Photo by Caleb Kaufmann, Mount Rainier from Paradise Valley, September 2012.

Mount Rainier Volcanic Hazard Map

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Geog 493: Digital Terrain Analysis

Abstract

- Volcanoes pose a major threat to many cities around the world from Pyroclastic flows which cause massive devastation to the surrounding environment to ash cloud deposits hindering transportation movements and affecting air quality of surrounding communities. The most damaging effect however comes from what are known as Lahars or large debris flows that originate on any of the volcano's flanks. Lahars are a mix of dirt, debris, trees, rocks, and primarily water. They can have a consistency of wet concrete and depending on elevation of the landscape, can reach speeds of up to 60-70 km/h. This allows them to travel for tens of or hundreds of kilometers downstream from their sources. Over time the Lahars will lose momentum and be diluted as the size is decreased and the consistency increases. They are considered a natural process until human life or property is affected at which point, they are then classified as a hazard.
- Inundation, another term for past lahar deposits, can be used to predict future lahar paths and damage potentials. This was possible by the creation of hazard-zone maps utilizing empirical and statistical based forecasting methods created by Iverson, R.M., Schilling, S.P., and Vallance, J.W. These models have helped in creating hazard-zonation maps that can predict any potentially hazardous areas under the threat of future lahars. These maps have also included pyroclastic flow zones, lava flows, or ash deposit hazard zones.
- The goal of this project is to create a volcanic hazards map of mount rainier using a series of statistical and geoprocessing tools created in the ArcMap suit called Larahz_Py in combination to the hydrology tool set and spatial analyst tool set. The outcome will be a map of potential areas of landscape that will be affected by the flow of lahars off Mount Rainier and the potential population at risk.

Research Question

- What would result from a potential future eruption of Mount Rainier on the surrounding communities and major cities?

Basic Information

- Mount Rainier is located less then 65 km southwest from Tacoma Washington and 95 km south-southwest of Seattle Washington, the largest city in the Northwest U.S.
- It is the largest Stratovolcano in the central U.S. with a height of 14,411 ft.
- The last major eruption was around 300bc, since then it has had 8 minor eruptions throughout the 1800s on a VEI scale of 3.

Methods and Process

- 1: Lahars Creation
  - Create Surface Hydrology Rasters (creates supplementary raster datasets for calculations)
  - Generate New Stream Network (creates a new raster stream network using a user defined stream threshold)
  - Hazard Zone Proximal (creates a proximal hazard zone)
  - Slope (determines the slope of a DEM for statistical calculations)
  - Flow Length (will calculate the distance a Lahar will travel along a path)
  - Flow Direction (creates a raster using flow length to determine where Lahars will flow)
  - Raster to Shapefile (converts raster to vector dataset)
  - Clip out census blocks to acquire total population effected by lahar's under worse case scenario

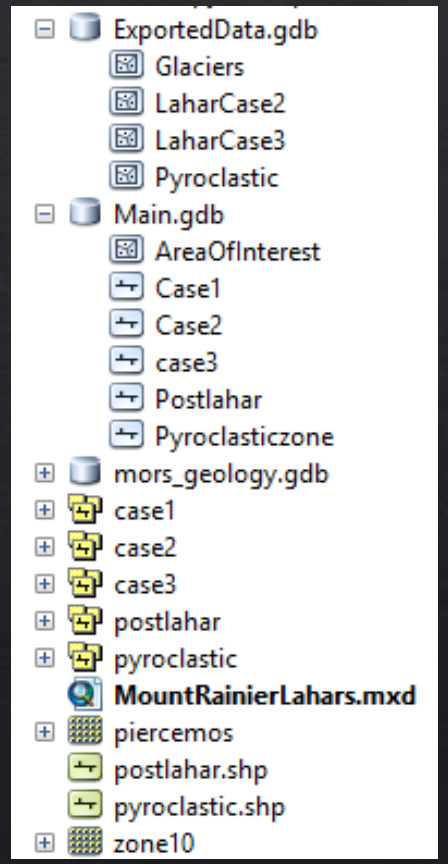
Methods and Process Continued

- 2: Ash Fall Zone
  - Multiring Buffer of Mount Rainier using a Calculation based on size of Eruption and amount of material ejected (Generic circle buffer for greatest area under a threat)
  - Clip out census blocks of ashfall buffer to acquire total population effected by ashfall
- 3: Pyroclastic Flow
  - Is already included/provided into the data for Lahar mapping data/toolset
  - Clip census blocks based on pyroclastic flow zone acquire total population effected

