# Hazard Areas and Populations Associated with Major Volcanoes in the Cascade Mountain Range

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ABSTRACT:

An eruption in the Cascade Mountain Range would deeply affect the lives of those who live near the volcanic mountains. This study determines the number of people within the hazard areas associated with the five largest volcanoes in the region: Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Adams and Mt. St. Helens. Using ArcGIS, I determined which geographic regions would be affected by tephra, pyroclastic blasts and lahar flows and then calculated the population sizes that live in each of these areas. Emergency preparedness programs designed for volcanic eruptions in the Cascades could be improved based on the findings of this study.

**Figure 1.** The Cascade Mountain Range in Washington State *(source: USGS)*

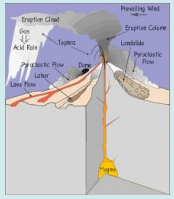


**Figure 2.** The anatomy of a volcano *(source: The Oregonian)*

INTRODUCTION:

The Cascade Mountain Range stretches across Washington State, as shown in Figure 1, and is part of a larger volcanic arch that stretches from British Columbia to Northern California (USGS). Fortunately, only five of these mountains pose the potentially large threat of erupting in the near future. An explosive eruption could produce tephra and pyroclastic flows that could reach distances far from their origin. More effusive eruptions could cause lava and lahar flows (Figure 2).

As the population of Western Washington continues to increase, many more people are living in the shadows of Washington's most threatening volcanoes. Adequate understanding of the risks associated with these areas is essential for the safety of people who live there. In this study I evaluated the population sizes of people who live within these potentially dangerous regions.

METHODS:

Data were obtained from the Washington State Department of Natural Resources, the US Census Bureau and USGS Cascades Volcano Observatory. All models were created using ArcGIS. Elevation data were downloaded for each county as DEM30 raster coverages to depict surface elevation in detail. Files were converted from EOO format in ArcCatalog to shape files that were imported into ArcMap and represented spatially (Figure 3). The Hillshade tool was used to represent elevation three dimensionally (Figure 4). Washington State population data from the year 2000 were downloaded by tract from the US Census Bureau. This layer was stacked on top of the hillshade layer that was previously placed into ArcMap. Population was categorized by size into four separate categories that are represented by different shades of purple (Figure 5). Hazard area data associated with Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Adams and Mt. St.Helens were downloaded as ArcInfo Export files from the USGS Cascades Volcano Observatory webpage. Files were converted from EOO format in ArcCatalog to shape files that were imported into ArcMap and represented spatially. The information available from the observatory about the volcanoes included data on blast hazard zones, lahar zones, and areas subject to pyroclastic blasts. Hazard areas of the volcanoes are represented as a separate ArcMap layer (Figure 6). The final model was created by combining these individual layers and using Clark 1866 UTM Zone 10 as the uniform projected coordinate system.

Emergency preparedness strategies were suggested as means to decrease damage to people living in selected communities.

LITERATURE CITED:

USGS Cascades Volcano Observatory. *Description: Washington State Volcanoes and Volcanics*. Vancouver, WA. 2002.

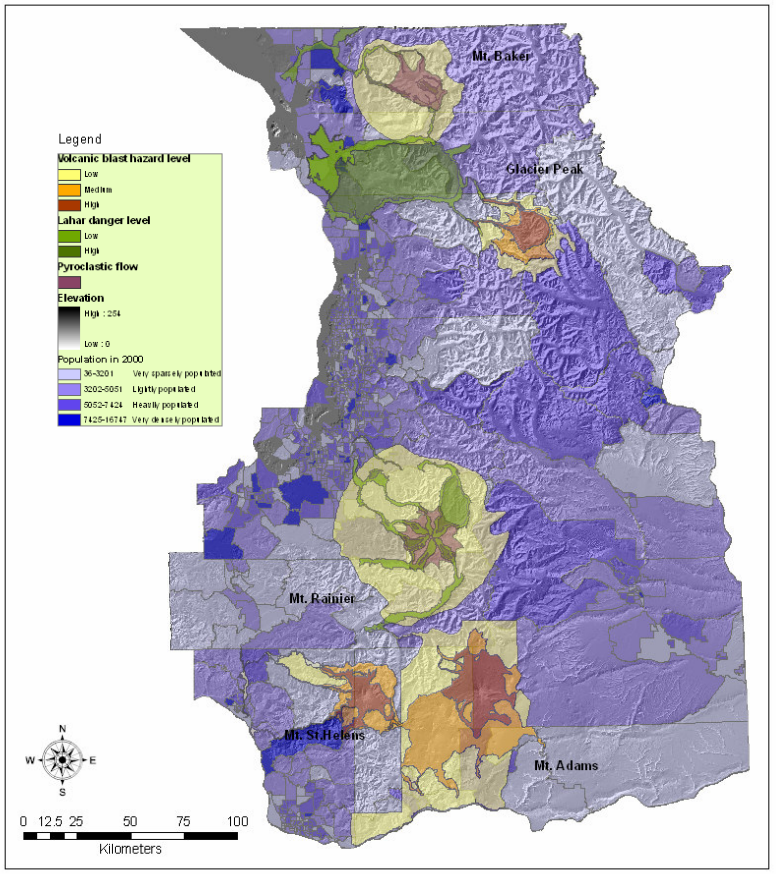


**Figure 7.** Hazard areas associated populations that surround Mt. Baker, Glacier Peak, Mt. Rainier, Mt. Adams and Mt. St.Helens

