Volcanic Eruption Hazard

The Pacific Northwest lies on the "Ring of Fire," an area of active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur along the Ring of Fire, in part, because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs known as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when the hotter, molten materials, or magma, rise to the surface. The primary volcanic threat to lives and property in Clackamas County is from eruptions of Mount Hood that generate mud and debris flows that can sweep down river valleys for tens of miles, and from ash clouds that drift downwind to the county from near or distant eruptions.

A Mount Hood eruption could impact up to 68 percent of homes, 60 percent of residents, 73 percent of businesses and 87 percent of employees in the Hoodland area of Clackamas County. A mega-eruption scenario would increase population exposure, but the increase is not substantial—typically 10 percent or less of an increase in population exposed.

Population exposure to volcano hazards is largest in the proximal hazard zone, including 65 percent of the local workforce, 80 percent of educational facilities, 82 to 100 percent of daytime visitors to recreation sites (summer and winter month averages, respectively), and approximately two thirds of overnight visitors. (USGS in publication)

Causes and Characteristics of the Hazard

History of the Hazard

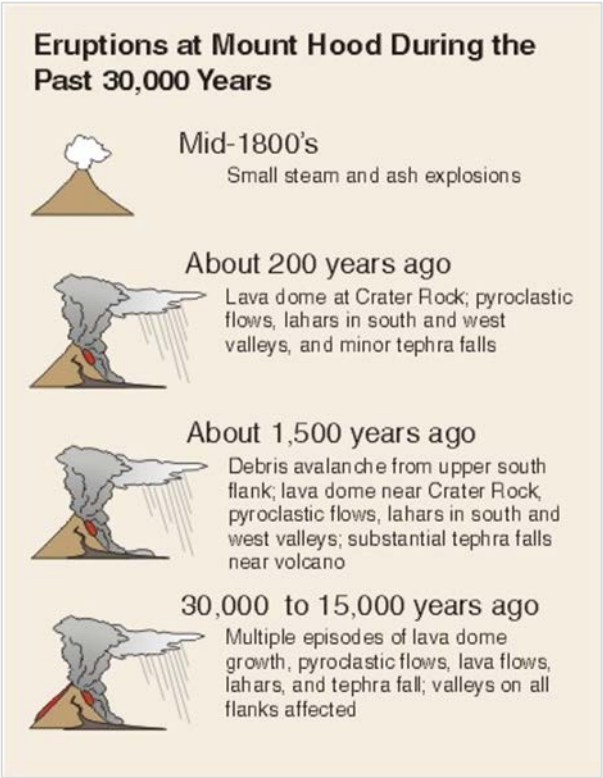
Any eruption in the Cascades could have an effect on Clackamas County if the wind blows in the right direction. Only Mount Hood and Mount St. Helens are known to have had direct effects in the county in the past. However, any eruption in the Cascades that affects regional infrastructure, air traffic, bridges, or Interstates 5 and 84 will have a direct or indirect impact on the county.

Mount Hood

Mount Hood is located on the eastern boundary of Clackamas County and has been recurrently active over the past 500,000 years. It has had two significant eruptive periods in recent times - one about 1,500 years ago and another about 200 years ago. Figure (USGS 060-00) shows the major geologic events in the Mount Hood Region during the past 30,000 years. In addition to these eruptive episodes, there is evidence of an eruption occurring just before Lewis and Clark traversed the region (1804-1806). There is also evidence of several minor eruptions between about 1846 and 1865.

The strongest earthquake in the Mount Hood area in decades occurred on June 29, 2002. The magnitude 4.5 event, which was located about 4.5 km south of the summit at a depth of

6 km, was widely felt. Hundreds of aftershocks followed, including two >M3. Typically, several earthquake swarms occur each year at Mount Hood, with little or no damage.



While Mount Hood maintains a very low level of volcanic activity in the form of earthquake swarms and gas emissions, scientists predict the next eruption will likely consist of lava dome growth and collapse, which will generate pyroclastic flows, ash clouds, and lahars (mud and debris flows). Future eruptions from Mount Hood could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in northwest Oregon and southwest Washington.

Although Mount Hood does not have a history of violent explosive eruptions, there are significant hazards associated with this volcano. The flanks of the volcano were formed in part by lava flows, which flowed up to 8 miles from the summit. These slow-moving lava flows are destructive, but do not pose a serious threat to life and safety because people have ample time to evacuate. Lava erupting from Mount Hood is too viscous to flow and accumulates around vents to form steep-sided lava domes. Lava domes can collapse, forming fast moving pyroclastic flows, hot avalanches of lava blocks, ash, and hot gases. These pyroclastic flows can swiftly melt snow and ice to form lahars or volcanic mudflows that can continue far down river valleys. Mount Hood has also generated lahars from landslides, or debris avalanches, of weakened, saturated masses of rock high on the volcano. Lahars are the most dangerous potential threat posed by the seemingly dormant volcano in eastern Clackamas County.