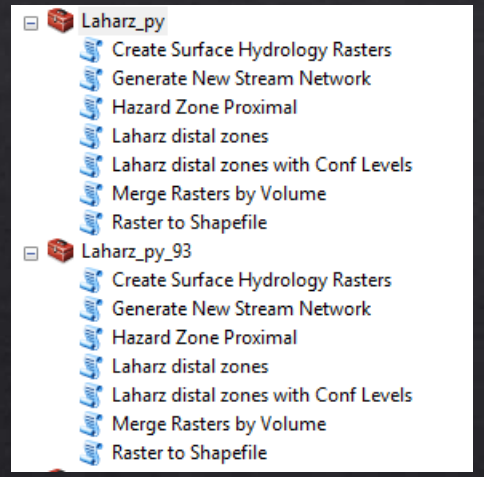
Datasets Used

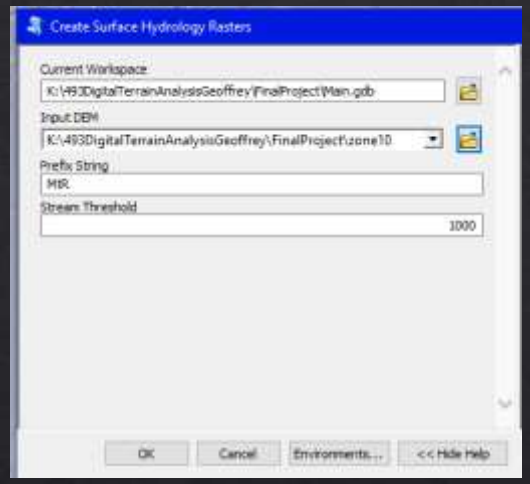
- Washington Census Tract by block joined with the population table provided by office of Financial Management
- Major Roads
- City Boundaries
- Lakes
- Major Cities
- Urban Boundaries

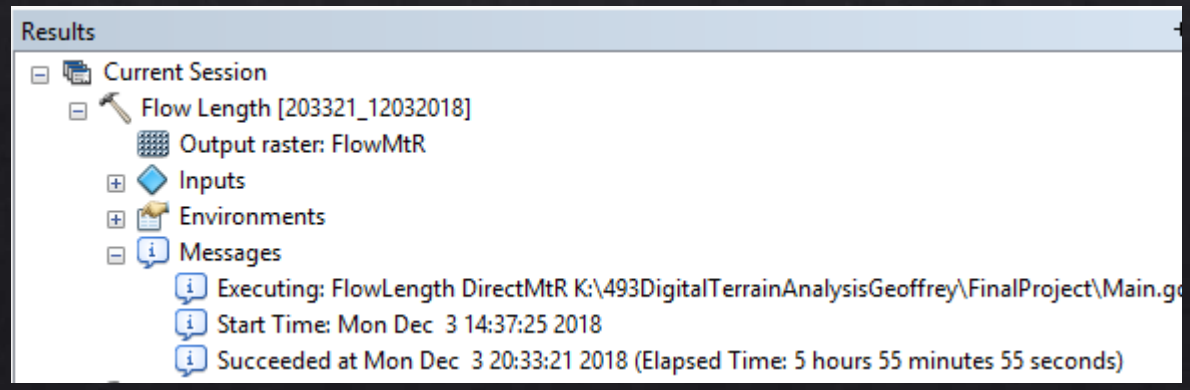
- Zone10 is a 10m DEM
- Case1-3, postlahar, & pyroclastic were provided by the Digital Data for Volcano Hazards data from the Geological survey site



