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Oversight Hearing on:

The Role of the U.S. Geological Survey and the U.S. Forest Service in Preparing for and Responding to Natural Hazard Events, as well as the Current Status of Mapping and Monitoring Systems.

Before the U.S. Senate Committee on Energy and Natural Resources

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Chairman Murkowski and Ranking Member Cantwell, members of the committee, thank you for inviting me to testify today. I am excited for this opportunity to share some of my views and tell you about some of the geological hazards in Washington State. I am the State Geologist representing the Washington Geological Survey, a Division of the Department of Natural Resources. I am also the Chair of the Geological Hazards Committee for the Association of American State Geologists (AASG).

The natural beauty of Washington, including its lush vegetation, hides many serious geologic hazards that present risks to public safety as well as the State's economic interests. Washington is one of the most at-risk states for a variety of geological hazards including earthquakes, volcanoes, tsunamis, and landslides.

Recent earthquakes and tsunami events in other parts of the world such as Japan (2011), Chile (2010), and Sumatra (2004) have highlighted the important role and need for better and more compelling information that can help prevent or minimize the loss of life, devaluation of property, and other serious disruptions to Washington's economy. According to the Federal Emergency Management Agency (FEMA), Washington is the second most at-risk state for earthquakes. The active subduction zone off the Washington coast can cause a magnitude 9 earthquake and deliver a tsunami to coastal areas in fewer than 30 minutes. In addition to the Cascadia subduction zone, Washington has many more faults capable of widespread damage,

including the Seattle Fault zone, the Southern Whidbey Island fault zone, the Darrington-Devils Mountain fault zone and countless more.

We collaborate with the USGS and FEMA to learn more about earthquake hazards, including paleoseismic trenching across newly discovered faults, performing risk analysis on areas prone to earthquakes, performing detailed geologic mapping to find new, undiscovered active faults, and deploying seismic equipment to refine earthquake locations. The data we generate informs building code updates that result in reduced damage or lives saved during the next earthquake.

The National Earthquake Hazard Reduction Program reauthorization is important to Washington to help provide funding, maintain expertise, and save lives in our state. We have worked closely with USGS and FEMA in the past but funding has been limited.

Tsunamis also present a significant risk in Washington. Tsunamis pose a great hazard because they arrive quickly and because they can be large, with tsunami waves being as high as 70 feet in some areas. A reasonable estimate for fatalities during a Cascadia subduction zone tsunami is 10,000 people. The largest tsunami in Washington in the last 500 years was generated on the Cascadia subduction zone on January 26, 1700. A more recent large subduction zone earthquake and tsunami is the 2011 Tohoku tsunami that cost over \$300 billion in total damages and at least 15,894 fatalities. Tsunamis are not just an outer coast hazard in Washington. Geologic evidence demonstrates that an earthquake on the Seattle Fault in the Puget Sound generated a significant tsunami about 1,000 years ago.

We partner with NOAA to model likely tsunami inundation from various earthquake scenarios and use that data to assist local communities in developing evacuation and mitigation strategies.

Reauthorization of the Tsunami Warning and Education Act as the Tsunami Warning, Education, and Research Act was a critical part of continuing to provide safety for Washington's citizens from tsunamis generated from Cascadia subduction zone earthquakes. We thank you for reauthorization of this important act. There are still large funding needs for Washington to help us with inundation modeling, developing evacuation route maps, and educating the public on what to do in the case of a tsunami.

The U.S. Geological Survey (USGS) calls Mount Rainier the most threatening volcano in the Cascades largely due to the size of the at-risk population. According to the U.S. Geological Survey, Washington is home to 4 of the 18 "Very High Threat" volcanoes in the United States. This number includes two well-known volcanoes, Mount Rainier and Mount St. Helens, as well as Mount Baker and Glacier Peak. All could erupt again in our lifetimes, and even if the eruptions were relatively small, the consequences would likely be high. Lahars are volcanic debris flows that can travel far from the volcano and inundate areas with mud tens of feet thick. The most recent example of that is from Mount St. Helens in 1980. However, about 600

years ago a large lahar buried the present site of the city of Orting 30 feet deep and continued to flow down the river to the Puget Sound. If this were to happen today, damage to structures alone will total an estimated \$13 billion in the Puyallup river valley.

We collaborate with the USGS to determine risk from these volcanic hazards and to develop evacuation and mitigation strategies with local communities.

The USGS has indicated that, with the exception of Mount St. Helens, these Very-High-Threat volcanoes are moderately to significantly under-monitored relative to their risk. Plans are in place to address these gaps, although there are substantial permitting and resource challenges to overcome before these plans can be put into action. One place where progress is being made is Mount Rainier, where, in partnership with Pierce County, the USGS has recently begun a project to upgrade and expand a lahar detection system for two of the more populated river drainages. Passage of the National Volcano Early Warning and Monitoring system act is important to Washington, as it will help fund additional monitoring along other populated corridors on the flanks of these volcanoes.

Washington is one of the most landslide-prone states and has hundreds of thousands of known and unknown landslides. Some of these landslides have been record setting in terms of size and the amount of damage and lives lost, such as the SR 530 or Oso landslide of 2014 that caused 43 fatalities, the Aldercrest-Banyon landslide that destroyed 137 homes, the Nile landslide that blocked the Naches River destroying 14 homes and Highway 410. The ongoing Rattlesnake Hills landslide has caused evacuation of 60 people and threatens I-82. Additionally, extreme winter precipitation events in Washington can produce thousands of rapidly moving landslides in a period of a few hours, simultaneously affecting entire regions of the state.

We collaborate with the USGS and other agencies when large-scale landslide events occur, sharing both data and expertise. Following large wildfires, we collaborate with the USGS to determine burned area vulnerability to debris flows, much like what occurred very recently in southern California following the Thomas fire.

The proposed National Landslide Preparedness Act is important because landslides in Washington are among the most frequently occurring natural hazards, and they are difficult to quantify both in terms of frequency and in terms of cost. Inventories, susceptibility, and hazard maps for the state are far from complete. Funding for improved landslide inventories, research, and for monitoring equipment allows us to learn more about these landslides and save lives and money. Having USGS as a partner and available for consultation or response is invaluable.

Lastly, an important part of the National Landslide Preparedness Act is the USGS 3DEP program, which is an important partnership that allows us to leverage funding for lidar that can help produce topographic products invaluable to landslide inventory mapping in Washington. We encourage continuation and expansion of this important program.