Mount St. Helens

Mount St. Helens remains an active and potentially dangerous volcano. The most recent episode of unrest occurred from October of 2004 through January of 2008 with the rebuilding lava dome and steam explosions. Ash fall was primarily limited to areas adjacent to the volcano.

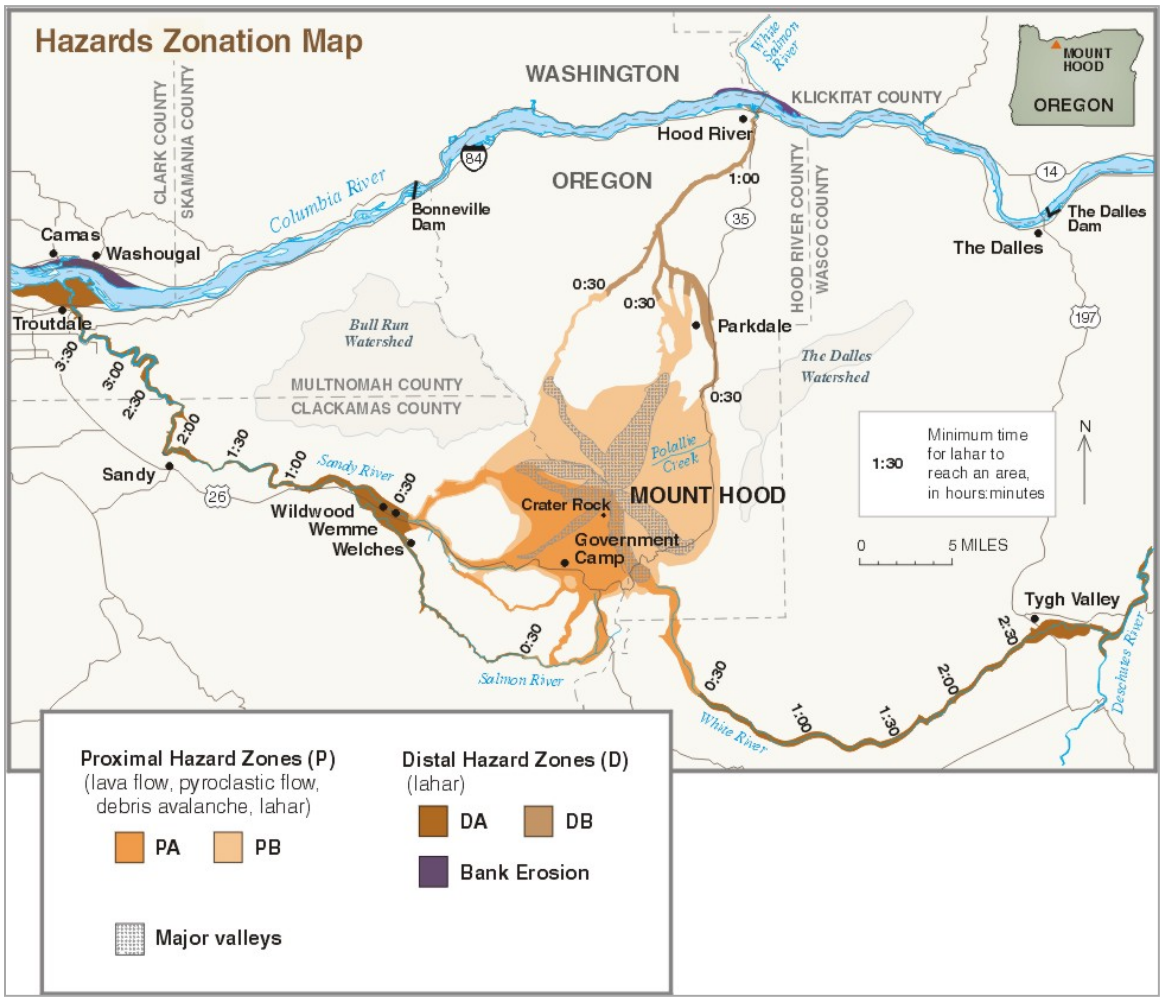
Mount St. Helens is a fifty thousand year old volcano, located in southwestern Washington about sixty miles northeast of Clackamas County. In the last 515 years, it is known to have produced 4 major explosive eruptions (each with at least 1 cubic kilometer of eruption deposits) and dozens of lesser eruptions. Two of the major eruptions were separated by only 2 years. One of those, in 1480 A.D., was about 5 times larger than the May 18, 1980

eruption, and even larger eruptions are known to have occurred during Mount St. Helens' brief but very active 50,000-year lifetime.