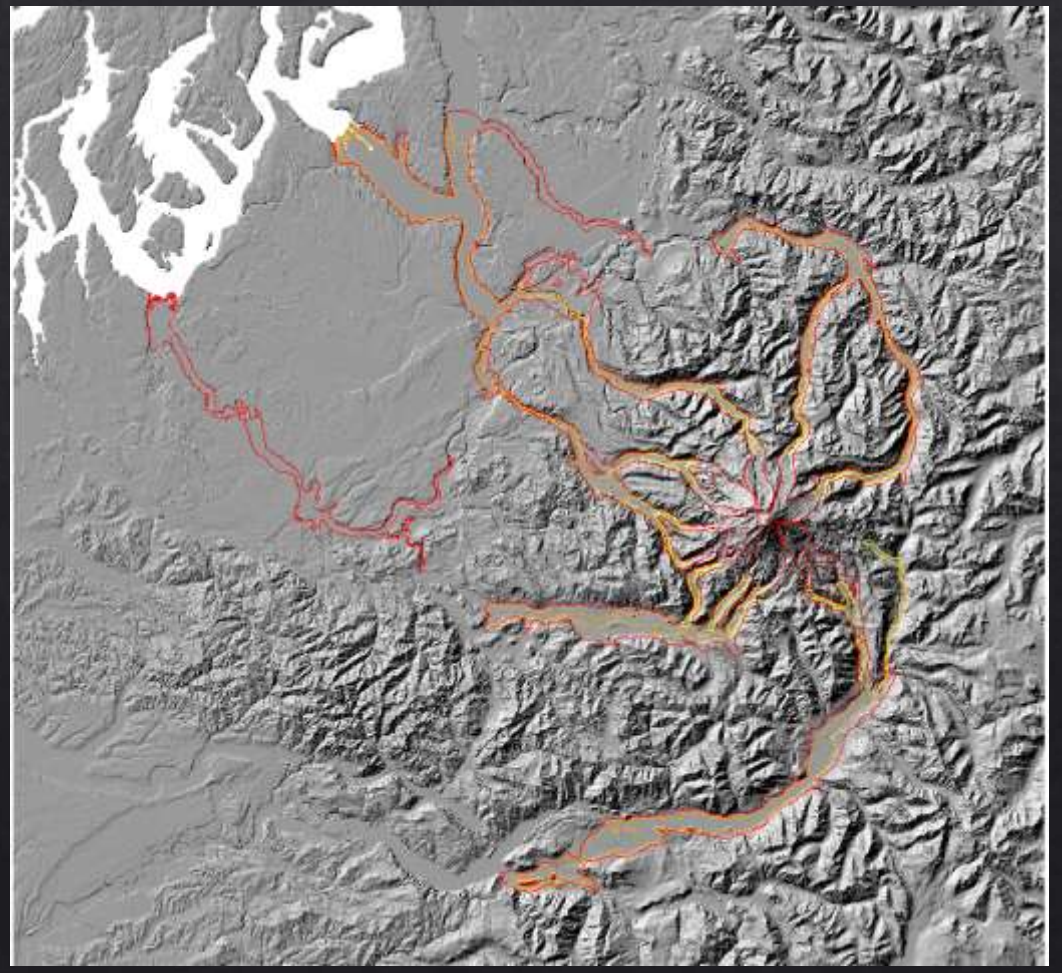
Photos of the Processes



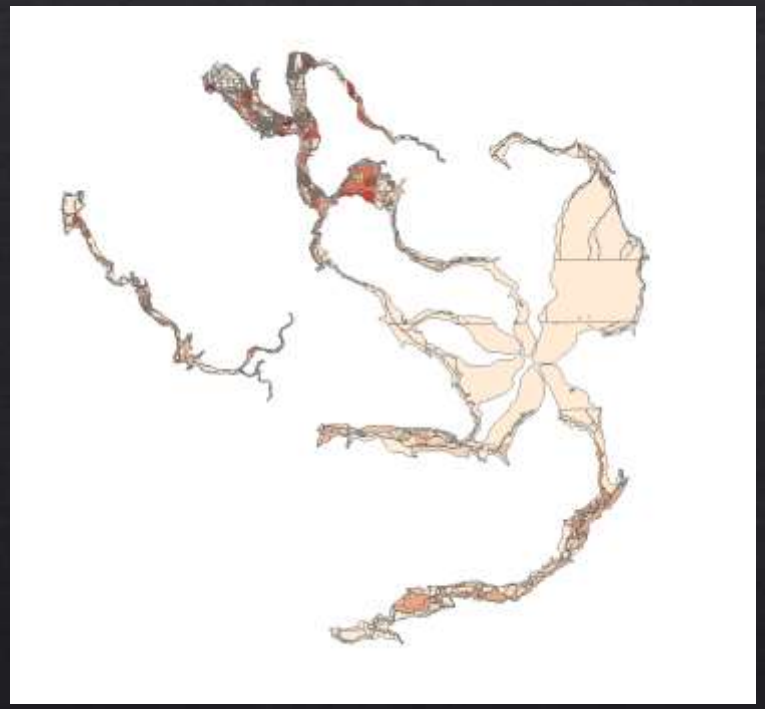




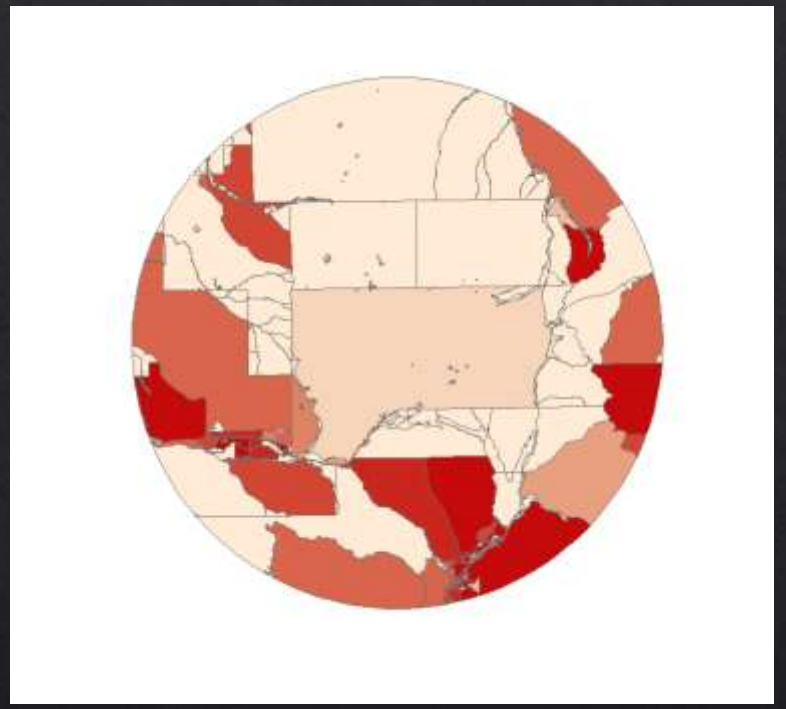
