being that this is the mouth of the Puyallup River; a Lahar would drop great volumes of sediment and debris causing operations to cease. This port is one of the nation's largest ports where services reach to states in the Midwest and 70% of all Alaskan goods come through this port. (Port of Tacoma, 2005) This recognized list is importance because it covers all of those who are affected by the Mt. Rainier thus creating better awareness to the elephant in the Sound.

Secondly, massive amounts of data collection would be necessary. To compare and build-off the characteristics of Hurricane Katrina, this project would need to look at different demographics from the 2010 Census to build and analyze. The Census demographic components to make up the socio-economic analysis include: Population below Poverty, Population over age 65, Population under 18, Total Disabled population, Median Income, Median House Value, and Population without Vehicles. The intent of these characteristics is to see "who most is at risk" or would need more help in the event of an evacuation. These are reflective of who were left behind during Katrina. The combinations of these would comprise the analysis of the geography of risk index.

Methods and Implementations

In setting up the lahar analysis comprised of three stages in sequence built on top of one another to create the completed project. In stage one the foundational pieces were collected. Majority of my foundational geographical data came from WAGDA and the United States Census Bureau's TIGER geographic data base. What were essential to the analysis were the parcels at risk that were affected by the pyroclastic flows. Gaining this information changed my geographic extent of the project to include bordering counties of King and Thurston Counties in conjunction to the majority of lands affected within Pierce County. At the same time, data collection began with gathering the numbers of my geographic index of socio-economic characteristics: Population below Poverty, Population over age 65, Population under 18, Total Disabled population, Median Income, Median House Value, and Population without Vehicles from the Census website. This data arrived consistently at the Census Tract level. The intended analysis was to be at the block group level but the some indicators were represented at the block group level. To continue the analysis it was decided to use the Census Tract level.

This decision in turn affected the geographic data as well. From TIGER, the Census Tracts of King, Pierce and Thurston Counties were added to the map. Once added to the map the process of determining which census tracts were affected need to be done. Using the Select by tool in ArcMap 10 I selected all census tracts that included Parcels at risk. From that I created a new layer of the Census Tracts affected to join the Census data of socio-economic indicators. Before this join, data had to be extracted from

the Census tables to clean-up information to what I needed. The data that was needed was the total populations of each category. Once this was completed, these tables needed to be imported into the lahar geodatabase to be compatible because Microsoft Excel tables show "NULL" values for anything joined with the Census Tracts Affected layer. Next, the joining of the correct tables was necessary before creating the index of geographic risk. To do join the two data together, there needed to be a matching characteristic between the tables of Census Tract Affected layer with the Socio-Economic table. They had matching Geographic Identification (GeoID) to perform the join. Now the data was ready to be indexed.

In order to index, I needed to standardize each variable. 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. These were named "ZPoverty, ZIncome, ZChildren, ZNoCar, ZElderly, ZMedianVal" to refer to the statistics to calculate. A standard score is a z-score and within these new Z fields this calculation was: ((Variable Field – MEAN) / STANDARD DEVIATION). What this calculation does is calculation 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.

Next I had to create a new field to compile the z-scores. These were named: ZPovertyClass, ZIncomeClass, ZChildrenClass and so on where this new field creates a classification. To classify z-scores I did this by:

> 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:

> [ZIncomeClass] + [ZChildrenClass] + [ZNoCarClass] + [ZPovertyClass] + [ZElderlyClass] + [ZMedianValClass]

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.

Results

With the analysis finished, it was surprising to see that of the 67 Census Tracts examined in the project only seventeen of them were deemed as "High Risk", meaning if an eruption were to happen, then these populations do not possess the ability to evacuate on their own. These census tracts had high combinations of different populations that included children, elderly, people below poverty level, and are disabled.

Other factors that deemed these as "High Risk" were median income, house values and if they had a vehicle. (See Figure 1)

Geographically, these census tracts are closer to the Puget Sound's urbanized areas. The cities' that have "High Risk" populations include: Auburn, Kent, Puyallup, Edgewood, Federal Way, Milton, Sumner, and Tacoma. Other high risk areas include unincorporated Pierce, Thurston, and King Counties with Eatonville being the other outlying city.

These findings show that the hypothesis of the project calculated that people at most risk do not live in the path of a lahar from Mount Rainier. The data shows instead that higher populations of people in higher socio-economic standings are choosing to live in places that are potentially hazardous. This shows the opposite of the situation of Hurricane Katrina where people who did not have the ability to evacuate lived in hazardous area, but here in the Puget Sound the environmental injustice is placed on people who choose to live there. This is reflective in the data where 26 of the 67 Census Tracts have "Low Risk" socio-economic factors. The cities that these tracts fall under are: Orting, Bonney Lake, Northeast Tacoma, Auburn, Puyallup and Federal Way. The average median income of these Census Tracts was $74,086- higher than the state average. Even though these have a "Low Risk" designation there is words of caution calling these low risks because take for instance the City of Orting. The whole city is in the path of the lahar where it would be completely wiped out in less than an hour. (City of Orting, 2012) This is completely at risk but with the data being shown and interpreted, it has a low risk because people who live there have the ability to evacuate.