Risk Assessment

How are Hazard Areas Identified?

Mapping: The USGS/Cascades Volcano Observatory (CVO) produced a volcanic hazard zonation report for Mount Hood in 1997 and 2000. The report includes a description of potential hazards that may occur to immediate communities. The hazard zones illustrated on Map (USGS 060-00) were determined based on the distance from the volcano, vent location, and type of hazardous events. The two Proximal zones show two potential eruptive scenarios. The zone shown in peach indicates failure of the vents on the north, east, or western flanks. The proximal hazard zone shown in orange is the more likely scenario, which is a failure of the lava dome, Crater Rock, and primarily would affect the drainages in the Sandy River basin in Clackamas County.



Geographic Extent: According to County GIS about 8% of total county acres are exposed to volcano hazards. These areas are centralized around potential failure areas in the proximal zone, as well as the Sandy and Hood River valleys in the distal zones. Only 5% of total county parcels are exposed, as the volcanic landscape generally does not lend itself well to development.

Probability of Future Occurrence

Frequency: Mount Hood represents the highest volcanic hazard to Clackamas County. The likelihood of a Mount Hood eruption originating near Crater Rock, the youngest lava dome on the mountain, is between 1 in 15 and 1 in 30 in the next 30 years. The likelihood of an extreme event is even lower -- 1 in 10,000 in the next 30 years, but such an event would be catastrophic for the region (Scott and others, 1997b). However, Mount St. Helens could also affect Clackamas County from ashfall and indirect regional environmental and economic impacts. Mount St Helens has a frequency of about 6 events every 100 years.

Vulnerability Assessment

Building and Infrastructure Damage

Ash fall of about 0.4 inch is capable of creating temporary disruptions of transportation operations and sewage disposal and water treatment systems. Highways and roads could be closed for hours, days, or weeks afterwards. The series of eruptions at Mount St. Helens in 1980 caused Interstate 90 from Seattle to Spokane to close for a week. US 26 in Oregon faced similar problems. The impact of the ash fall caused the Portland International Airport to close for a few days. The airport faced a series of challenges in cleaning up the ash that accumulated on its runways.

The fine-grained, gritty ash can also cause substantial problems for internal-combustion engines and other mechanical and electrical equipment. The ash can contaminate oil systems, clog air filters, and scratch moving surfaces. Fine ash can also cause short circuits in electrical transformers, which in turn cause power blackouts.

During an eruption at Mount Hood, Bonneville Power Administration transmission lines may be severed. A number of high voltage lines are located in the immediate vicinity of Mount Hood. These lines provide a portion of the electrical power to Clackamas County, the Portland Metropolitan Area, and the rest of the Willamette Valley.

Pollution and Visibility

Ash fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice. High-altitude winds may carry finer ash from tens to hundreds of miles from the volcano, posing a hazard to flying aircraft, particularly those with jet engines.[1] Fine ash in water supplies will cause brief muddiness and chemical contamination. Ash suspended in the atmosphere is especially a concern for airports, where aircraft machinery could be damaged or clogged.

Ash fall also decreases visibility and disrupts daily activities. For example, some individuals may encounter eye irritation. When the ash fall produced by the Mount St. Helens' eruption

[1] Volcano Hazards of the Lassen Volcanic National Park Area, (March 2001), USGS.

started to blow towards Oregon in June 1980, some of the airlines at the Portland International Airport responded immediately by stopping their service.

Economy

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, cause rapid wear of machinery, clog air filters, block drains, creeks, and water intakes, and impact agriculture.[2] Removal and disposal of large volumes of deposited ash can also have significant impacts on government and business.

The interconnectedness of the region's economy can be disturbed after a volcanic eruption. Roads, railroads, and bridges can be damaged from lahars and mudflows. The Mount St. Helens' May 1980 eruption demonstrated the negative effect on the tourism industry. Conventions, meetings, and social gatherings were canceled or postponed in cities and resorts throughout Washington and Oregon in areas not initially affected by the eruption. However, the eruption did lead to the creation of a thriving tourist industry for decades following event.