Lahar Hazard worse case scenario



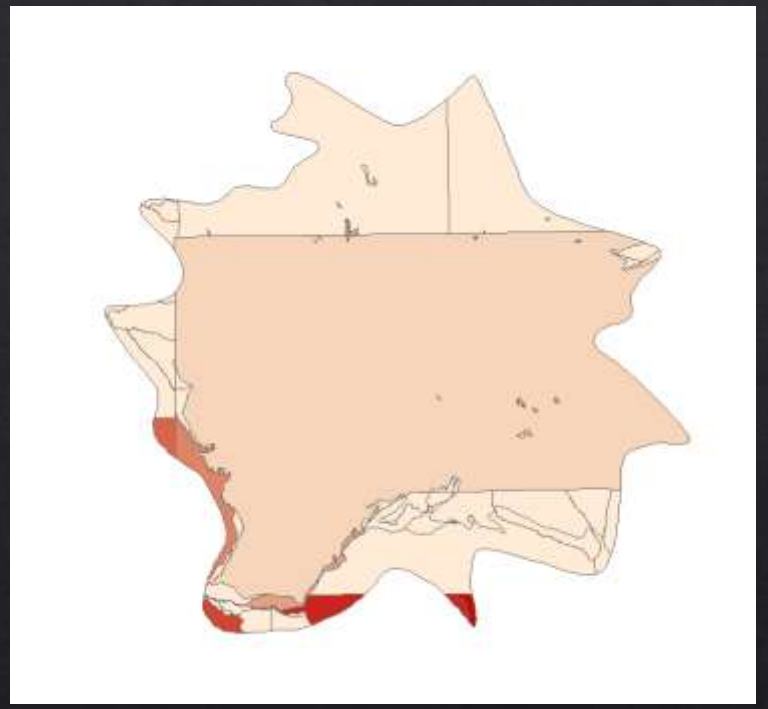
Census blocks within Case1 of the Lahar hazards