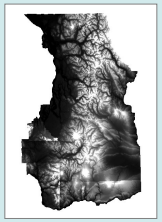

**Figure 3.** Elevation based off of DEM30 raster coverages

**Figure 4.** Elevation depicted with use of the hillshade tool

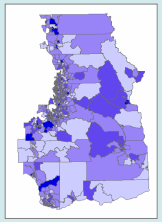

**Figure 5.** Population size in 2000 by tract

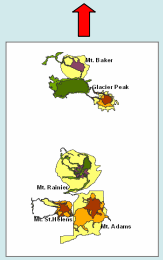


**Figure 6.** Hazard areas of the five major volcanoes

IMPORTANT TERMS:

**Tephra**: Fragments of volcanic rock and lava that are blasted into the air by explosions. Tephra includes large dense blocks and bombs, and small light rock debris such as scoria, pumice, and ash.

**Pyroclastic Flow**: A ground-hugging avalanche of hot ash, pumice, rock fragments, and volcanic gas that rushes down the side of a volcano as fast as 100 km/hour or more with a temperature that may be greater than 500°C.

**Lahar**: A volcanic mudflow or debris flow formed chiefly by the rapid melting of snow and ice by pyroclastic flows or as a consequence of debris avalanches. (*Source: USGS)*

**Mt. Baker**

**Mt. St.Helens**

**Mt. Rainier**

**Mt. Adams**

**Glacier Peak**

METHODS (continued):

Populations within volcano hazard areas was calculated for each of the five volcanoes. Results were determined by performing the following calculations (example of calculations executed for Mt. Adams shown in blue):

- Count total # population tracts that intersect volcano hazard area (8)
- Sort tracts into population size categories (very sparse: 4; lightly populated: 2; heavily populated: 2; densely populated: 0)
- Calculate percent area of each tract covered by hazard area by estimating ratios (very sparse: 10%, 100%, 75% ,50%; lightly populated: 100% ,20%; heavily populated: 75%, 90%)
- Multiply average total population of tract by percent area covered by hazard area (very sparse: 1500/.10, 1500/1.0, 1500/.75,1500/.50; lightly populated: 4000/.10, 4000/.20; heavily populated: 6000/.75, 6000/.90)
- Sum populations within common population categories (very sparse: 150+1500+750+1200; lightly populated: 4000+800; heavily populated: 4500+5400)
- Sum totals from each population category (3600+4800+9900= 18300)
- Repeat calculations for all five volcanoes; Sum

For results, see Table 1

**Table 1.** The number of people that live within volcano hazard areas for each volcano

| Name of Volcano | Number of people in volcano hazard areas |
|---|---|
| Mt. Baker | 32,300 |
| Glacier Peak | 41,000 |
| Mt. Rainier | 68,750 |
| Mt. St.Helens | 4,050 |
| Mt. Adams | 18,300 |
| **Total** | **164,400** |

RESULTS:

The results of my model suggest that up to approximately 165,000 people in the Cascade Mountain Range live within hazard range of a volcanic eruption. This is approximately 3% of the state's total population (US Census Bureau, 2000). Results conclude that Mt. Rainier would have the largest impact on human populations due to its close vicinity to heavily settled areas in the South Puget Sound region. Approximately 69,000 people could potentially be affected by pyroclastic blasts, tephra released in an explosive eruption, and lahar flows in the eruption of Mt. Rainier alone. Mt. Baker is also near thickly settled areas and an eruption would have a direct impact on over 30,000 people in the Northern Cascades. The blast zone that would be affected by tephra discharge from Glacier Peak would affect only sparsely and lightly populated areas. However, the relatively large lahar flow that is predicted to occur to the West of the mountain in the aftermath of an eruption would cover urban areas, causing over 40,000 people total to be within the hazard zone of the peak. Results indicate that Mt. St.Helens and Mt. Adams would have the lowest impact on surrounding populations. This is due to small population sizes in the vicinity of these volcanoes. Overall, each mountain would have a varying degree of disturbance to local populations in the event of an eruption.

CONCLUSION:

Due to the difficulty of predicting a volcanic eruption, it is important for communities within the determined hazard areas to have appropriate emergency plans. Warning systems and evacuation routes should be established in these areas. In addition, information about these systems should be made accessible to populations at risk. A comprehensive program such as the Mt. Rainier Volcanic Hazards Response Plan is a model system that other strategies should be based on. The large number of people that surround the five most threatening volcanoes in Washington State should be protected by such preparedness plans and should be educated about the level of risk associated with each active volcano.