To better understand what else is at risk within the path of the lahar, a second analysis and visualization was done to highlight the monetary value of parcels. Figure 2 is a 3-dimensional map that depicts the data. What this shows is that many of the Puget Sound's agricultural and industrial areas are too at risk. This includes the Port of Tacoma, rail lines to industrial distributions centers in Kent, Algona, Sumner, Auburn, Fife, and Puyallup. This brings financial costs for industrial parcels alone to over a $2 billion in the initial fallout from a lahar. This cost will continue to rise because this disaster would cripple the Pacific Northwest's economy and trade. (Port of Tacoma, 2012)

Critical Analysis and Conclusion

Before moving on, it is recognized that a word of precaution need to be aware is that misinterpretation of the data represented presents a great deal of judgment. The lahar geography of risk analysis is to depict characteristics from the population who at most at risk in their ability to evacuate the hazardous zone. It is imperative that *ALL* populations that are within the zone are at risk no matter what socio-economic standing they are in. The user of this data has to interpret these lahar analyses with that understanding. (Monmonier, 1996)

Secondly, to better understand the data being presented here in terms of local use. Users need to refer to local governments and municipalities to receive in greater detail evacuation plans as well as information on what to do locally. This helps bridge the discussions of Critical GIS for the user. Since this project did not include any

participatory GIS there can be data that is missing or have a different meaning as the creator versus end-user. (Pickles, 1995) For the user to better understand a location by visiting it can the user gain a better perspective on how to evacuate. The example of this is seen with Pierce County's emergency management plans highlighting evacuation routes via roadway. In contrast, the City of Orting's procedure is to get to high ground above 80 feet by walking due to over congestion of roadways in their locality. (City of Orting, 2012) In effect, future Participatory GIS analysis can effectively create clearer results in different location if this project were to expand. This could change the factors of what is measured in the "geography of risk" aspect of the project. (Cidell, 2010; Elwood, 2006; Pavlovskaya, 2006)

What this research shows is the different levels of need that populations will have in the event of an eruption from Mount Rainier. Its aims were to assess the geography to highlight where populations will be most at risk. It was surprising to see the results where more people in higher socio-economic standing are living in the areas prone to damage from Lahars. This shows opposite of the environmental injustices that occurred with Katrina.

