Statement of David Applegate
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Thank you Chairman Murkowski, Ranking Member Cantwell, and members of the committee. My name is Dave Applegate, and I am the Associate Director for Natural Hazards at the U.S. Geological Survey (USGS). I am also currently exercising the authority of the Deputy Director. I appreciate the opportunity to testify here today about natural hazards and to share with the committee current USGS activities that are helping make communities and the Nation safer and more resilient. Every day, people and communities across the Nation face risks associated with geologic hazards. These hazards include: earthquakes, volcanoes, landslides and subsidence, coastal erosion, tsunamis, and even naturally occurring contaminants. While these hazards threaten lives, they also threaten homes, buildings, wildlife, the environment, and the infrastructure that underpins our economy and our way of life.

In carrying out our natural hazards mission, the strength of the USGS is the range of capabilities and partnerships we can bring to bear to deliver useful, actionable hazards information to first-responders, emergency managers and other local, state and federal decision makers.

USGS monitoring networks enable rapid situational awareness tools for effective response, while our hazard and risk assessments and scenarios help communities understand and mitigate their exposure. And all these real-time and long-term products are underpinned by targeted research to improve our understanding of hazard processes and maintain world-class expertise. Other USGS capabilities that serve multiple purposes also contribute. Improved elevation data collected through the 3D Elevation Program, or 3DEP, lead to better flood inundation maps as well as new discoveries of faults, landslides, and deposits from past volcanic eruptions that inform us of the frequency of eruptions and the reach of volcanic hazards on the landscape. Geologic mapping improves our understanding of energy and mineral resources as well as geologic hazards.

Even the most thorough geologic research does not automatically lead to better designed buildings or residents who know how to properly evacuate. For science to make a difference in the outcomes that matter most to society, it is essential that we integrate our geoscience research with engineering and social science and then engage directly with users to shape the collection, investigation, and delivery of our information. This integration empowers the public, policymakers at all levels, businesses, governments, and individuals, to effectively assess their risks from hazards and to build communities that are more resilient. This is what we at the USGS and our many partners are focused on. It is a responsibility that we carry with us to work every day.

Getting our information into the hands of those who can use it when they need it is of paramount importance. After the Thomas Fire in southern California this past month, the USGS produced maps of debris-flow hazards for the area that supported the NOAA National Weather Service issuance of public warnings. These maps were used by CALFIRE and the California Geological Survey Watershed Emergency Response Teams to identify property and infrastructure, including oil and gas infrastructure, at risk from post-fire debris flows and flash flooding. Those assessments in turn formed the basis for emergency response and evacuation planning by Santa Barbara and Ventura Counties. Our ability to serve the public in anticipation of, during, and subsequent to natural hazard events is exemplified by USGS delivery of coastal inundation and erosion hazard forecasts for the series of major hurricanes (Harvey, Irma, Jose, Maria and Nate) and nor'easters that impacted our Gulf and Atlantic coastal communities this past year. The ability to do so is a result of persistent mapping, monitoring and research programs that inform effective planning, response, and recovery by our federal, State, and local partners.

In accordance with congressional funding, we are working with the States, university partners, and private foundations to develop an earthquake early warning system called *ShakeAlert* for the West Coast, and we are working with private firms and public agencies to integrate those warnings into automated systems and emergency announcements. With new funding directed by Congress in recent years for this purpose, the system is now about half-completed and we expect to begin limited public alerting by the end of this year. There are many technical and other challenges remaining, including determining the appropriate federal, state and local cost share, before full, border-to-border public alerting will achieved. However, an earthquake early warning system would be able to provide an additional layer of safety from inevitable large earthquakes. If completed, this technology is expandable to other regional seismic networks of the USGS Advanced National Seismic System, such as Alaska, Nevada, and Utah, providing a significant boost in the capabilities of those seismic networks, which have declined in recent years due to constrained state and federal funding.

In the U.S. and around the globe, large-scale natural hazard events shape our landscapes and our lives. Nowhere is that more evident than it is for the landscapes that sit astride subduction zones, where two tectonic plates collide and one subducts, or is driven beneath, the other. The margins of the Pacific Ocean consist of a series of subduction zones, known as the Ring of Fire, linked by transform faults such as the San Andreas Fault. The Pacific subduction zones most relevant to the U.S. border the Pacific Northwest (Cascadia), Southern Alaska and the Aleutian Islands, the Marianas Trench, and the Tonga zone near American Samoa. The U.S. Territories of Puerto Rico and the Virgin Islands, are also atop a subduction zone in the Caribbean.

