Using high-resolution geomorphometry and normalized difference vegetation index (NDVI) to assess slope stability in the watersheds of Taiwan: A case study of the section between Chinhe and Fuxing, from 92K to 99K of Taiwan Provincial Highway 20

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Abstract

Due to the increasing impacts of global climate change in recent years, nations around the world have been grappling with frequent natural disasters. Taiwan, situated on the Pacific Rim seismic belt, is shaped by active orogeny, resulting in its rugged terrain. The island has experienced numerous typhoons, extreme rainfall, and complex hydrological conditions, making its mountainous areas particularly vulnerable to natural disasters. The accumulation of soil and sediment further alters the landscape of its watersheds, putting both infrastructure and residents at significant risk. This study therefore focuses on the monitoring and maintenance of slopes in Taiwan's watershed areas.

Since the inspection of mountain roads is limited by terrain and vegetation, this study utilizes the high-resolution Digital Elevation Model (DEM) for geomorphometric analysis to precisely target landslide hot spots, and Unmanned Aerial Vehicles (UAVs) to observe more detailed topographical features. Meanwhile, the Normalized Difference Vegetation Index (NDVI) is used to interpret landslide and vegetation restoration status, while Multi-Temporal InSAR (MTInSAR) is employed to detect topographical changes and observe post-disaster alterations.

Taking the section between Chinhe and Fuxing (92K to 99K) of Taiwan Provincial Highway 20 as a case study, this highway serves as a critical horizontal transportation hub. Following the impact of Typhoon Morakot in 2009, the region has experienced highly unstable and complex hydrological conditions, resulting in persistent damage to its roads and bridges. This study primarily employs high-resolution LiDAR DEM to analyze pre- and post-disaster changes in terrain and river channels. Then the NDVI interpretation, derived from SPOT satellite imagery, reveals that the crown of the original landslide area has been actively developing, leading to the movement of rocks and debris. The MTInSAR results further corroborate this interpretation, confirming that the crown area of Yushui River remains prone to landslides, with new slide events and significant sediment accumulation in

downstream areas.

In summary of the analysis and on-site data, the primary disaster-prone factors are the meandering of the Lanong River and the accumulation of soil and sand, leading to extreme instability in the alluvial fans on both banks. After multiple landslides, the damage mechanism is analyzed, revealing that the region is highly susceptible to tectonic activity. The initial results facilitate the overall slope stability evaluation and provide relevant agencies with governance and maintenance recommendations to enhance road safety.

Keyword：High-resolution Digital Elevation Model, DEM、Normalized Difference Vegetation Index,NDVI、Multi Temporal InSAR, MT-InSAR.