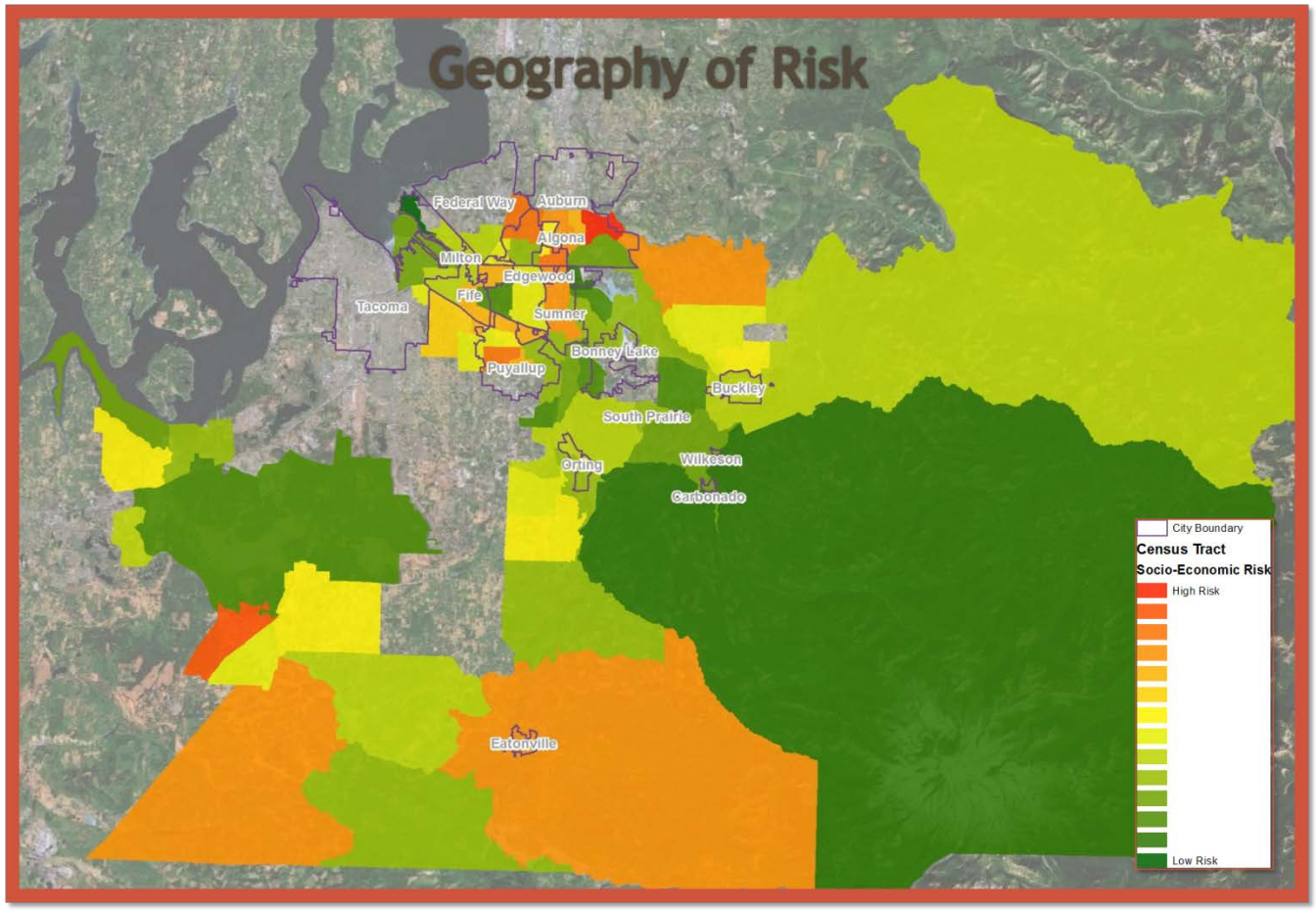

FIGURE 1

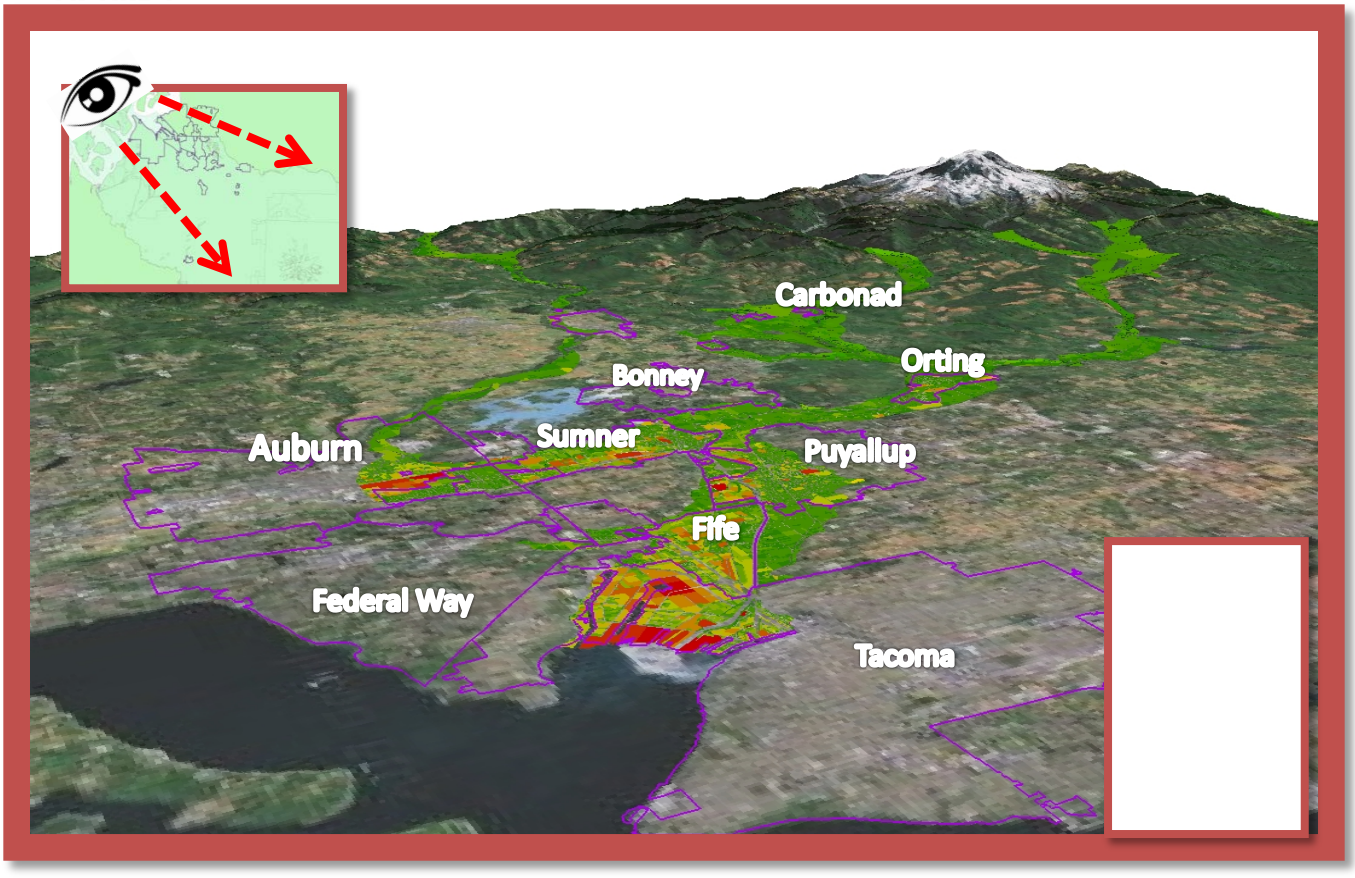

FIGURE 2

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