Congressional Research Service
Informing the legislative debate since 1914

Landslides: Federal Role in Research, Assessment, and Response

June 2, 2023

Congressional Research Service
https://crsreports.congress.gov
R47588

CRS REPORT
Prepared for Members and
Committees of Congress

Congressional Research Service
Informing the legislative debate since 1914

SUMMARY

R47588

June 2, 2023

Linda R. Rowan
Analyst in Natural Resources and Earth Sciences

Landslides: Federal Role in Research, Assessment, and Response

Landslide hazards may occur across the United States and its territories, and landslide risks may be increasing. A *landslide* is a movement of a mass of rock, debris, or soil down a slope. Mountainous, hilly, or cliff terrains (e.g., vertical shorelines, roadcuts, surface mining walls) are most susceptible to landslides. Landslides are most often triggered by rainfall, particularly rainfall on burned, steeply sloped terrain (e.g., a post-wildfire debris flow). Earthquakes or volcanic activity that cause ground motion also can trigger a landslide. Landslides may harm people and damage property; in addition, they may block roads, waterways, and water drainage systems, leading to further damage and economic losses. Landslide risks may increase in the near future due to increased development in hazardous regions and increased potential for more frequent weather-related hazards (e.g., intense rain storms, hurricanes, wildfires) that may trigger more landslides.

The U.S. Geological Survey (USGS) Landslide Hazards Program (LHP) is the only federal program dedicated to landslide hazard science and applications. Other federal agencies involved in landslide science and applications as components of larger programs include the National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA), federal land management agencies, U.S. Department of Transportation, and Federal Emergency Management Agency.

The National Landslide Preparedness Act of 2021 (NLPA, P.L. 116-323, 43 U.S.C. §§3101 et seq.) directed the Secretary of the Interior, acting through the Director of the USGS, to establish a National Landslide Hazards Reduction Program (NLHRP). NLHRP activities include identifying, mapping, assessing, and researching landslide hazards; responding to landslide events; and coordinating with state, local, territorial, and tribal entities to reduce landslide risks. In particular, the act required development of a national strategy for landslide risk reduction that includes goals and priorities for the NLHRP and an interagency plan that details programs, projects, and budgets to implement the national strategy.

The USGS completed the National Strategy for Landslide Loss Reduction, and submitted the national strategy to Congress in January 2022. As of June 2023, much of the national strategy has not been implemented, and the USGS has not completed the interagency plan detailing projects and budgets. Congress may consider whether to engage in oversight of the national strategy and the implementation of NLHRP activities, goals, and priorities. In FY2021-FY2023, Congress appropriated less than the amounts authorized for the USGS, NSF, and NOAA to implement the NLHRP; appropriations are authorized through FY2024. Congress may consider whether appropriations levels have been sufficient for the agencies to coordinate and implement the NLHRP and what funding level to provide for the program in FY2024. Additionally, Congress may consider whether to authorize appropriations for the NLHRP beyond FY2024 through reauthorization.

Contents

Figures

Contacts

Introduction

Landslide *hazards* may occur across the United States and its territories, especially where there are steep slopes that rock, soil, and other debris may slide down.[1] Earthquakes, volcanoes, and especially rainfall may trigger a landslide or amplify landslide hazards.[2] Landslide hazards also may trigger other hazards that may cause damage or disruption, such as dammed waterways, tsunamis, or flooding. Landslides are estimated to cause billions of dollars in damage and multiple fatalities and injuries each year in the United States.[3] Landslide *risks* may increase in the near future for two primary reasons: (1) increased development in hazardous regions, such as mountainous, hilly, or cliff terrains (i.e., more people and more property in harm's way), and (2) more frequent and extreme weather-related events that may trigger more landslides (e.g., increasing frequency and/or magnitude of intense rain storms, rising temperatures, and wildfires forecast by some studies).[4]

Federal agencies are involved in landslide science and applications in different ways.[5] The U.S. Geological Survey (USGS) Landslide Hazards Program (LHP) is the only federal program dedicated to landslide hazard science and applications.[6] Some other federal agencies are involved in landslide science and applications as components of larger programs. The National Science Foundation (NSF) provides research grants for landslide hazard science. The National Oceanic and Atmospheric Administration (NOAA) supports landslide science and applications, especially regarding atmospheric or oceanic triggers for landslides (e.g., hurricanes, rain, snowstorms) or landslide-caused tsunamis. In particular, NOAA's National Weather Service (NWS) may integrate landslide warnings into flood watches and warnings based on weather forecasts and LHP landslide hazard assessments.

Some federal land management agencies support science and applications for landslide hazards on federal lands.[7] The U.S. Army Corps of Engineers (USACE) assesses and responds to

[1] *Hazard* refers to the natural event, such as the land sliding down a hill in a landslide.

[2] U.S. Geological Survey (USGS), Landslide Hazards Program (LHP), "Landslides 101," at https://www.usgs.gov/programs/landslide-hazards/landslides-101; Lynn M. Highland and Peter Bobrowsky, *The Landslide Handbook: A Guide to Understanding Landslides*, USGS, USGS Circular 1325 (Reston, VA: 2008), at https://www.usgs.gov/publications/landslide-handbook-a-guide-understanding-landslides (hereinafter Highland and Bobrowsky, *Landslide Handbook*).

[3] Landslide losses in terms of fatalities and direct and indirect economic losses are difficult to estimate on an annual basis and for the entire nation, because the occurrence of landslides, number of fatalities, and economic losses are highly variable in time and location. In addition, data on the occurrences and impacts of landslides are incomplete or not reported. Benjamin B. Mirus et al., "Landslides Across the USA: Occurrence, Susceptibility, and Data Limitations," *Landslides*, vol. 17 (December 19, 2020), pp. 2271-2285, at https://doi.org/10.1007/s10346-020-01424-4.

[4] *Risk* refers to the potential for damage from a hazard, such as a house being destroyed by a landslide. See Federal Emergency Management Agency (FEMA), "Determining Risk," at https://hazards.fema.gov/nri/determining-risk. See also Jonathan W. Godt et al., *National Strategy for Landslide Loss Reduction*, USGS, Open File Report 2022-1075, 2022, p. 2, at https://pubs.usgs.gov/of/2022/1075/ofr20221075.pdf (hereinafter Godt et al., *National Strategy*).

[5] *Science* may include research, monitoring, observations, modeling, and data/computer services in support of scientific efforts to understand natural hazards. *Applications* may include preparedness, planning, training and outreach, assessment, response, mitigation, and recovery from natural hazards and the impacts of natural hazards.

[6] USGS, *FY2023 USGS Budget Justifications (Greenbook)*, p. 82, at https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/media/files/FY23-USGS-Greenbook.pdf; USGS, LHP, "What We Do: Landslide Hazards Program," at https://www.usgs.gov/programs/landslide-hazards/what-we-do-landslide-hazards-program.

[7] Federal land management agencies include the National Park Service, the Bureau of Land Management, and the Fish and Wildlife Service in the Department of the Interior and the U.S. Forest Service in the Department of Agriculture. (continued...)

landslide hazards impacting its engineering and construction activities. The U.S. Department of Transportation supports applications and offers financial and technical assistance to state and local departments of transportation for landslide hazards impacting their transportation activities. The Federal Emergency Management Agency (FEMA) supports science, applications, and financial and technical assistance to communities for landslide hazards.

In addition to federal agencies, state and local entities (e.g., geological surveys, land management agencies, transportation departments, and emergency response agencies) support science, applications, and assistance for landslide hazards in their communities. State and local entities may seek assistance or coordination with federal agencies for their landslide hazard activities.

