

Postprint: Characteristics of Large-Scale Watershed Geohazard Chains in the Eastern Himalayan Syntaxis

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Abstract

In the Eastern Himalayan Syntaxis region, watershed-scale geological hazards occur frequently, causing significant casualties and infrastructure damage. This study establishes a systematic research methodology from regional scale to individual hazard sites, including construction of geological hazard databases, identification of hazard chain patterns, analysis of dynamics and barrier dam breaching, and risk assessment. The main achievements are as follows: (1) A total of 175 high-risk river-blocking hazard sites were identified in the lower Yarlung Tsangpo River, where watershed-scale hazards are well developed. Considering comprehensively the geomorphological characteristics of hazard sites, historical hazard events, landslide zoning, and material composition, five typical hazard generation patterns are proposed. InSAR data were also utilized to conduct risk zone identification and assessment for typical hazard sites. (2) An inversion analysis was performed on the 2021 large-scale ice-rock avalanche hazard chain event in Sedongpu Gully, with model and parameters calibrated using seismic ground motion signal records. The results show that the event lasted approximately 300 seconds, with a maximum velocity of about 77.2 m/s and a flow thickness of less than 100 m. Through analysis of dynamic processes and mechanical characteristics, a better understanding of the movement stages and phase transition processes of the hazard chain was achieved. (3) Watershed-scale hazards often lead to river blocking, subsequently forming barrier lakes. For example, the peak discharge from the Yigong landslide reached as high as $12.4 \times 10^4 \text{ m}^3/\text{s}$, equivalent to 36 times the seasonal flood discharge of the Yigong Zangbo River, and its dam-break flood poses a serious threat to downstream engineering construction. This study provides insights for hazard pattern identification and analysis of multi-stage hazard chain dynamic characteristics, and also provides research methods and technical support for hazard investigation and integrated risk assessment in the alpine gorge region of the Eastern Syntaxis.

Full Text

Characteristics of Massive Glacier-Related Watershed Geohazard Chains in the Eastern Himalayan Syntaxis, China

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Abstract

In the Eastern Himalayan Syntaxis region, frequent watershed geohazards have caused significant casualties and infrastructure damage. This study establishes a systematic research methodology spanning from regional scale to individual hazard sites, encompassing geohazard database construction, hazard chain pattern identification, dynamic and dam breaching analysis, and risk assessment. The main achievements are as follows: (1) In the lower Yarlung Tsangpo River basin, 175 high-risk river-blocking hazard sites were identified where watershed geohazards are well-developed. Based on comprehensive analysis of geomorphic characteristics, historical hazard events, landslide zoning, and material composition, five typical disaster formation patterns are proposed. InSAR data were also utilized to conduct risk zone identification and assessment at typical hazard sites. (2) A back-analysis of the large-scale ice-rock avalanche disaster chain event at Sedongpu Gully in 2021 was conducted, with model parameters calibrated using seismic signal records. Results indicate that the event lasted approximately 300 seconds, reached a maximum velocity of about 77.2 m/s, and had a flow thickness of less than 100 m. Analysis of dynamic processes and mechanical characteristics provides improved understanding of the motion phases and phase transition processes of the disaster chain. (3) Watershed geohazards often lead to river blockage and subsequent formation of barrier lakes. For instance, the Yigong landslide generated a peak flood discharge of $12.4 \times 10^4 \text{ m}^3/\text{s}$, equivalent to 36 times the seasonal flood discharge of the Yigong Tsangpo River, with its dam-break flood posing severe threats to downstream engineering projects. This study provides insights into hazard pattern recognition and multi-stage disaster chain dynamic characteristics, while offering research methodologies and technical support for hazard investigation and integrated risk assessment in the high mountain canyon regions of the Eastern Syntaxis.

Keywords: watershed geohazard chains; disaster formation patterns; ice-rock avalanche; dynamics; barrier lake; Eastern Syntaxis region

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

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