Transportation of goods may also be halted. Subsequent airport closures can disrupt airline schedules for travelers. In addition, the movement of goods via the Columbia River and other major waterways can also be halted due to debris in the river, and tephra in the air. The Mount St. Helens event in May 1980 cost the trade and commerce industry an estimated $50 million in only two days, as ships were unable to navigate the Columbia.[3] Clouds of ash often cause electrical storms that start fires and damp ash can short-circuit electrical systems and disrupt radio communication. Volcanic activity can also lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates into an eruption.

Risk to Life & Property: High

Proximal Hazard Zones 1 and 2 are areas subject to rapidly moving debris avalanches, pyroclastic flows, and lahars that can reach the hazard boundary in less than 30 minutes, as well as slow-moving lava flows. Areas within proximal hazard zones should be evacuated before an eruption begins because there is little time to get people out of harm's way once an eruption starts. Most pyroclastic flows, lava flows, and debris avalanches will stop within the proximal hazard zone, but lahars can travel much farther. Evacuation may prove problematic, as volcanoes are difficult to predict, and there is only one primary route (Hwy 26) off the mountain. In addition, Mount Hood is a prime destination for visitors during all seasons. For these reasons, the threat to life is quite high.

Risk to Critical Facilities and Infrastructure: High

Distal Hazard Zone 3 includes areas adjacent to rivers that are pathways for lahars. Estimated travel time for lahars to reach these zones is more than 30 minutes, which may allow individuals time to move to higher ground and greater safety if given notice. Lahars could affect transportation corridors by damaging or destroying roads, and can damage Bull Run pipelines that cross the Sandy River. Although only one critical facility is exposed to the

[2] Ibid.
[3] Clackamas County Courier Newspaper. October, 1986.

volcano hazard, the affect of lahars and pyroclastic flows and ashfall on equipment and infrastructure will be devastating.

Community Hazard Issues

Volcano hazards could impact, depending on event severity (typical eruption and mega-eruption, respectively), between 50 to 60 percent of residents, 63 to 73 percent of businesses, and 84 to 87 percent of employees.

The number of daytime visitors to recreation sites is greatest in the winter season (averaging 129,300 people per month) largely due to snow sport activity on Mount Hood, which places these people in the proximal volcano hazard zone.

The number of daytime visitors to recreation sites in summer months is less (averaging 58,000 people per month) and, in addition to being exposed to proximal volcano hazards, they also are in areas classified as having a "moderate" or greater wildfire risk. The number of overnight visitors is greatest during the summer (an average of 34,000 people per month) with 71 percent of them in areas considered less than a "moderate" level of wildfire risk but 66 percent of them in proximal volcanic hazards. In general, volcano hazards pose threat to an average of approximately 94,000 people per month regardless of event magnitude with 82 percent facing impact specifically from fast-traveling, proximal volcanic hazards. (USGS in publication)

Implementing Volcano Hazard Mitigation Activities

Clackamas County Emergency Management hosted the Regional Emergency Management Governance (REMG) members in May 2010 for a facilitated discussion using a Mount Hood scenario as a way to discuss the range of decisions and uncertainties when responding to volcanic unrest and the need for advance relationships between scientists and public safety officials.

The County's Hazard Mitigation Coordinator participated in a volcano hazards briefing to the Congressional Hazards Caucus in Washington DC in April 2010. Clackamas County discussed its approach to understanding the low probability but high consequence volcanic threat in the context of nearby mountain communities, recreational and resort destinations and regional critical infrastructure.

In early 2012 FEMA announced the Volcano Crisis Awareness Course (AWR-233) is now listed in the National Training and Education Division catalog. This course provides an understanding of: the processes, impacts, and causes of volcanic hazards; current monitoring and hazard assessment tools and products; volcano warning and dissemination systems and methods and community response to eruptions and volcanic crises. The Cascades version (also Alaska and Hawaii versions) allows students to participate in a facilitator-led Mount Hood Scenario. In these activities participants apply their knowledge of the presented materials to actual preparedness, mitigation, and response issues. https://ndptc.hawaii.edu/training/catalog/4

The Mount Hood Coordination Plan was adopted in September 2005 to coordinate the actions that various agencies must take to minimize the loss of life and damage to property before, during, and after hazardous geologic events at Mount Hood volcano. The plan

strives to ensure timely and accurate dissemination of warnings and public information leading up to the point of activating an incident command structure. The plan also includes the necessary legal authorities as well as statements of responsibility of County, State and Federal agencies. In June of 2012, the Plan's Facilitating Committee reconvened to initiate a review and update for the plan.

Volcanic Eruption Mitigation Action Items

Volcano actions are listed in Section 3 Mitigation Strategy. For detailed information regarding each action, please refer to Appendix A – Action Items.

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