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Application of LTFGF and PLAAF for Topographic Characteristics and Activity Assessment: Case Studies of Wuhe and Tsaoling

Sz-Han Yang[1,2*], Che-Ming Yang[2], Yuan-Ting Chiu[1], Yung-Ning Yang[1], Tzu-Yu Hsiao[1], Ping-Yu Hsieh[1]

[1]Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan
[2]Department of Construction Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan

(*Corresponding E-mail: s1314988@gmail.com)

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Abstract: **Taiwan's convergence of active tectonic plates, heavy rainfall, and fragile geology leads to frequent landslides and persistent slope instability, further aggravated by extreme climate events. To enhance landslide susceptibility assessment and support risk management, this study systematically evaluates 2,500 potential large-scale landslides identified by the Central Geological Survey and Mineral Management Center. The Landslide Topographic Feature Grading Form (LTFGF) was developed to score topographic indicators such as scarps, sliding mass, lateral boundaries, toe morphology, and erosion conditions, classifying 1,566 sites into Grades A–D. Thirty-five representative sites, including Wuhe and Tsaoling, were further assessed using the Potential Large-scale Landslide Activity Assessment Form (PLAAF), which integrates failure mechanism interpretation, adverse stability features, historical bare area ratios, and displacement ratios (d/L). Statistical analysis shows Grades A + B represent 7.7% of sites, with LTFGF and PLAAF scores exhibiting a strong positive correlation (r = 0.706). Wuhe exhibits RS+TC composite failure mechanisms with localized toe cutting and secondary scarps, scoring 80 (Grade B) in LTFGF and 68 in PLAAF (high activity). Tsaoling shows PS+TC mechanisms, extensive scarp exposure, and significant historical landslide activity (126 records), achieving the highest PLAAF score of 84. Results confirm that the combined LTFGF–PLAAF framework effectively identifies high-risk landslides, prioritizes monitoring targets, and supports decision-making for resource allocation and long-term disaster prevention planning.**

Keywords: ***Potential large-scale landslides, Topographic feature grading and classification, Activity assessment, Cut bank erosion.***

Introduction

Taiwan's tectonic setting, heavy rainfall, and fragile geology cause persistent slope instability, worsened by extreme climate events. This study classifies 2,500 potential large-scale landslides and develops the Landslide Topographic Feature Grading Form (LTFGF) and Potential Large-scale Landslide Activity Assessment Form (PLAAF) (Figure 1 and Figure 2). Case studies at Wuhe and Tsaoling validate these tools for improving landslide risk management and long-term monitoring.

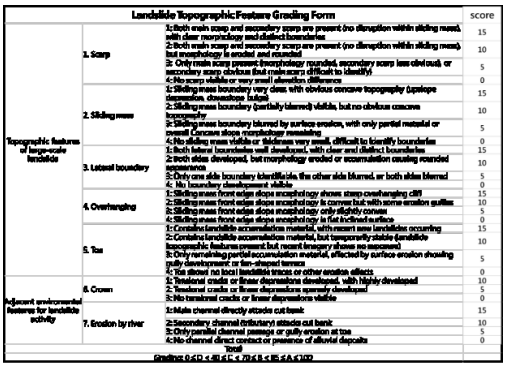

Figure 1, Landslide Topographic Feature Grading Form.

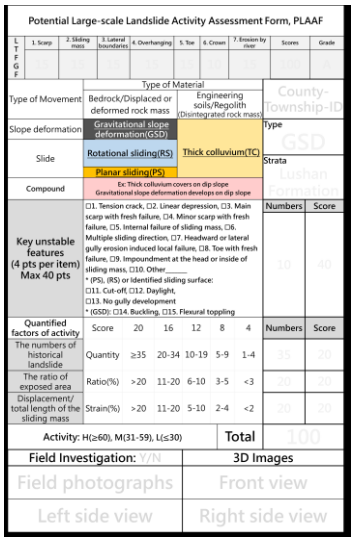

Figure 2, Potential Large-scale Landslide Activity Assessment Form.

Research methods

This study interprets landslide topographic features using LiDAR DEMs, contour maps, geological maps, and historical satellite imagery (Figure 3). The Landslide Topographic Feature Grading Form (LTFGF) scores scarps, sliding mass, boundaries, toe morphology, and erosion conditions, classifying 1,566 sites into Grades A–D (6, 114, 960, 486 sites). Thirty-five sites, including Wuhe and Tsaoling—were further assessed using the Potential Large-scale Landslide Activity Assessment

Form (PLAAF), which considers failure mechanisms (GSD, RS, PS, TC), adverse features, historical bare area ratios, and displacement ratios (d/L) (Chigira, 2009).