The National Landslide Preparedness Act of 2021 (NLPA; P.L. 116-323, 43 U.S.C. §§3101 et seq.) directed the Secretary of the Interior, acting through the Director of the USGS, to establish a National Landslide Hazards Reduction Program (NLHRP; 43 U.S.C. §3102) and a three-dimensional elevation program (3DEP; 43 U.S.C. §3104).[8] LHP plans to expand its landslide science and application activities while leading the implementation and coordination of the NLHRP. The complementary 3DEP, within the USGS National Geospatial Program, aims to map the nation's topography and built environment to better identify landslide hazards and risks (and for many other purposes).[9]

This report provides an overview of landslide types, hazards, causes, and impacts, as well as a discussion of landslide susceptibility and risk in the United States. The report describes the federal role in landslide hazards and the plans and efforts to implement the NLHRP. Congress may consider oversight of the NLHRP and whether the program and related activities are sufficient to reduce landslide risks.

Landslide Types, Hazards, Causes, and Impacts

A *landslide* is a movement of a mass of rock, soil, and/or debris down a slope. Landslides may be divided into four types based on the mode of slope movement—falls, topples, slides, spreads, or flows—and the type of materials in the slide—rock, soil, water, and other debris (see textbox entitled, "Examples of Landslide Types and Their Impacts on Communities"):

1. *Slow-moving landslides* consist of slow-moving or spreading rock or soil that generally does not threaten people but may damage property.
2. *Rock falls* consist of rocks falling from cliffs, roadcuts, excavations, or other steep walls, often where there is exposed and typically loose rock. Rock falls may harm people and damage property, especially near roads.
3. *Rock* or *debris avalanches* consist of rapid and often large landslides of mostly rock and soil in mountainous regions. Rock/debris avalanches may be hazardous to people or property in mountainous regions.

CRS Report R43429, *Federal Lands and Related Resources: Overview and Selected Issues for the 118th Congress*, coordinated by Katie Hoover.

[8] For more on the National Landslide Preparedness Act of 2021 (NLPA; P.L. 116-323, 43 U.S.C. §§3101 et seq.), see CRS Insight IN11008, *Enactment of the National Landslide Preparedness Act (P.L. 116-323)*, by Anna E. Normand.

[9] USGS, "3D Elevation Program," at https://www.usgs.gov/3d-elevation-program; Vicki Lukas and William J. Carswell Jr., *The 3D Elevation Program—Landslide Recognition, Hazard Assessment, and Mitigation Support*, USGS, January 2017, at https://doi.org/10.3133/fs20163094.

4. *Debris flows* (also called *mudflows* or *mudslides*) consist of slurries of rock, soil, water, and debris that may flow rapidly downhill over long distances, especially along stream channels. Debris flows may harm people and damage property.[10]

Examples of Landslide Types and Their Impacts on Communities

Four photographs showing the four different types of landslides and examples of the damage they may cause.

Photograph (1): Example of a slow moving landslide in Denali National Park, Alaska, that transitioned into a faster moving landslide due to permafrost thaw. A slow moving landslide below the roadbed required road maintenance every two to three years since the 1960s. In 2021, the road dropped approximately 14 vertical feet (drop-off shown in photograph) as the landslide began moving downhill at over 10 inches per day over a two week period.

Photograph (2): Example of a rock fall and rock slide in Clear Creek Canyon, CO, in 2005. The event closed the road for weeks to clean-up debris and repair the road. The closure contributed additional economic losses related to transport. Also shown is a rock curtain (metallic screen), a commonly applied barrier for hazardous rock surfaces.

Photograph (3): Example of a rock/debris avalanche, the Thistle landslide, near Thistle, UT, in 1983. The landslide dammed the Spanish Fork River, backing up water that flooded the town of Thistle. Roads and a rail line had to be re-routed. The rail line was re-routed by excavating through an adjacent mountain and building a protective tunnel.

Photograph (4): Examples of landslides and debris flows near La Conchita, CA, in 1995 and 2005.The 1995 landslide damaged homes and left an unstable debris apron above the community. In 2005, a rapidly moving debris flow (a remobilization of the 1995 landslide; estimated to have flowed 30 feet per second on the steeper slope and 15 feet per second on the flatter slope through the community) damaged more homes and caused fatalities.

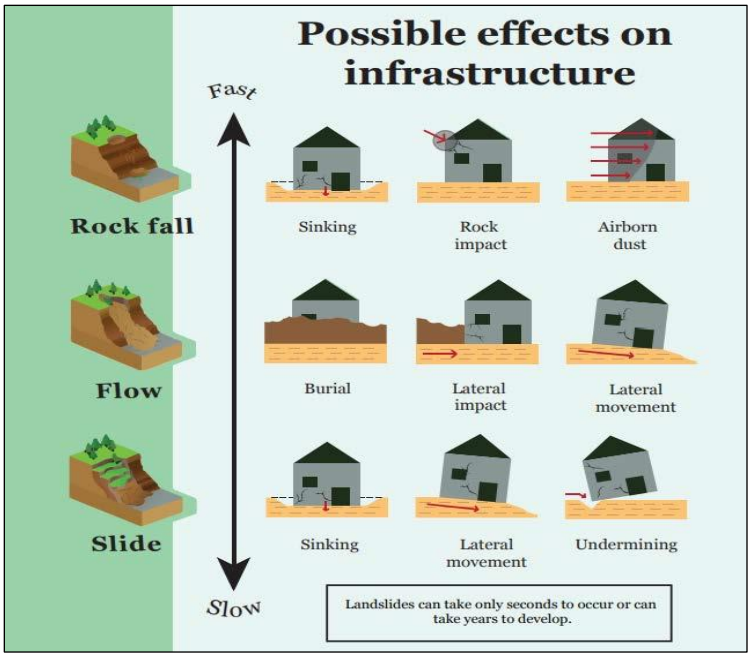
Sources: Photograph (1): Godt et al., *National Strategy*, p. 9 and National Park Service, "Denali National Park Closes Section of Park Road Due to Landslide Activity," at https://www.nps.gov/dena/learn/news/road-closure-pretty-rocks-2021.htm. Photographs (2), (3) and (4) from Lynn M. Highland and Peter Bobrowsky, *The Landslide Handbook - A Guide to Understanding Landslides*, USGS, USGS Circular 1325, Reston, VA, 2008,

[10] Godt et al., *National Strategy*, p. 2. See also Highland and Bobrowsky, *Landslide Handbook*, and USGS, LHP, "Landslides 101," at https://www.usgs.gov/programs/landslide-hazards/landslides-101.

https://www.usgs.gov/publications/landslide-handbook-a-guide-understanding-landslides and Randall W. Jibson, *Landslide Hazards at La Conchita, California*, USGS, Open-File Report 2005-1067, Reston, VA, 2005, https://pubs.usgs.gov/of/2005/1067/pdf/OF2005-1067.pdf.

Landslides may happen without any warning and the event may be over in seconds to minutes. Alternatively, a slow-moving landslide may occur over days or longer and allow communities to receive a warning about potential risks. Landslides may be caused by topographic (e.g., steep slope), geologic (e.g., loose rock), atmospheric (e.g., precipitation rates), or anthropogenic conditions (e.g., roadcut or mining excavation creating an engineered steep slope). Earthquakes, volcanoes, hurricanes, intense rainfall, and wildfires may trigger or contribute to the magnitude of a landslide.[11] Landslides may cause additional hazards that lead to more potential risk, such as blocked roadways or railways and dammed waterways. **Figure 1** shows examples of the types of damage to a building that different types of landslides could cause.

Figure 1. Examples of Potential Damage to Buildings from Landslides



Source: USGS, University of Puerto Rico, Mayaguez, and Natural Hazards Center, *Landslide Guide for Residents of Puerto Rico*, 2020, at https://hazards.colorado.edu/uploads/documents/PuertoRico_LandslideGuide_2020.pdf.