This past June, the USGS released Circular 1428, a subduction zone science plan that defines USGS science priorities and identifies potential partnerships with other organizations involved in related scientific research, emergency management, policy making, and planning. The plan highlights knowledge gaps and opportunities for improvement in three crucial areas—(1) advancing observations and modeling of subduction zone processes, (2) quantifying subduction zone natural hazards and risk, and (3) providing forecasts and rapidly delivered updates during and after subduction zone events. The plan lays out an achievable vision for addressing the hazards associated with subduction zones, which include some of the most catastrophic natural disasters in history.

Off-shore earthquakes and landslides may trigger tsunamis, some so large that they traverse the entire Pacific Ocean, while others are localized but still deadly. A megathrust earthquake off the Aleutians or Cascadia could cause tsunamis as far away as Hawaii or southern California. Monitoring for these tsunamis requires integrated warning systems and close cooperation between the USGS and NOAA. The magnitude-9.2 Great Alaskan Earthquake of 1964 occurred when part of the Pacific Plate snapped while subducting beneath the North American Plate causing tsunamis, 129 deaths in 3 states, and an estimated $2.4 billion in property losses (in 2017 dollars).

Subduction zones also generate strings of active volcanoes. From Northern California to the Aleutians, to the Mariana Islands and beyond, these volcanic hazards pose immediate threats to nearby communities and also produce ash clouds that disrupt international air traffic. The 1991 eruption of Mount Pinatubo in the Philippines was the largest eruption of the 20th century. There, forecasts by the USGS and Philippine authorities led to the evacuation of 75,000 people, including 18,000 U.S. military personnel, and averted an estimated $250 million in property losses. Fast-moving debris flows of volcanic material known as lahars threaten communities downslope from volcanoes. The USGS and Pierce County, Washington, are working together to establish a lahar detection and warning system for all major drainages of Mt. Rainier. When completed, it will serve as a model for protecting populations at risk of lahars from other volcanoes. The USGS is currently finalizing a congressionally mandated report that specifies the implementation plan for a National Volcano Early Warning System that will ensure that all volcanoes in the U.S. are monitored at levels commensurate with their threat that makes use of the latest national threat level assessment to be published by the USGS in 2018.

In Alaska, USGS science and hazard monitoring operations focus on threats from earthquakes, tsunami, volcanic eruptions, landslides, coastal change and geomagnetic storms. Regarding earthquakes, the report language accompanying the *Consolidated Appropriations Act, 2017,* directed the USGS to report back to the House and Senate Appropriations Committees with “an implementation plan, including cost estimates, for the adoption of future seismic stations." The relevant seismic stations are those of the National Science Foundation's EarthScope Transportable Array (TA), currently deployed across Alaska for a period of two years. The USGS implementation plan will provide a detailed strategy and costs for the adoption of 60 of 270 TA seismic stations, the retention of the TA equipment upgrades at 30 permanent stations, upgrades to 28 of 140 geodetic stations that are part of NSF's Plate Boundary Observatory project, and construction and operation of an earthquake early warning system for the Anchorage region. Of these investment options, the USGS prioritizes the retention of the TA equipment upgrades at 30 permanent stations of the Alaska Seismic Network and Alaska Volcano Observatory network, plus two other high-value stations for monitoring high-threat volcanoes in the state. USGS has begun discussion with the National Science Foundation about potential adoption of these stations.

USGS is also prioritizing the update of the Alaska Seismic Hazard Model, which is the basis for earthquake-safe construction state-wide. Because Alaska hosts significant elements of the national critical infrastructure, such as the Trans-Alaska Pipeline, major ports and military bases, earthquake-resistant construction is especially important, not only for the state but for the nation. The current USGS map is significantly outdated and does not accurately account for new scientific information on large earthquake occurrence and related earthquake ground shaking data. In 2016, this need was recognized as a priority by the Alaska Seismic Hazards Safety Commission**.** Completing—and subsequently maintaining and improving—this major update is part-in-parcel with the USGS priority for expanding subduction zone science. Its activities and results will be applicable to other subduction zone environments, including Cascadia and Puerto Rico.

All of our efforts—to understand hazards, to build monitoring and warning systems that produce actionable products and inform the public, and to integrate USGS information into official and private-sector responses—depend ultimately on equipment and personnel. In this regard, I would emphasize another example of critical infrastructure, namely our country's scientific capabilities. When our science infrastructure is robust and efficient, it improves our ability to protect other infrastructure, to repair damage quickly, and to restore it to an even more resilient state.

On behalf of the 8,000 employees of the USGS, thank you for inviting us to testify and for the attention you are giving to this important topic. I am happy to answer any questions you may have.