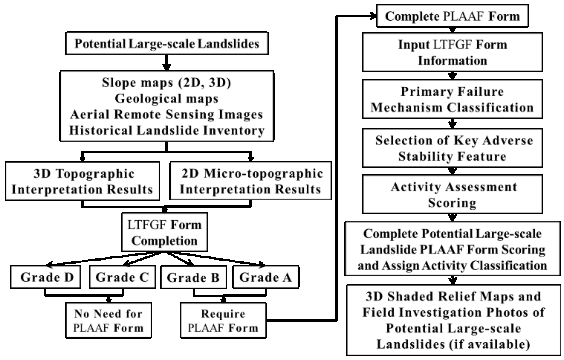

Figure 3, Flowchart of potential large-scale landslide grading and classification assessment procedure.

Results

Grades A + B account for 7.7% of sites, C for 61.3%, and D for 31.0%, with LTFGF scores normally distributed (5–85, peak at 45). PLAAF scores (20–84) correlate positively with LTFGF (r = 0.706). All Grade A cases show high activity. Wuhe: LTFGF score = 80 (Grade B), PLAAF = 68 (high). Field investigations reveal colluvial sliding mass, secondary scarps, toe cutting, and RS+TC failure mechanisms. Tsaoling: LTFGF = 70 (Grade B), PLAAF = 84 (highest). Shows PS+TC failures, extensive scarp exposure, toe erosion, and 126 historical landslides, triggered by rainfall and river undercutting.

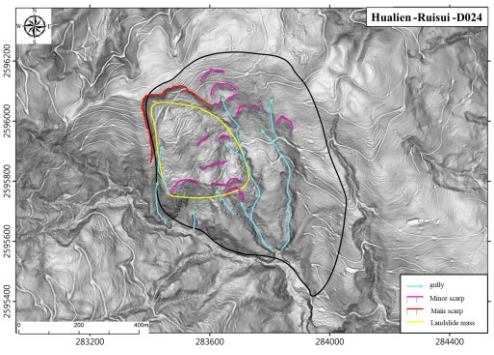

Figure 4, LiDAR interpretation of Wuhe.

Figure 5, 2024 SPOT satellite imagery of Wuhe.

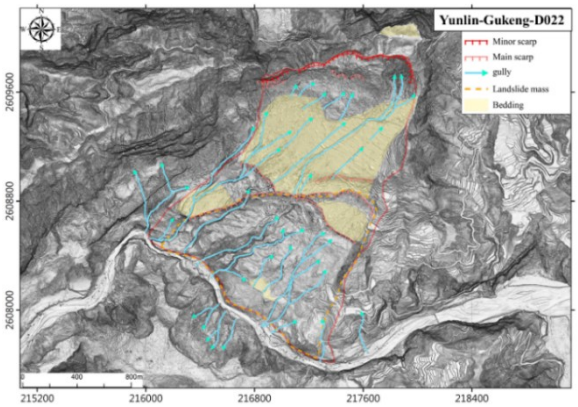

Figure 6, LiDAR interpretation of Tsaoling.

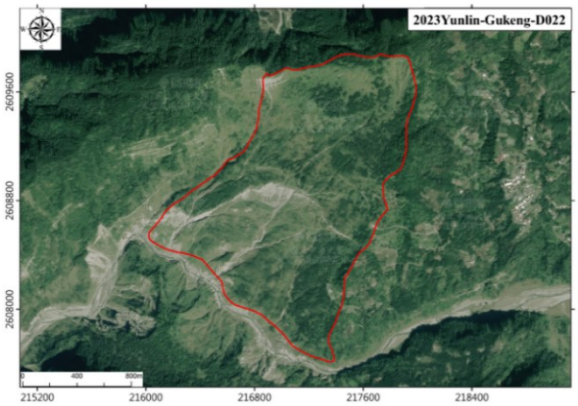

Figure 7, 2023 SPOT satellite imagery of Tsaoling.

Conclusions

The combined LTFGF–PLAAF framework effectively screens and prioritizes high-risk landslides. Wuhe and Tsaoling demonstrate high activity and different failure mechanisms, confirming the method's applicability for resource allocation, monitoring, and disaster prevention planning.

Acknowledgement

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