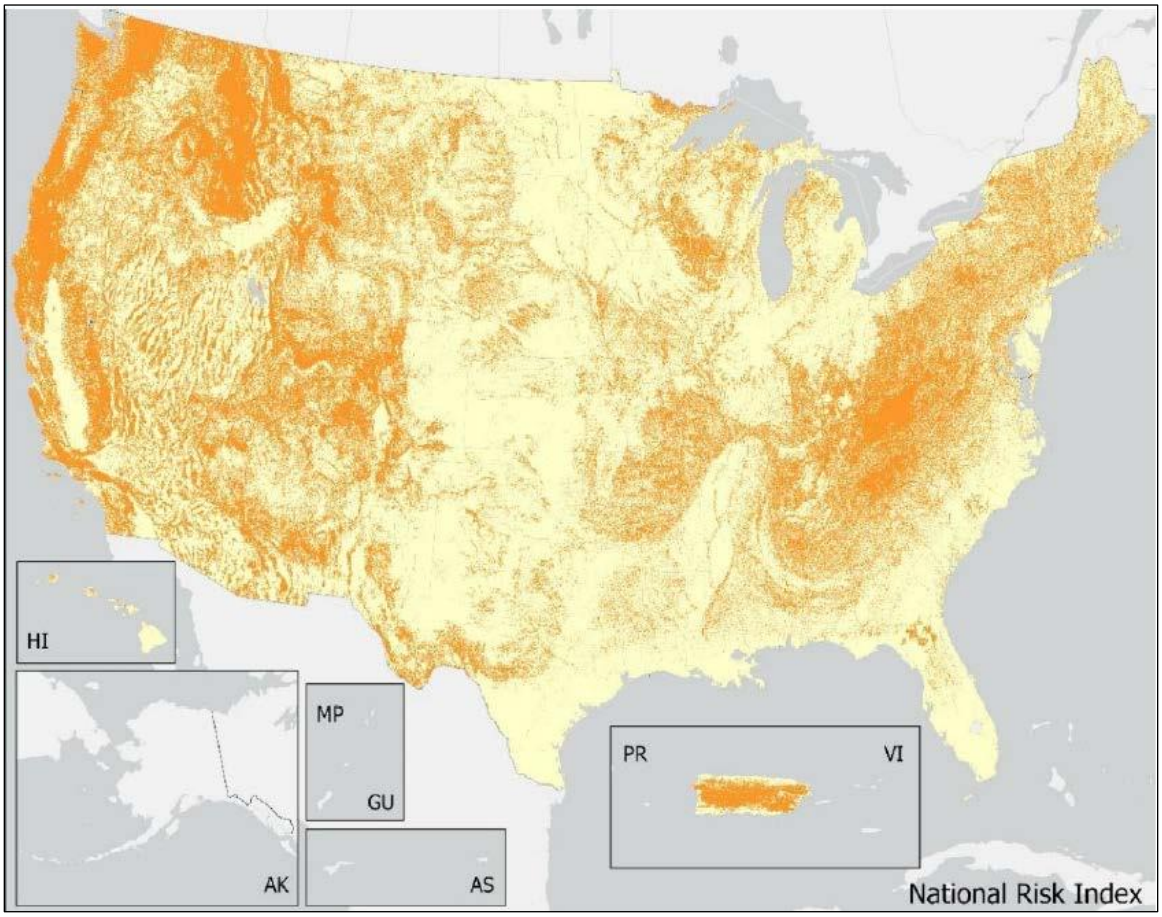
Landslide Susceptibility and Risk in the United States

Landslides in the United States and its territories are most likely to start in mountainous, hilly, or cliff terrains. Such landslides are most often triggered by water (e.g., intense rainfall events), but also may be triggered by earthquakes, volcanic activity, melting glaciers, and other causes.

[11] A landslide at Mount St Helens volcano associated with the volcano's 1980 eruption in Washington is among the largest known subaerial landslides. The slide traveled at 70 - 150 miles per hour for over 14 miles. The landslide was triggered by an earthquake and an eruption. USGS, "What Was the Largest Landslide in the United States? In the World?" at https://www.usgs.gov/faqs/what-was-largest-landslide-united-states-world.

Landslides near populated areas or infrastructure may cause damage and represent the highest landslide risks. In general, the USGS has identified areas in the United States and its territories that are susceptible to landslide hazards and FEMA has identified areas that face potential landslide risks. The USGS landslide hazard susceptibility map shows areas of steep slopes where landslides may be more likely to begin (**Figure 2**). The map does not depict areas that may have the most damaging impact on a community, nor does it show where the landslides may travel to and deposit rock, soil, and other debris. FEMA uses the susceptibility map as a starting point to estimate landslide risk in the National Risk Index.[12] The National Risk Index defines *landslide risk* as a combination of landslide hazard likelihood, the size and vulnerability of the community in the path of the hazard, and the potential for damage from the hazard. **Figure 3** shows the expected annual loss from a landslide estimated by county in the United States and its territories from FEMA's National Risk Index.[13]

Figure 2. Landslide Hazard Susceptibility Map



Sources: Federal Emergency Management Agency (FEMA), *National Risk Index, Technical Documentation*, March 2023, p. 15-2, Figure 87, at https://www.fema.gov/sites/default/files/documents/fema_national-risk-index_technical-documentation.pdf. Maps and data from the USGS used to create this map include Jonathan W. Godt et al., "Prototype Landslide Hazard Map of the Conterminous United States," *Landslides and Engineered*

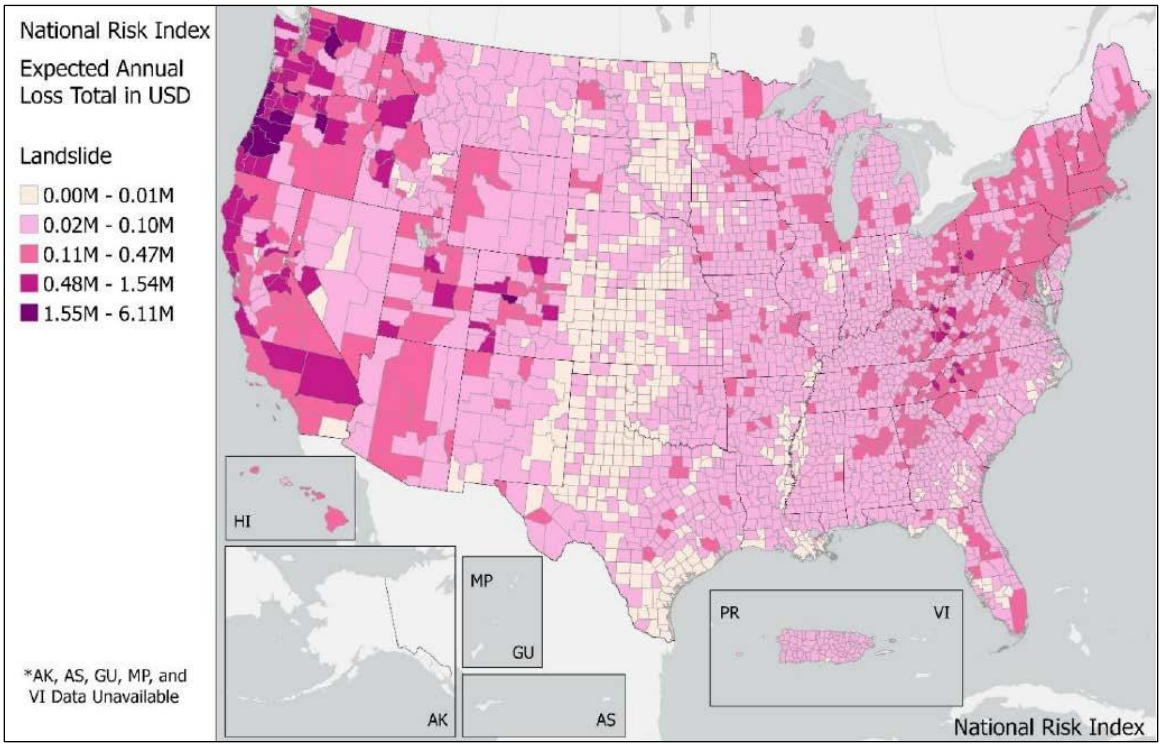
[12] FEMA, "The National Risk Index," at https://hazards.fema.gov/nri/.

