Hazard Assessment of Slope Geohazards in Shenzhen Using Airborne LiDAR (Postprint)

Authors: Deng Bo, Zhang Hui, Bai Jun, Dong Xiujun, Jin Dianqi, Zhang Shaobiao

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Abstract

Shenzhen is a megacity that emerged following China' s reform and opening-up, having experienced rapid urbanization with frequent land transformation. Affected by a subtropical monsoon climate, the region features abundant rainfall and dense vegetation cover, making it difficult to identify geological hazard risks widely distributed across artificial slopes and natural slopes. First, using high-precision digital elevation models of the entire Shenzhen area obtained from airborne light detection and ranging (LiDAR) as the data source, over 3,500 typical samples of slope-type geological hazards were established through multi-source remote sensing identification. Second, comprehensively considering three major factors (eight factors) including topography, geological structure, and human engineering activities, and proposing a rainfall convergence factor based on the rainfall-induced disaster mechanism, the weights-of-evidence method was employed to complete hazard assessment of geological hazards under rainfall-induced conditions. Finally, a hazard threshold classification method for "key control points" was proposed in the context of individual hazard scenarios. The results demonstrate that airborne LiDAR technology can more extensively identify unstable slope bodies beneath vegetation layers, expanding the original computational sample database by approximately 330%, and the receiver operating characteristic curve validation value of the hazard assessment model reached 0.903. The assessment results align with actual conditions and can effectively evaluate the probability of rainfall-induced slope failure, forming a refined assessment system for slope-type geological hazard risk applicable to densely vegetated urban areas.

Full Text

Preamble

Hazard Evaluation of Slope Geological Disasters Based on Airborne LiDAR Data in Shenzhen, China

DENG Bo[1], ZHANG Hui[2], BAI Jun[1], DONG Xiujun[1], JIN Dianqi[2], ZHANG Shaobiao[2]

(1. State Key Laboratory of Geohazard Prevention and Geoenvironmental Protection, Chengdu University of Technology, Chengdu 610059; 2. Shenzhen Urban Public Safety and Technology Research Institute, Shenzhen 518046)

Abstract

Shenzhen, a megacity that emerged following China' s reform and opening-up, has experienced rapid urbanization and frequent land modification. Influenced by a subtropical monsoon climate, the region receives abundant rainfall and maintains dense vegetation coverage, making it difficult to detect geological hazard risks widely distributed across both artificial and natural slopes. This study utilized high-precision digital elevation models (DEMs) covering the entire Shenzhen area, obtained via airborne Light Detection and Ranging (LiDAR), as the primary data source to establish over 3,500 typical markers for slope-type geological hazards through multi-source remote sensing interpretation. The research comprehensively considered three major factors (eight indicators) encompassing terrain, geological structure, and human engineering activities, and introduced a rainfall convergence factor based on the mechanism of rainfall-induced disasters. Employing the Weight of Evidence method, we completed a hazard evaluation of geological disasters under rainfall-induced conditions. Additionally, we proposed a hazard threshold classification method for "critical control points" within the context of individual disaster scenarios.

The results demonstrate that airborne LiDAR technology can more extensively identify unstable slope bodies concealed beneath vegetation canopies, expanding the original computational sample database by approximately 330%. The receiver operating characteristic (ROC) curve validation of the hazard evaluation model achieved an effective value of 0.903, with evaluation results consistent with actual conditions. The model can effectively assess the probability of rainfall-induced slope instability, thereby forming a refined evaluation system for slope-type geological hazard risk applicable to densely vegetated urban areas.

Keywords: Shenzhen; airborne LiDAR; geological hazards; hazard evaluation model; Weight of Evidence method

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