Lahar Flow Hazards of Mount Rainier

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Introduction

Mount Rainier is located in Pierce County, Washington and is an active volcano partially covered by glaciers. Over time, as hydrothermal fluids and meltwater from glaciers move through the underlying rock, weathering occurs which results in the breakdown of rock. This altered rock remains precariously perched at a steep angle. If the ice and snow were to catastrophically melt, or if an earthquake were to occur, this fluidized sediment would flow down the side of the volcano into the surrounding area in an event called a lahar. In the past, similar events have occurred and old lahar deposits can be seen surrounding the mountain and filling in drainages.

Agricultural, commercial and residential land now surrounds the volcano, and much of it is situated in the path of future lahars. It is important to predict exactly which areas are threatened by lahar flows, so that warning systems can be put in place.

Currently, the south facing slope of Mount Rainier is receiving more sun than the other faces of the mountain. It was not part of the most recent slope failures, so it remains intact, but dangerously held in place. Snow and ice continue to melt, and there is a significant amount of sediment at that may be unstable. This project focused on the volume of altered material available for a lahar flow from this southern slope, and which areas in the surrounding region might be inundated by a lahar from this material using the LAHARZ flow path modeling tool developed by the USGS.

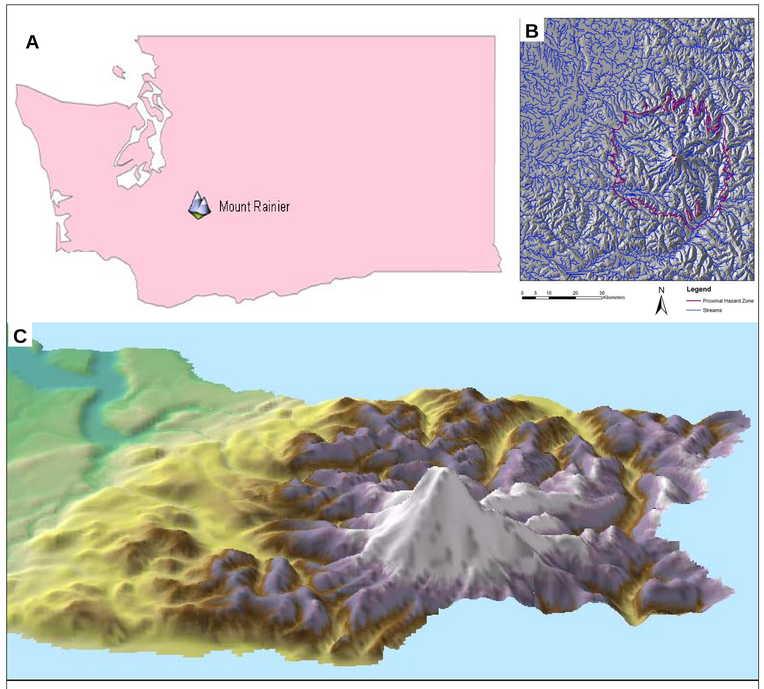

Figure 1. Different perspectives of Mount Rainier. [A] Map of Washington State, showing the location of Mount Rainier. [B] Top view of Mount Rainer. [C] 3-D view of Mount Rainier looking toward the North, showing major drainages.

Methods

Altered rock, slope stability, and a combination altered rock and slope stability maps (Reid, 2001) were digitized, and polygons were created for each of the coverages. The polygons that combined slope intensity and alteration were assigned values for instability ranging from 1-1.7 (1 as least stable). DEMs covering Peirce county and areas surrounding Mount Rainier (USGS) were downloaded and mosaicked together. Drainage basins for Mount Rainer were created based on topography. The combination polygons were then intersected with the different drainage basins to create a new layer representing the area of altered rock per drainage basin. The area of unstable material for each drainage basin was calculated for 3 different situations. In situation 1, areas of instability ranging from 1-1.3 were used, in situation 2, areas of instability ranging from 1-1.5 were used, and in situation 3, areas ranging from 1-1.7 were used. The areas of sediment for situation 1 (4.1 km^2), 2 (12.0 km^2), and 3 (24.6 km^2) for the south facing slope basin were run through LAHARZ software (USGS), and a map was