[13] Expected annual loss for landslide hazards is one component of risk that is calculated and displayed on FEMA's National Risk Index. To see other risk components, other hazards, or more detailed data about a county or region, see FEMA, "The National Risk Index," at https://hazards.fema.gov/nri/map.

Slopes: Protecting Society Through Improved Understanding: Proceedings of the 11th International and 2nd North American Symposium on Landslides and Engineered Slopes, 2012; USGS, "Preliminary Landslide Susceptibility Maps and Data for Hawaii," 2018, at https://www.usgs.gov/programs/landslide-hazards/science/preliminary-landslide-susceptibility-maps-and-data-hawaii; and K. S. Hughes and W. H. Schulz, *Map Depicting Susceptibility to Landslides Triggered by Intense Rainfall, Puerto Rico*, USGS, USGS Open-File Report 2020-1022, at https://doi.org/10.3133/ofr20201022.

Notes: Orange shaded areas are susceptible to landslide hazards, and yellow shaded areas are not susceptible. Light gray shaded areas, including Alaska (AK), American Samoa (AS), Guam (GU), Northern Mariana Islands (MP), and the Virgin Islands (VI), have no susceptibility data. HI = Hawaii; PR = Puerto Rico. USGS susceptibility for the conterminous United States is based on slope and relief datasets and past landslide inventories from Oregon, New Jersey, New Mexico, the San Francisco Bay region, and parts of North Carolina.

Figure 3. Total Expected Annual Loss from a Landslide, by County



Source: FEMA, *National Risk Index, Technical Documentation*, March 2023, p. 15-14, Figure 92, at https://www.fema.gov/sites/default/files/documents/fema_national-risk-index_technical-documentation.pdf.

Notes: Loss is given in U.S. dollars (USD), and all amounts are converted to January 2022 dollars. M = million. The expected annual loss from a landslide is calculated based on the estimated landslide occurrence, building value, and population. Light gray shaded areas, including Alaska (AK), American Samoa (AS), Guam (GU), Northern Mariana Islands (MP), and the Virgin Islands (VI), do not have enough data to calculate risk. HI = Hawaii; PR = Puerto Rico. See FEMA, *National Risk Index, Technical Documentation*, March 2023, pp. 4-6 and 15-1 to 15-14 for more information about the calculations, data, and data limitations.

Federal Roles in Landslide Hazards and Risks

Various federal agencies perform landslide science and/or application activities that in general are small components of larger programs with broader objectives. These federal roles existed before

the 2021 enactment of the NLPA. Below is an overview of some of the existing federal programs the NLPA aims to coordinate to promote landslide risk reduction by establishing the NLHRP.[14]

U.S. Geological Survey

The USGS Natural Hazards Mission Area, within the Department of the Interior, includes program line items for science and applications for landslides (LHP), as well as earthquakes (Earthquake Hazards Program, or EHP) and volcanoes (Volcano Hazards Program, or VHP), among others.[15] The mission area works with many partners to research, monitor, assess, and respond to natural hazards. Since before the NLPA was enacted, LHP has conducted targeted research, developed methods and tools for targeted landslide hazard assessments and forecasts, provided technical assistance in some landslide emergencies, and conducted outreach to some affected communities.[16] LHP works with EHP and VHP on earthquake- or volcano-triggered landslide hazards, respectively, and with the USGS Coastal and Marine Hazards and Resources Program on coastal- and marine-triggered landslide hazards.[17]

National Science Foundation

The NSF does not have a specific award program for landslide research, but it may award research grants for landslide-related research. NSF organizes its competitive and meritorious research grant program across general areas of science rather than specific topics. For example, the Geosciences Directorate may award a research grant to better understand landslide processes. The Engineering Directorate may award a research grant to develop innovative engineering principles for landslide mitigation. The Social, Behavioral, and Economic Sciences Directorate may award a research grant to understand how people perceive landslide risks or how people react to a landslide warning.

In addition, NSF awards cooperative agreements and grants to research facilities that may support landslide research. In some cases, NSF grant awardees and research facilities work with the USGS and other federal agencies on landslide research activities.[18]

---

[14] The NLPA lists the Secretaries of the Interior, Agriculture, Army, Commerce, Homeland Security, and Transportation and the Director of the National Science Foundation (NSF) as departments/agencies to coordinate within the NLHRP.

[15] USGS, "Natural Hazards Mission Area, Programs," at https://www.usgs.gov/mission-areas/natural-hazards/programs.

[16] USGS, "Landslide Hazards Program," at https://www.usgs.gov/programs/landslide-hazards. Before enactment of the NLPA, the USGS formed LHP under the USGS Organic Act, 1879 (43 U.S.C. §31) and other authorities, such as the Disaster Relief Act of 1974 (P.L. 93-288). The Earthquake Hazards Program is the USGS component of the multiagency National Earthquake Hazards Reduction Program (NEHRP), established by Congress in 1977 (P.L. 95-124). The Volcano Hazards Program leads the National Volcano Early Warning and Monitoring System established by Congress in 2019 in Title V, Section 5001 (43 U.S.C. 31k), of the John D. Dingell Jr. Conservation, Management, and Recreation Act (P.L. 116-9). These three programs have similar objectives for coordinated research, monitoring, assessment, response, and recovery for geologic hazards, such as landslides, earthquakes, and volcanoes.

[17] USGS, "Coastal and Marine Hazards and Resources Program," at https://www.usgs.gov/programs/cmhrp.

[18] For example, the Puerto Rico Landslide Hazard Mitigation Project is a partnership between the USGS, the Natural Hazards Center at the University of Colorado, Boulder (i.e., an NSF-funded research facility), and the University of Puerto Rico, Mayaguez. The USGS provided funding for this project from supplemental appropriations in response to hurricane and earthquake disasters in Puerto Rico that triggered nearly 40,000 landslides (Additional Supplemental Appropriations for Disaster Relief Act 2018 [P.L. 115-123] and USGS, "2018 Supplemental Appropriations Activities," at https://www.usgs.gov/supplemental-appropriations-for-disaster-recovery-activities/2018-supplemental-appropriations). Natural Hazards Center, "Puerto Rico Landslide Hazard Mitigation Project," at https://hazards.colorado.edu/news/research-projects/puerto-rico-landslide-hazard-mitigation-project.

