

U.S. East Coast landslide impacts from Puerto Rico to Vermont and in between

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New installation of a slope monitoring station in Yauco, Puerto Rico, by a SLIDES-PR team. Credit: Stephen Hughes

In the U.S., we may often think of landslides as primarily a West Coast problem, mostly plaguing the mountainous terrain of California, Oregon, and Washington. A [technical session](#) at the upcoming GSA 2023 Joint Southeastern & Northeastern Section Meeting in Reston, Virginia, U.S., will highlight the major impacts of landslides on the U.S. East Coast and what is being done to save lives and deal with the damages.

Landslides are projected to be a growing concern as [climate change](#) produces more [extreme rainfall events](#) that can destabilize slopes and trigger these events. Research presented in the session will include investigations of [landslide](#) hazards in Puerto Rico, Vermont, Pennsylvania, Michigan, Tennessee, West Virginia, and southern and central Appalachia.



Aerial view of destroyed homes in the mountainous area of Utuado, Puerto Rico. After Hurricane Maria, many homes, businesses, roads, bridges, and government buildings suffered major damage due to strong winds and heavy rain. Credit: Andrea Booher, FEMA

Puerto Rico

After Hurricane Maria in 2017, researchers documented more than 70,000 [landslides](#) on the island of Puerto Rico. Geologist Stephen Hughes at the University of Puerto Rico Mayagüez saw a gap in the monitoring and forecasting of landslides on the island, and to fill that gap he started a research and outreach program: Storm-induced Landslide Impact Dynamics on Environment and Society in Puerto Rico (SLIDES-PR). Through partnership with the U.S. Geological Survey, SLIDES-PR has developed a landslide susceptibility map for the island and installed 14 [real-time](#) monitoring stations on landslide-prone slopes.

"These are shallow, relatively small landslides, but extremely widespread. It doesn't matter that it's a small landslide if it comes through your house," says Hughes.

The monitoring stations measure soil moisture, pore pressure, and groundwater level, collecting data every five minutes and sending it back to the university every hour. The monitoring network has already saved lives. During Hurricane Fiona in 2022, Hughes was able to use real-time monitoring to warn the town of Naguabo that the soil moisture had crossed the threshold for imminent slope failure, prompting evacuation before a debris flow buried a home.

In addition to monitoring and forecasting, the SLIDES-PR program has developed guides for residents to understand the warning signs for

landslides, what human activities can promote them, and ways to prepare and cope after they happen. At the conference, Anishka Ruiz-Perea will share [the science and risk communication work done by SLIDES-PR](#) , and Kiara Cunillera-Cote [will present on the development of forecasting thresholds using the data from monitoring stations.](#)



The scar from the 2019 Cotton Brook Landslide in Waterbury, Vermont. Credit: Jonathan Kim, Vermont Geological Survey

Vermont

In 2019, a hillside in [Vermont's Mt. Mansfield State Forest failed](#) and generated a 12.5-acre landslide with a volume equivalent to 80 Olympic-

sized swimming pools. The material formed a dam in Cotton Brook, which eventually carried the influx of sediment to the nearby Waterbury Reservoir.

Smuggler's Notch, one of the most popular tourist destinations in the state, is a 1,000-foot high mountain gap that has seen major rock slides over several decades, sometimes dropping boulders the size of school buses onto the road below.

"We are convinced, just like many others, that as climate change gets more extreme, we will generate more landslides and more sediment systems," explains Jonathan Kim of the Vermont Geological Survey, [who will present on the many approaches taken to assess, monitor and mitigate landslide hazards](#) in Vermont.

The Vermont Geological Survey has been collaborating with the University of Vermont (Burlington) and Norwich University (Northfield, Vermont) to [establish comprehensive tools for monitoring](#) and understanding the risk of landslides in the state. These investigations led to a Federal Emergency Management Agency (FEMA) buyout of a parcel containing a large landslide that posed a threat of additional slope failures in 1999. Rainfall and flooding during Hurricane Irene in 2011 led to slope instability throughout the state, prompting the [development of statewide landslide protocols and the formation of a statewide landslide database](#) that can be contributed to by landslide experts and residents.



One of the more than 200 landslides observed in the greater Pittsburgh region after record-breaking rain in February–April 2018. The slide blocked the main access road into a large housing development and ultimately led to demolishing three houses at the top. Credit: Helen Delano, Pennsylvania Geological Survey

Pennsylvania

The greater Pittsburgh region experienced record rainfall in February–April 2018 that triggered more than 200 landslides. Built on clay-rich sedimentary rocks and with steep topography from downcutting by river erosion, southwestern Pennsylvania is one of the more landslide-prone regions in the country. The landslides are small and typically not deadly, affecting residences, roads, streams, and other infrastructure. As a result of the 2018 landslides, one [natural gas pipeline](#)

ruptured, and the resulting explosion destroyed a house and several other buildings.

"It's very clear that this was a climatically anomalous circumstance. We had a hugely anomalous amount of rain in February when Pittsburgh would normally be getting snow and the ground would be frozen. The ground wasn't frozen, and almost all of the precipitation fell as rain. We had shallow soil slides as well as deeper-seated slides that require bigger changes in hydraulic conditions," explains Helen Delano of the Pennsylvania Geological Survey, who will present [about the record landslide year](#) at the conference.

While the scope of damage from the landslides was extensive, an application for FEMA support was denied because the several months of increased landslides were not deemed a single event. When considered as separate events, they did not meet the threshold of damages required to declare a federal disaster. Delano says the record-breaking year has increased awareness at the state level of the need to prepare for landslides. Clean-up from the landslides of 2018 remains ongoing.

Provided by Geological Society of America

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