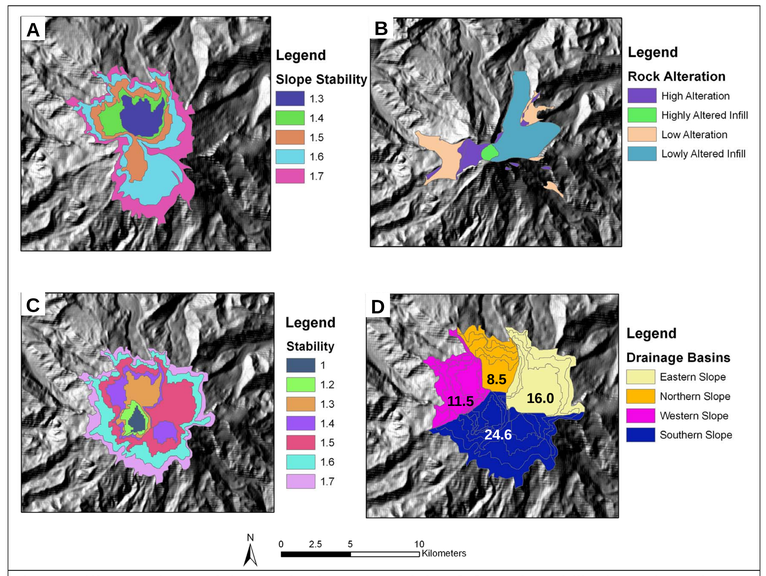

Fig. 2. Different views of the peak of Mount Rainier. [A] Rock stability based on slope ranging from 1.3 (least stable) to 1.7 (most stable). [B] Amount of alteration of peak rocks. [C] Rock stability based on a combination of alteration and slope aspect ranging from 1 (least stable) to 1.7 (most stable). [D] Drainage basins for the peak showing area of rock predicted to flow down each basin in km^2.

produced showing the area that would be inundated by each flow. It was assumed that each area was 100 meters thick (Reid, 2001). LAHARZ produced this map by first creating a proximal hazard zone (which separates the areas of erosion from deposition), then it filled in the drainage by creating a cross section at each pixel and filling in the volume of sediment, and finally it created polygons of the inundated area that could be overlain on DEMs. The polygons were then converted to kmz files and imported into Google earth, so the extent of destruction could be viewed. Situation 2 was examined in more detail than the others because it is the most realistic.

All maps were created by Miriam Gale in ArcGIS or AscScene (unless otherwise specified), and are projected in geographic coordinates WGS 1984.

Results and Conclusions

If slope failure was to occur on the south side of Mount Rainier, the sediment would follow a radial drainage pattern and head to the North West. If this slope failed (scenario 2), the towns of Ashford, Elbe, Alder, La Grande, and local farms could potentially be flooded and covered with deposits from further upstream. The reservoir, and all the lake houses on its edge would be covered by the lahar. The reservoir dam could break, and the water and sediment would pour down the current stream, destroying even more than the GIS predicted destruction area.

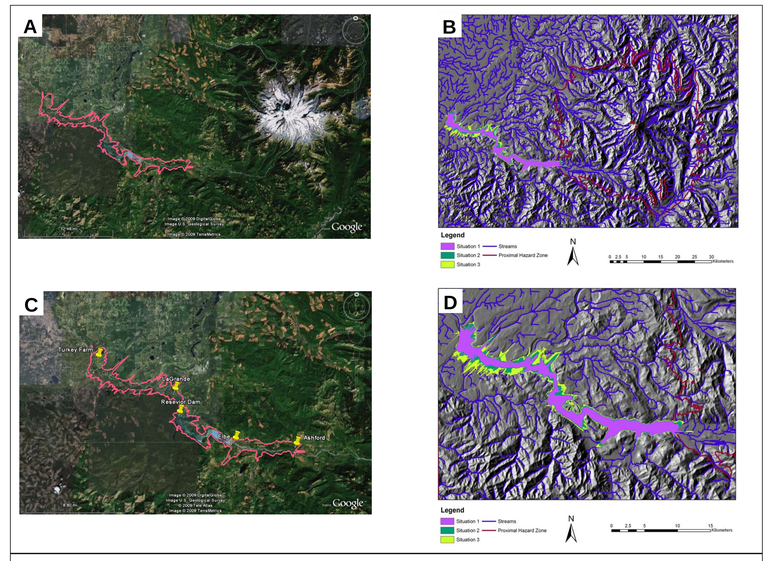

Fig. 3. Inundation area of lahar flow from the south basin. [A] Google image of situation 2. [B] Map of all situations overlaid on each other. [B] Closer view of Google image for situation 2 showing towns [C] Closer view of image B.

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