National Oceanic and Atmospheric Administration

NOAA, in the Department of Commerce, conducts targeted research, develops methods and tools for landslide hazard assessments and forecasts, provides technical assistance in landslide emergencies, and conducts outreach to affected communities. For example, NOAA's Office of Oceanic and Atmospheric Research conducts some landslide-related research, primarily where oceanic or atmospheric conditions may trigger a landslide or where a landslide may trigger an oceanic or atmospheric hazard (e.g., a landslide-triggered tsunami). The National Weather Service (NWS) also plays a role in landslide warnings. Weather events may trigger landslides, and the NWS integrates information about potential landslides, especially debris flows, into flood or flash-flood watches and warnings for a given area.[19] The USGS worked with the NWS to test pilot debris flow early warning systems in Northern California (1985-1995) and Southern California (2005-2008).[20]

Federal Emergency Management Agency

FEMA, in the Department of Homeland Security, provides many resources for planning, preparedness, response, recovery, and mitigation for landslide hazards. It also identifies and calculates landslide risks nationwide.[21] FEMA's National Flood Insurance Program (NFIP) may cover mudflows, a landslide type most often associated with intense rainfall and flooding (see "Landslide Types, Hazards, Causes, and Impacts"). FEMA provides guidance to reduce mudflow risks and for recovery assistance under NFIP.[22] FEMA also provides hazard mitigation assistance to communities and homeowners for landslide and other hazards through the Hazard Mitigation Assistance Program.[23]

Federal and Tribal Land Management Agencies

Various federal land management agencies have roles related to landslide science and applications to deal with landslide hazards and risks on lands they administer. The U.S. Forest Service, in the Department of Agriculture, is responsible for research, assessment, response, and recovery related to landslide hazards and risks on Forest Service lands.[24] The National Park Service, Bureau of Land Management, Fish and Wildlife Service, and Bureau of Indian Affairs, all in the Department of the Interior, are responsible for assessment, response, and recovery related to landslide hazards and risks on their respective federal or tribal lands. In addition, within the Department of the Interior, the Office of Surface Mining Reclamation and Enforcement is responsible for research,

[19] National Weather Service (NWS) debris flow watches and warnings are similar to flash-flood or flood watches and warnings. See NWS, "Flood Warning vs. Watch," at https://www.weather.gov/safety/flood-watch-warning. A *watch* is issued when conditions are favorable to cause a debris flow. A *warning* is issued when a debris flow is imminent or occurring. NWS, *Post Wildfire Flash Flood and Debris Flow Guide*, August 2015, at https://www.wrh.noaa.gov/lox/hydrology/files/DebrisFlowSurvivalGuide.pdf.

[20] Guzzetti et al., "Geographical Landslide Early Warning Systems," January 2020, *Earth-Science Reviews*, vol. 200, at https://www.sciencedirect.com/science/article/pii/S0012825219304635.

[21] For example, FEMA, "Hazard Mitigation Planning," at https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning; FEMA, "Landslide," at https://community.fema.gov/ProtectiveActions/s/article/Landslide; FEMA, "The National Risk Index," at https://hazards.fema.gov/nri/map.

[22] FEMA, "Understanding Mudflow and the NFIP," January 2018, at https://www.fema.gov/sites/default/files/2020-05/FINAL_Backgrounder_Understanding_Mud_and_the_NFIP_2018.pdf; and FEMA, "National Flood Insurance Program Summary of Coverage," at https://www.nh.gov/insurance/consumers/documents/summary_cov.pdf.

[23] FEMA, "Hazard Mitigation Assistance Grants," at https://www.fema.gov/grants/mitigation.

[24] USDA, "Forest Service," at https://www.fs.usda.gov/.

assessment, response, and recovery related to landslide hazards and risks on abandoned mine lands projects.[25]

Federal Highway Administration

The Federal Highway Administration (FHWA), within the Department of Transportation, is responsible for research, assessment, response, and recovery related to landslide hazards and risks on federal aid and federal lands highway systems.[26] For example, the Federal Lands Highway Program's Unstable Slope Management Program conducts research to mitigate landslide hazards on the federal lands highway system.[27] Most of the FHWA's other programs provide financial and/or technical assistance to state and local governments to make America's roads and highways safe, including making them safe from natural hazards such as landslides.[28]

U.S. Army Corps of Engineers

USACE, within the Department of Defense, is responsible for engineering, assessment, response, and recovery related to landslide hazards and risks impacting military and civilian USACE projects. Most civilian projects consist of planning, construction, and operation of water resources infrastructure, such as maintaining navigable channels, reducing flood and storm risks, and conducting environmental restoration activities.[29] USACE civilian projects face landslide risks, such as blocked waterways or eroding cliffs near infrastructure (see "Landslide Types, Hazards, Causes, and Impacts"), and USACE works to reduce these risks.

National Landslide Preparedness Act

The NLPA directed the Secretary of the Interior, acting through the Director of the USGS, to establish the NLHRP to identify, map, assess, and research landslide hazards; respond to landslide events; and coordinate with state, local, tribal, and territorial entities (SLTTs) for landslide hazards preparedness and response. NLHRP coordination includes the following components:

- National Strategy for Landslide Hazards, Risk Reduction, and Response (hereinafter, National Strategy)
- Interagency plan to implement the National Strategy
- Interagency Coordinating Committee on Landslide Hazards (ICCLH)[30]

[25] U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement, "About OSMRE," at https://www.osmre.gov/about.

[26] U.S. Department of Transportation, Federal Highway Administration (FHWA), "About FHWA," at https://highways.dot.gov/about/about-fhwa.

[27] U.S. Department of Transportation, FHWA, "Geologic and Geotechnical Services," at https://highways.dot.gov/federal-lands/geotechnical.

[28] For more on the FHWA, see CRS Report R47022, *Federal Highway Programs: In Brief*, by Robert S. Kirk; and CRS Report R44332, *Federal-Aid Highway Program (FAHP): In Brief*, by Robert S. Kirk.

[29] U.S. Army Corps of Engineers (USACE), "About Us," at https://www.usace.army.mil/About/; and CRS Report R46320, *U.S. Army Corps of Engineers: Annual Appropriations Process*, by Anna E. Normand and Nicole T. Carter.

[30] The Interagency Coordinating Committee on Landslide Hazards includes the following or their designee: Secretaries of the Interior, Agriculture, Army, Commerce, Homeland Security, and Transportation, and Directors of the National Science Foundation, Office of Science and Technology Policy, and Office of Management and Budget (P.L. 116-323, 43 U.S.C. §§3101 et seq.). LHP has established an Interagency Coordinating Committee on Landslide Hazards. USGS, FY2024 Budget Justifications, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf, p. 72. Personal correspondence between CRS and the USGS, April 2023.

- Advisory Committee on Landslides (ACL)[31]

The USGS submitted a *National Strategy for Landslide Loss Reduction* to Congress in January 2022.[32] During its first meeting in February 2023, the ICCLH discussed creating an interagency plan to implement the National Strategy, including programs, projects, and budgets. ICCLH has indicated its intention to move forward with coordinating and preparing such a plan.[33]

National Landslide Hazards Reduction Program

The NLHRP objectives are to identify, map, assess, research, plan, prepare for, warn, and respond to landslide hazards and to reduce landslide risks nationwide. The USGS, primarily through LHP, leads the NLHRP. LHP has been expanding its landslide science and application activities to carry out the USGS components of NLHRP.[34]

In addition to committees, strategies, and plans, the NLHRP requires the following activities:

Research and Assessment[35]

- Identify, map, assess, and research landslide hazards
- Establish a National Inventory of Landslide Hazards
- NSF may provide grants for landslide research
- USGS may provide grants to SLTTs to research, map, assess, and collect data on landslide hazards within their jurisdictions through a cooperative landslide hazard mapping and assessment grant program

Planning and Preparedness[36]

- Use research and assessment activities to develop planning and preparedness resources for federal agencies and SLTTs to reduce landslide losses

Warning and Response[37]

- Expand debris flow early warning systems

[31] The advisory committee is to have no fewer than 11 members. The members may be representatives of state or local entities, such as geological surveys, transportation departments, and emergency management agencies, plus institutions of higher education and industry standards development organizations (P.L. 116-323, 43 U.S.C. §§3101 et seq.). The USGS has drafted a charter for the advisory committee that is undergoing internal review. After charter approval, anticipated in the third quarter of FY2023, the USGS plans to post a *Federal Register* notice asking for committee member nominations. The USGS expects the advisory committee to meet in the fourth quarter of FY2023. Personal correspondence between CRS and the USGS, April 2023.