Census blocks within Ashfall/Tephra hazard area



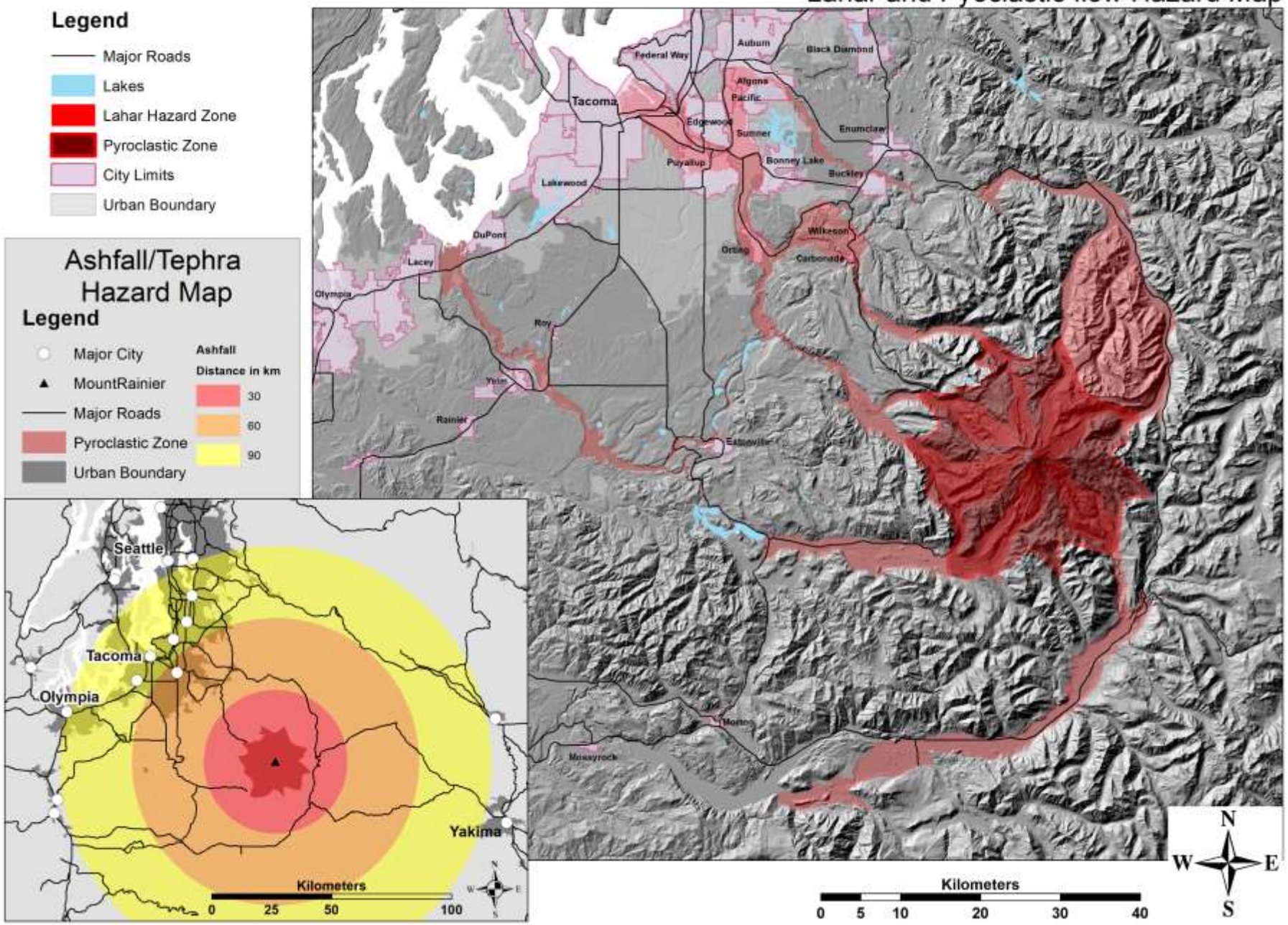
Census blocks within Pyroclastic flow hazards



Results

- Lahar hazard map presented a total population of 121,047 people who would be directly effected due to an eruption.
- Ashfall will cause disturbances of up to 90+ km from Mount Rainier and a direct hazard to 2,337 total people (numbers are very inflated) within 30 km of the mountain. Ashfall is a complex object to map as it can change based on weather and the time of year the eruption takes place. There are plenty of models that can predict the flow and fall of ash but for this project I chose to do a simple ring buffer for a general what if case. It would be estimated that around a foot of ash would fall on the slopes and only an inch would fall 90 km or further.
- Pyroclastic flows will directly effect the lives of 240 people living on or near the base of Mount Rainier.

Mount Rainier Hazards Map



References and Sources

- Schilling, S.P., 2014, Laharz_py. GIS tools for automated mapping of lahar inundation hazard zones: U.S. Geological Survey Open-File Report 2014-1073, 78 p., http://dx.doi.org/10.3133/ofr20141073.
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- Portland State Geography Department: RLIS data.
- WSDOT GIS Data webpage: http://www.wsdot.wa.gov/mapsdata/geodatacatalog/
- Washington Geospatial Open Data Portal: http://geo.wa.gov/

Photo by Caleb Kaufmann, Mount Rainier from Paradise Valley, July 2013.