

Comprehensive Remote Sensing Monitoring and Deformation Mechanism Analysis of Typical High-Elevation Landslides in the Longmenshan Strong Earthquake Zone: Postprint

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Abstract

The Longmenshan strong earthquake area is characterized by extensively developed “V” -shaped erosional and denudational alpine gorge landforms. The Longmenshan fault zone within this region has maintained intense tectonic activity since the Quaternary, leading to frequent collapse and landslide disasters that pose severe threats to the lives and property of mountain residents. High-elevation landslides, in particular, exhibit strong concealment and high destructiveness. Due to their high-position shear outlets, they typically possess favorable free-face conditions, making them highly susceptible to high-speed long-runout movement and capable of triggering sudden geological disasters of enormous scale and extensive travel distance. This study focuses on the Bulancun landslide (soil) and Feishaguan landslide (rock) in Wenchuan County, Sichuan Province, employing integrated space-air-ground monitoring technologies—including multi-temporal optical satellite remote sensing, spaceborne Interferometric Synthetic Aperture Radar (InSAR), multi-temporal aerial remote sensing, Global Navigation Satellite System (GNSS), Ground-based Interferometric Synthetic Aperture Radar (GB-InSAR), and ground surveys—to conduct landslide deformation monitoring and deformation mechanism analysis. A comparison of the deformation evolution characteristics between the Bulancun landslide and Feishaguan landslide reveals: Different deformation evolution patterns: Although the deformation magnitude of the Bulancun landslide gradually increased during the monitoring period, its deformation rate exhibited periodic variations, with the landslide remaining in a steady deformation stage for an extended duration; conversely, the Feishaguan landslide, after experiencing frontal collapse triggered by the 2008 earthquake, spontaneously entered an accelerated deformation stage following several years of evolution, exhibiting sudden deformation characteristics; Different main controlling factors: The

deformation and failure of the Bulancun landslide are primarily controlled by external factors such as rainfall and human engineering activities, whereas those of the Feishaguan landslide are mainly driven by internal factors including earthquakes, geological structure, and topographic and geomorphological conditions.

Full Text

Integrated Remote Sensing Monitoring and Deformation Mechanism Analysis of Typical High-Elevation Landslides in the Longmenshan Strong Earthquake Zone

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Abstract

The Longmenshan strong earthquake zone is characterized by widespread V-shaped erosion-denudation alpine canyon landforms. The Longmenshan fault zone has maintained strong tectonic activity since the Quaternary, resulting in frequent landslide disasters that pose a serious threat to life and property in mountainous regions. High-elevation landslides are particularly hazardous due to their strong concealment and high destructiveness. Their high shear outlet positions provide favorable free-face conditions, making them prone to high-speed, long-runout movements that can trigger sudden, large-scale geological disasters with extensive travel distances.

This study focuses on the Bulancun landslide (soil-type) and Feishaguan landslide (rock-type) in Wenchuan County, Sichuan Province. Employing integrated “space-air-ground” collaborative monitoring techniques—including multi-temporal optical satellite remote sensing, spaceborne Interferometric Synthetic Aperture Radar (InSAR), multi-temporal aerial remote sensing, Global Navigation Satellite System (GNSS), Ground-based Interferometric Synthetic Aperture Radar (GB-InSAR), and ground surveys—we conducted comprehensive landslide deformation monitoring and mechanism analysis.

Comparative analysis reveals distinct differences in deformation evolution characteristics between the two landslides. First, their deformation evolution patterns differ significantly: the Bulancun landslide exhibited gradually increasing deformation magnitude but with periodic variations in deformation rate, maintaining a long-term uniform deformation stage. In contrast, the Feishaguan landslide naturally entered an accelerated deformation stage after several years of evolution following the 2008 earthquake-triggered frontal collapse, demonstrating sudden deformation characteristics. Second, their dominant controlling factors differ: the Bulancun landslide’s deformation and failure are primarily

controlled by external factors such as rainfall and human engineering activities, whereas the Feishaguan landslide' s deformation and failure are mainly driven by internal factors including earthquakes, geological structure, and topographic-geomorphic conditions.

Keywords: high-elevation landslides; space-air-ground collaborative monitoring; Interferometric Synthetic Aperture Radar (InSAR); optical satellite remote sensing; Global Navigation Satellite System (GNSS); Ground-based Interferometric Synthetic Aperture Radar (GB-InSAR)

Note: Figure translations are in progress. See original paper for figures.

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