[32] Godt et al., *National Strategy*. NLHRP directs the USGS, in coordination with the advisory committee, to publish a national strategy for landslide hazards, risk reduction, and response in the United States and its territories within one year of enactment and every five years thereafter (P.L. 116-323, 43 U.S.C. §§3101 et seq.).

[33] Personal communication between CRS and USGS, April 2023.

[34] The USGS describes the relation between LHP and NLHRP as, "The entirety of the USGS contribution to the NLHRP is within the activities of the LHP." Personal correspondence between CRS and USGS, April 2023.

[35] The program directs the Secretary of the Interior, in coordination with existing USGS activities and other federal agencies and with state, local, tribal, and territorial entities (SLTTs), to carry out these activities (P.L. 116-323, 43 U.S.C. §§3101 et seq.).

[36] The program directs the Secretaries of the Interior, Agriculture, Army, Commerce, Homeland Security, and Transportation and related SLTTs to carry out these activities (P.L. 116-323, 43 U.S.C. §§3101 et seq.).

[37] The program directs the Secretaries of the Interior, Commerce, and Homeland Security and related SLTTs to carry out these activities (P.L. 116-323, 43 U.S.C. §§3101 et seq.).

- Support emergency response efforts, including data collection and further research to understand the causes and impacts of landslide hazards
- Prepare publicly available significant landslide event reports that identify community impacts and recommend ways to reduce landslide losses based on lessons learned from the event and other data

The NLPA authorized annual appropriations for FY2021 to FY2024 of $25 million for the USGS, $11 million for NSF, and $1 million for NOAA to carry out the NLHRP.

Implementation of the National Strategy for Landslide Loss Reduction

The National Strategy describes the goals and actions to reduce the nation's risk from landslide hazards.[38] The goals and requisite actions can be divided into the activity categories described above, namely research and assessment, planning and preparedness, and warning and response. The status of the implementation of activities in these three categories are described below. The USGS indicated that implementation of some activities would proceed at a slower pace in FY2024 and some activities would be delayed for two or more years.[39] In addition, the National Strategy does not include an interagency plan as required by NLPA. The USGS indicates that the ICCLH is planning to prepare an interagency plan.[40]

Research and Assessment

Actions to achieve the research and assessment goals in the National Strategy include (1) the characterization of the societal risks posed by landslide hazards; (2) the expansion of research and development to better understand where, when, and why landslide hazards arise; and (3) the development of a publicly accessible national landslide hazards and risk database. To facilitate carrying out these actions for the entire nation, LHP plans to integrate the USGS 3DEP data products on topography, vegetation, and the built environment plus the National Aeronautics and Space Administration (NASA) and NOAA satellite data products on precipitation, soil moisture, land-cover, and land-surface deformation to develop characterizations, understanding of landslide processes, and assessments. For example, LHP can use the 3DEP data products on topography for Alaska to identify some past landslide events and steep slopes with high landslide potential to develop a landslide susceptibility map for Alaska. In addition, LHP aims to use other earth observations, cutting edge technology, machine learning, and high performance computing to develop characterizations, understanding of landslide processes, and assessments.

National Landslide Inventory Database

According to the National Strategy, LHP plans to add data and expand the National Landslide Inventory Database so that it covers the nation in a consistent, systematic, and accessible database.[41] Version 2 of the National Landslide Inventory Database, released online on April 18,

[38] Godt et al., *National Strategy*.

[39] The USGS indicated that implementation of NLPA would proceed at a slower pace in FY2024. USGS, FY2024 Budget Justifications, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf, p. 70.

[40] Personal communication between CRS and USGS, April 2023.

[41] Godt et al., *National Strategy*, p. 14.

2022, contains more data and was redesigned to be more accessible.[42] LHP aims to add more data and establish the working group in order to expand the inventory. In particular, LHP plans to work with SLTTs to systematically include more local data into a publicly accessible national database. As noted in the National Strategy, LHP plans to establish a National Landslide Hazard Risk Reduction Working Group—consisting of SLTTs, other organizations, and public or private sector entities. LHP intends to use the working group to create a common platform for (1) leveraging expertise that exists within individual agencies, (2) sharing best practices, (3) developing collaborative products, and (4) providing input on priorities for cooperative grants. In addition, the cooperative grants described in the next section are envisioned to add data to the national inventory database.

Cooperative Grant Program and Research Grants

The National Strategy calls for the LHP to develop and maintain a cooperative landslide hazard mapping and assessment grant program awarded to SLTTs to advance research and assessment, particularly to enhance the National Landslide Inventory Database with SLTT data and other research results. Congress appropriated $1 million to the USGS in FY2023 specifically for the cooperative grant program. LHP is establishing the program using the FY2023 appropriations and anticipates the first application period to start in FY2024.[43]

Subject to appropriations, NSF may provide grants for landslide research as a component of the NLHRP.[44] The NLPA authorized annual appropriations of $11 million for NSF landslide research grants. In general, NSF awards competitive grants based on the merits of the proposed research, not based on the specific research topic. Congress did not appropriate funds for any specific landslide research grants at NSF in FY2021-FY2023; however, explanatory statements accompanying FY2022 and FY2023 NSF appropriations encouraged the foundation to award meritorious landslide research grants in support of the NLHRP.[45] NSF is part of the ICCLH and, similar to the role NSF plays in NEHRP, the foundation may identify research results or potential results of awarded grants that advance landslide science and contribute to achieving the objectives of the NLHRP. In addition, NSF research facilities may contribute to and coordinate with federal agencies and SLTTs on NLHRP activities.[46]

Planning and Preparedness

The National Strategy calls for LHP, with other federal agencies and SLTTs, to (1) provide guidance, tools, and training to include landslide information in hazard planning and (2) develop

[42] USGS, LHP, "Maps," at https://www.usgs.gov/programs/landslide-hazards/maps; and USGS, "Landslide Inventories Across the United States Version 2," at https://www.usgs.gov/data/landslide-inventories-across-united-states-version-2.

[43] USGS Landslide Hazards Program, "External Grants Overview," at https://www.usgs.gov/programs/landslide-hazards/science/external-grants-overview.

[44] The USGS National Strategy to implement the USGS components and partnerships of the NLHRP does not discuss the NSF research grant component of the NLHRP.

[45] For example, the FY2023 explanatory statement accompanying Division B of P.L. 117-328 stated, "NSF is encouraged to fund grants for meritorious landslide research, data collection, and warning systems in fulfilment of the National Landslide Preparedness Act (Public Law 116–323) and the National Earthquake Hazards Reduction Program Reauthorization Act (Public Law 115–307). NSF is further encouraged to prioritize funding for the deployment of early warning systems in States with high levels of both landslides and seismic activities." Explanatory Statement, *Congressional Record*, vol. 168, No. 198 (December 20, 2022), p. S7951. Congress also encouraged NSF to support landslide research grants as part of the NLHRP in the explanatory statement accompanying Division B of P.L. 117-103. U.S. Congress, House Committee on Appropriations, *Consolidated Appropriations Act, 2022*, Legislative Text and Explanatory Statement Book 1, p. 304.

[46] NSF, "Facilities," at https://www.nsf.gov/about/partners/facilities.jsp.

landslide outreach initiatives to improve public knowledge and preparedness planning.[47] Other specific plans in the National Strategy to enhance preparedness include developing landslide preparedness curricula and training modules for federal entities and SLTTs; developing guidelines on the design of landslide-related emergency management exercises, and creating a "Landslide Ready" program, similar to the NWS TsunamiReady, that recognizes community-level planning for future landslides.[48]

Warning and Response

The National Strategy envisions developing and operating a nationwide landslide surveillance system that can be integrated with existing USGS earthquake and volcano monitoring and NWS weather monitoring. LHP plans to coordinate with other federal, state, or local systems and provide situational awareness about landslide potential, so that stakeholders are able to prepare, plan for, and respond to landslide hazards.

