Technical Note

Recurrent Landslide Hazards in Ramban District, NW Himalaya, India: An Interplay of Geology, Climate Change, and Anthropogenic Factors

Irfan Maqbool Bhat[1] and Waseem Qader[2]

Abstract: Landslide hazards along the Banihal–Ramban corridor of the Jammu–Srinagar National Highway (NH-44) represent a critical geoenvironmental challenge in Northwestern Himalaya, where active tectonics, fragile lithology, steep terrain, and increasing extreme precipitation interact with intensive infrastructure development. This technical note presents a focused analysis of flash floods and landslides of April 20, 2025, examining their triggering mechanisms, cascading geomorphic processes, and impacts on transportation infrastructure and settlements. Historical landslide records (1990–2025) and regional hydroclimatic observations are incorporated to contextualize the event within evolving patterns of hazard frequency and anthropogenic slope modification along the NH-44 corridor. The April 2025 disaster resulted from the localized high-intensity precipitation, which elevated pore-water pressures, reduced slope stability, and triggered multiple failures in structurally weakened rock formations. Results highlight a transition from isolated slope failures toward compound and cascading hazard scenarios involving flash floods, debris flows, and infrastructure disruption. The study underscores the increasing vulnerability of this strategic Himalayan lifeline. It emphasizes the need for geologically informed engineering design, improved drainage management, and integrated early warning strategies to enhance long-term resilience. **DOI: 10.1061/NHREFO.NHENG-2757**. *© 2026 American Society of Civil Engineers*.

Author keywords: Himalaya; Hazard; Climate change; Landslide; Flash-flooding.

Introduction

Landslides are among the most significant geomorphic hazards in mountainous regions, particularly within tectonically active regions such as the Himalayan Belt. In India, approximately 12.5% of the landmass is susceptible to landslide hazards, with the highest vulnerability concentrated in the Himalayan states, including Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and the Northeastern Region (NDMA 2019). The combination of fragile geology, steep terrain, active tectonics, and intense monsoonal rainfall produces inherently unstable slope conditions, resulting in frequent mass movements and substantial socioeconomic losses (Das et al. 2022; Habib et al. 2025; Paul et al. 2025a, b). The Northwestern Himalaya represents a critical landslide hotspot where anthropogenic pressures further amplify natural susceptibility. Active tectonic deformation, structurally weakened, and highly weathered lithologies interact with extreme precipitation events to generate recurring landslide activity (Shrestha et al. 2025). Human interventions such as deforestation, road widening, and large-scale infrastructure development have further reduced slope stability by modifying natural drainage patterns and removing slope support (Tyagi et al. 2025). Triggering mechanisms commonly include cloudbursts, prolonged antecedent rainfall, and seismic activity, which increase pore-water pressure and reduce shear strength, particularly in clay-rich or low-permeability formations (Tang et al. 2017). Historical records indicate that frequent landslide activity has intensified across the region, with more than 1,234 landslides documented in Jammu and Kashmir between 1990 and 2020, resulting in over 1,000 fatalities (Shah et al. 2022).

Within this regional context, the Ramban District, traversed by the strategically important Jammu–Srinagar National Highway (NH-44), represents a critical case study to examine evolving landslide hazard dynamics along a major Himalayan infrastructure corridor (Mir et al. 2025). This technical note primarily analyzes the April 20, 2025, cloudburst-triggered flash flooding and landsliding event and its cascading impacts on slope stability and transportation infrastructure. Historical landslide records (1990 to 2020) are incorporated as contextual evidence to evaluate whether recent extreme events represent an escalation in hazard intensity driven by combined geological, hydroclimatic, and anthropogenic factors. By focusing on the interaction among extreme rainfall, fragile geological conditions, and infrastructure modification, the study aims to provide process-based insight into the emerging pattern of compound geohazards along NH-44 and to support improved risk mitigation strategies for this highly vulnerable Himalayan corridor.

Topography, Geology, and Climate

The Ramban Area of Jammu and Kashmir is characterized by highly rugged and dissected mountain terrain, reflecting active tectonics and intense fluvial incision (Mir et al. 2025). The landscape exhibits a pronounced ridge-ravine morphology, steep slopes, deeply incised gorges, and narrow valleys separated by sharp, high-relief ridgelines (Fig. 1). Elevation ranges approximately from 1,600 to 4,000 m above sea level, resulting in significant altitudinal gradients that strongly influence geomorphic processes, climate variability, and

[1]Assistant Professor, Centre for Disaster Risk Reduction, Islamic Univ. of Science and Technology, Kashmir, Jammu and Kashmir 192122, India (corresponding author). ORCID: https://orcid.org/0000-0002-4000-6170. Email: irfan.maqbool@iust.ac.in

[2]Assistant Professor, Centre for Disaster Risk Reduction, Islamic Univ. of Science and Technology, Kashmir, Jammu and Kashmir 192122, India. Email: waseem.qader@iust.ac.in

Note. This manuscript was submitted on October 10, 2025; approved on March 9, 2026; published online on July 13, 2026. Discussion period open until December 13, 2026; separate discussions must be submitted for individual papers. This paper is part of the ***Natural Hazards Review***, © ASCE, ISSN 1527-6988.