

A summary of the USGS scientific response: mapping, hazard assessment, aerial reconnaissance, and public available data from the 2024 southern Appalachian landslide event.

BACKGROUND

Hurricane Helene made landfall as a **Category 4 storm on September 26, 2024**, continuing inland across the southern Appalachians and producing record rainfall (www.noaa.gov/climate). Antecedent rain compounded the impact – cumulative rainfall reached **848 mm** in some locations; wind gusts exceeded 170 km/h in western North Carolina, eastern Tennessee, and southwest Virginia (Schaefer et al., 2025). The resulting landslides caused fatalities, destroyed critical infrastructure and thousands of structures, and severed connectivity across the region (Schaefer et al., 2025).

The USGS **Landslide Assessments, Situational Awareness, and Event Response Research (LASER) team** activated September 28, 2024, to support state geological survey, and later deployed under **FEMA mission assignment DR-4827-NC**.



RESPONSE TIMELINE

September 23 - 26, 2024

Storm Event

Antecedent rain and Category 4 landfall. Record precipitation across western NC, eastern TN, SW Virginia. Widespread debris flows, flooding, infrastructure damage.

September 28 - October

LASER Activation

USGS activated to support North Carolina and Tennessee Geological Surveys. Remote sensing began immediately. Rapid hazard estimate maps generated; collaborative mapping dashboard launched.

October 3-5 and 13-17

Aerial Reconnaissance

Low-level helicopter and fixed-wing overflights. Geotagged oblique photographs documented landslide locations across the affected region.

October 18, 2024

FEMA Briefing (DR-4827-NC)

Formal briefings at Buncombe County EOC. Preliminary field report (1,155 locations at time of briefing) delivered to FEMA. Nine-county assessment completed.

2025

Data Releases and Publications

Final inventory (2,217 points) published in January 2025. Aerial photos released March 2025. OFR 2025-1028 in June 2025. Schaefer et al., GSA Today, December 2025.

KEY FINDINGS – LANDSLIDE INVENTORY



SCIENTIFIC OBSERVATIONS (Schaefer et al., 2025)

• Orographic enhancement concentrated the hazard

Rainfall amplified along a ~250 km swath of the Blue Ridge escarpment, focusing landslide initiation in a distinct corridor rather than uniformly across the storm footprint.

• Slope aspect-controlled initiation

Landslides initiated predominantly on southeast – facing (windward) slopes; localized clustering pointed to strong hillslope-scale meteorological and geomorphic controls.

• Shallow slides and long-runout debris flows

Many shallow failures mobilized into highly mobile debris flows that graded into floods, greatly amplifying destructive reach beyond the initial failure zones.

• Elevated hazard persists for months to years

Freshly exposed scarps and remobilized deposits continue to pose threats during rainfall – particularly near steep slopes and active recover operations.

PUBLICLY AVAILABLE DATA & PRODUCTS

Helene Event Page
2024 Hurricane Helene Landslide Hazards ACTIVE
By Landslide Hazards Program September 30, 2024

Overview Science Publications Web Tools News Partners

Hurricane Helene produced widespread and damaging landslides. The USGS is mapping landslides to support our partners. This page provides information about the extent and severity of landslide impacts. Hurricane Helene made landfall in Florida as a Category 4 storm on Thursday, September 26th, 2024. The hurricane continued across the southern Appalachian Mountains producing record rainfall.

This landslide event page serves as an event summary to communicate timely science information to our partners. This information includes what is currently understood about the event and ongoing activities of the USGS and partner agencies and maybe be subject to change.

Study Area

Contacts
Geologic Hazards Science Center
1711 Illinois St.
Golden, CO 80401
United States
Phone: 303-273-8500

Landslide Hazards Programs
12201 Sunrise Valley Dr
Reston, VA 20192
United States

Steven Sobieszczyk
(Former Employee)
Public Affairs Specialist

Disclaimer: This information is preliminary or provisional and is subject to revision. It is being provided to meet the need for timely best science. The information has not received final approval by the U.S. Geological Survey (USGS) and is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

Our thoughts go out to the millions of people affected by Hurricane Helene and the significant flooding and landslide activity that continues to impact the region.

How to stay safe:

- Landslides can still happen for the next few days to weeks, especially with more rain. Listen to National Weather Service weather alerts. Follow emergency messages from local authorities.
- Pay attention to the landslide warning signs. Watch for new cracks forming on the ground. [Learn more](#)

Aerial Photographs
Geotagged oblique photos from the 13th and 17th of October overflights. USGS data release with interactive photo viewer map. Documents damage and landslide characteristics across the region.

Field Report OFR 2025-1028
Originally prepared for Federal Emergency Management Agency; modified for public release. Nine-county hazard assessment, aerial reconnaissance findings, and guidance on ongoing risks.

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Landslide Hazards Program

Preliminary Field Report of Landslide Hazards Following Hurricane Helene
Open-File Report 2025-1028

U.S. Department of the Interior
U.S. Geological Survey

FIND OUR DATA

Helene Event Page [usgs.gov/programs/landslide-hazards/science/2024-hurricane-helene-landslide-hazards](https://www.usgs.gov/programs/landslide-hazards/science/2024-hurricane-helene-landslide-hazards)
Landslide Response Data (ScienceBase) sciencebase.gov/catalog/item/6f6fc243cd34e3d9dd5de00f2
Schaefer et al., 2025 doi.org/10.1130/GSATG625A.1
LASER Program Page usgs.gov/programs/landslide-hazards/science/landslide-assessments-situational-awareness-and-event-response

Hazard Estimate Map
Relative landslide hazard generated from National Weather Service precipitation estimates and U.S. Geological Survey National Susceptibility Model (Martinez et al., 2024). Produced during active response.

Hurricane Helene Landslide Hazard Estimate

USGS science for a changing world

Map showing relative landslide hazard across the southern Appalachian region. Legend indicates Low (green) to High (red) hazard. Includes scale bars in miles and kilometers, and an inset map of the United States.

Observations Dashboard
Interactive map of 2,217 mapped landslide points; updated in real time during response. Multi-agency effort with North Carolina Geological Survey and partners.

Hurricane Helene Landslide Observations

USGS science for a changing world

Map showing 2,217 mapped landslide points across the southern Appalachian region. Includes legend for point types (e.g., River, Building, Road) and a list of participating agencies (USGS, NASA, DEQ, etc.).

YOUR FEEDBACK
What questions does this response raise for you? Were you able to find these pages and data resources? Were they helpful? What information would be most useful for your work during a future event?