The NLPA calls for the expansion of the debris flow early warning system; in particular, expanding the early warning system for post-wildfire debris flow in recently burned areas across the western United States. The act calls for an expansion of post-wildfire debris flow early warning systems, in part, because past flows have caused significant losses (see textbox entitled "Montecito, CA: Post-wildfire Debris Flow") and warning systems may help to reduce future losses.

Montecito, CA: Post-wildfire Debris Flows

The Montecito, CA, post-wildfire debris flows in 2018 caused 23 fatalities, at least 167 injuries, and 408 damaged homes. These losses are among the highest attributed to a landslide disaster in the United States since the beginning of the 21st century. Studies suggest that these conditions may occur more frequently in the future, leading to the potential for more post-wildfire debris flows and that, because of the growth of communities in such hazardous areas, more communities are vulnerable to potentially more frequent debris flow hazards.

One of the largest wildfires in U.S. history, the Thomas fire, started on December 4, 2017, and burned through the Santa Ynez Mountains, the Los Padres National Forest, and parts of Santa Barbara and Ventura Counties in California. The fire increased the susceptibility of steep slopes of burned landscape to debris flows.

On January 9, 2018, before the fire was contained, a burst of intense rainfall (about 0.6 inches of rain in 5 minutes) fell on the burned area above Montecito, CA. The intense rainfall triggered a series of debris flows that mobilized 24 million cubic feet of sediment (including boulders greater than 18 feet in diameter) at velocities as high as 35 miles per hour. The photographs below show examples of the debris flows' impact on communities:

1. A house constraining the lateral extent of the overbank debris flow from San Ysidro Creek
2. Debris plugging an 8 foot diameter culvert in Buena Vista Creek
3. Debris flow crashing through a house near Buena Vista Creek
4. Debris flow separating into two flows around a bridge on Cold Spring Creek

[47] The NLPA directs the Secretary of the Interior to coordinate landslide hazard and risk preparedness for communities with the Secretaries of the Army, Commerce, Homeland Security and Transportation and the heads of other relevant federal agencies, in consultation with SLTTs. Beyond the activities of NSF and NOAA, this cooperation allows greater coordination with existing programs that deal with landslides at USACE, the Department of Transportation, and FEMA (see "Federal Roles in Landslide Hazards and Risks").

[48] NWS, "NWS TsunamiReady Program," at https://www.weather.gov/TsunamiReady/.

Sources: Photographs from Jason W. Kean, USGS public domain, and text based on Jason W. Kean et al., "Inundation, Flow Dynamics, and Damage in the 9 January 2018 Montecito Debris-Flow Event, California, USA: Opportunities and Challenges for Post-wildfire Risk Assessment," *Geosphere*, vol. 12, no. 4 (June 7, 2019), pp. 1140-1163, at https://doi.org/10.1130/GES02048.1; Benjamin B. Mirus et al., "Landslides Across the USA: Occurrence, Susceptibility, and Data Limitations," *Landslides*, vol. 17 (December 19, 2020), pp. 2271-2285, at https://doi.org/10.1007/s10346-020-01424-4; U.S. Department of Agriculture, Forest Service, *Thomas Burned Area Report*, FSH 2509.13, January 16, 2018, at https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd573382.pdf; and National Weather Service, "Flash Flood & Debris Flow Event, Montecito, California January 9, 2018," at https://noaa.maps.arcgis.com/apps/MapJournal/index.html?appid=541c23aa483b48978d1bc9904a6fb14d.

Landslide Monitoring

Landslide monitoring sites in Alaska, California, Colorado, North Carolina, Oregon, and Washington existed before enactment of the NLPA.[49] LHP has not added monitoring sites in other states as envisioned in the National Strategy. LHP develops and operates landslide monitoring sites to understand landslides and in some cases to monitor potential landslide conditions in near real time. Through FY2022 and FY2023 appropriations, Congress directed the USGS to conduct landslide assessment and monitoring in Prince William Sound, AK (see text box entitled "Prince William Sound, AK, Landslide and Tsunami Hazard Monitoring System"). The USGS FY2024 budget request includes $4 million for continued research and monitoring of the landslide and other natural hazards in Prince William Sound.

[49] USGS, LHP, "Landslide Monitoring Stations," at https://www.usgs.gov/programs/landslide-hazards/science/landslide-monitoring-stations.

Prince William Sound, AK, Landslide and Tsunami Hazard Monitoring System

Congress directed about half to one third of annual appropriations for the U.S. Geological Survey (USGS) Landslide Hazards Program in FY2022 and FY2023 respectively to research, assessment and monitoring related to the Prince William Sound Landslide and Tsunami Hazard Monitoring System.

The Barry Arm landslide (landslide A in photograph), located in the northwestern corner of Prince William Sound, Alaska, is the largest recorded landslide in Alaska (about 650 million cubic yards) and has the potential to cause significant damage and loss. Rapid, catastrophic failure of the landslide could generate a tsunami that would be life-threatening for anyone near the shoreline in Barry Arm, Harriman Fjord, and parts of Port Wells. Significant risks also exist in other, outer locations of western Prince William Sound, including the town of Whittier, Alaska.

Several landslides with variable rates of movement, often related to the melting and retreat of the Barry Glacier, have been documented since the early 1910s. Slow movement of landslide A has been documented over several decades. Increased movement (velocities up to about 85 feet per year versus 2-4 feet per year) was observed during a period of rapid retreat of the Barry Glacier from 2010 – 2016. Movement velocities returned to a lower level as the retreat of the Barry Glacier slowed.

An Interagency Science Team, including the U.S. Geological Survey, Alaska Division of Geological and Geophysical Surveys, Alaska Earthquake Center, and National Oceanic and Atmospheric Administration National Tsunami Warning Center, monitors landslide movement and the potential for landslide or tsunami hazards to harm people or damage property. As conditions warrant, the Interagency Science Team provides updates about potential landslide and tsunami hazards risks as conditions warrant to federal, state, and local authorities, emergency managers, and others.

Sources: Alaska Division of Geological and Geophysical Surveys, "Barry Arm Landslide and Tsunami Hazards," at https://dggs.alaska.gov/hazards/barry-arm-landslide.html. Photograph taken by Gabriel Wolken, June 26, 2020, and annotated by the USGS. Photograph is USGS public domain.

Debris Flow Hazard Assessments and Warnings

The National Strategy aims for LHP to improve and expand post-fire debris flow assessments (PFDFs).[50] PFDFs model the likelihood of a debris flow in a burned area for a given rainfall

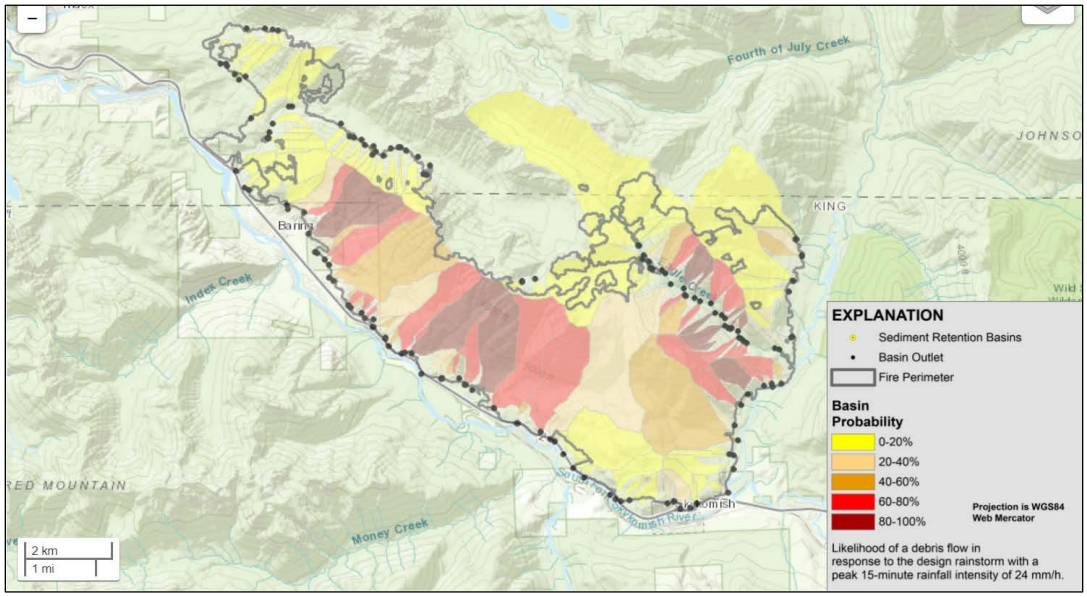
[50] Godt et al., *National Strategy*.

intensity (**Figure 4**).[51] The USGS provided 407 PFDFs in western states between 2013 and 2021 and has increased its coverage of burned area in these western states on an annual basis.[52] LHP plans to expand PFDFs to other states and to provide more assessments for more post-fire areas.

The National Strategy plans for LHP with the NWS to expand the debris flow early warning system in western states. For vulnerable landscapes where PFDFs have identified debris flow risks, the USGS and the NWS may deploy a debris-flow early warning system. A typical system consists primarily of rain gages and streamgages transmitting real time data about rain or stream flow intensity respectively. The USGS has worked with the NWS to test debris flow early warning systems in Northern California (1985-1995) and Southern California (2005-2008).[53] The USGS indicates that it plans to expand the debris flow warning system in other parts of California and other western states in partnership with the NWS in FY2024.[54]

Figure 4. Example of Post-fire Debris Flow Hazard Assessment for Bolt Creek Fire, WA

Bolt Creek, Mt. Baker-Snoqualmie National Forest, WA



Source: USGS, Landslide Hazards Program, "Bolt Creek (Mt. Baker- Snoqualmie National Forest, WA)," at https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=451.

Notes: The map depicts the likelihood of a debris flow in response to a rainstorm with a peak 15-minute rainfall intensity of almost one inch per hour in the area that was burned in the Bolt Creek fire in September 2022. The extent of the fire is indicated by the medium-gray outline. The basins colored in the darkest red have an 80%-100% probability of a debris flow starting in response to the modeled rainstorm. More information about the Bolt Creek fire is available from InciWeb, "Bolt Creek Fire," at https://inciweb.nwcg.gov/incident-information/wanws-bolt-creek-fire.

[51] USGS Landslide Hazards Program, "Emergency Assessment of Post-Fire Debris-Flow Hazards," at https://landslides.usgs.gov/hazards/postfire_debrisflow/.

[52] USGS, FY2024 Budget Justifications, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf, p. 71, and USGS Landslide Hazards Program, "Emergency Assessment of Post-Fire Debris-Flow Hazards," at https://landslides.usgs.gov/hazards/postfire_debrisflow/.

[53] Guzzetti et al., "Geographical Landslide Early Warning Systems," January 2020, *Earth-Science Reviews*, vol. 200, at https://www.sciencedirect.com/science/article/pii/S0012825219304635.

[54] USGS, FY2024 Budget Justifications, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf, p. 71, and personal correspondence between CRS and USGS, April 2023.

Response and Recovery

The National Strategy aims for LHP, with partners, to (1) improve response actions by having USGS technical experts on-site for a landslide hazard emergency and (2) provide publicly available reports of significant landslide events.[55] The National Strategy defines *significant landslide events* as those that are part of a presidentially declared disaster under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 100-707) or those determined to be significant by the ICCLH. Significant landslide event reports will likely include descriptions of the event and its societal effects, as well as recommendations for assessing and communicating risk, disseminating warnings, and improving preparedness and response efforts.

Issues for Congress

Congress may consider whether the NLHRP is being implemented to the extent and on a time frame sufficient to reduce landslide risks nationwide and to meet the intended aims of the NLPA. As required in the NLPA, the USGS submitted a National Strategy to implement the NLHRP to Congress and established an ICCLH. Many of the other components of the NLHRP have not been implemented. Some such elements are planned, partially completed as part of existing projects, or delayed, according to the USGS.[56]

The NLPA required an interagency plan to be submitted to Congress with the National Strategy, within one year of enactment (i.e., by January 5, 2022). No interagency plan has been submitted to Congress; the ICCLH discussed such a plan in February 2023.[57] An interagency plan would help inform Congress about the time, staff, and resources needed to implement the NLHRP. Congress may direct the agencies on the ICCLH to prioritize planning and submission of such a plan.

In establishing the NLHRP, the NLPA required an advisory committee and working groups that have not been established since enactment. Congress may seek information about why these committees and working groups have not been established, when they might be established, and how the lack of these coordinating groups impacts NLHRP implementation.

The NLPA authorized $25 million annually for the USGS, $11 million for NSF, and $1 million for NOAA to carry out the NLHRP for FY2021-FY2024. Congress did not appropriate any funds for NSF and NOAA, and it appropriated less than $14 million annually in FY2021 through FY2023 for the USGS.[58] Congress increased annual appropriations for LHP, which is tasked with implementing the USGS component of the NLHRP, in FY2021 to FY2023, but some of these appropriations were directed to specific landslide monitoring projects. Congress provided annual appropriations to LHP of about $8 million for FY2021, $9 million for FY2022, and $14 million for FY2023.[59] Between one-half and one-third of these total annual appropriations were directed to the Prince William Sound, AK, monitoring system (see box entitled, “Prince William Sound,

[55] Godt et al., *National Strategy*.

[56] USGS, *FY2024 Budget Justifications*, p. 71, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf; and personal correspondence between the USGS and CRS, April 2023.

[57] The ICCLH discussed a detailed interagency plan that would include projects, programs, and budgets to implement the NLHRP at its first meeting (in February 2023), but such a plan has not yet been prepared. Personal correspondence between the USGS and CRS, April 2023.

[58] In FY2022 and FY2023, report language accompanying appropriations legislation encouraged NSF to support research grants as established in the NLHRP and NEHRP. See footnote 45.

[59] Amounts are rounded to the nearest million in constant dollars.

AK, Landslide and Tsunami Hazard Monitoring System").[60] Congress may consider whether the amount and directed spending of annual appropriations are sufficient to implement the NLHRP.

Author Information

Linda R. Rowan
Analyst in Natural Resources and Earth Sciences

Disclaimer

[60] Congress increased the total appropriation for the USGS LHP in FY2021 by $4 million compared with the FY2020 appropriation. In the explanatory statement accompanying Division G of P.L. 116-260, Congress directed the $4 million increase for Prince William Sound, AK, landslide and tsunami analysis and monitoring in coordination with NOAA and other stakeholders (see box on Prince William Sound, Alaska Landslide and Tsunami Hazard Monitoring System). U.S. Congress, House Committee on Appropriations, *Consolidated Appropriations Act, 2021*, Legislative Text and Explanatory Statement, p. 1372. Congress included similar language and appropriated similar amounts for the Prince William Sound project in FY2022 and FY2023. U.S. Congress, House Committee on Appropriations, *Consolidated Appropriations Act, 2022*, Legislative Text and Explanatory Statement, Book 2, p. 1438. The President's budget request for FY2024 includes $4 million for the Prince William Sound project. USGS, FY2024 Budget Justifications, at https://www.doi.gov/sites/doi.gov/files/fy2024-usgs-greenbook.pdf-508.pdf.