Assessment of Active Tectonics Using Geomorphic Indices in the Badlands of Southwestern Taiwan

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Date: 2024/10/25

Abstract

Southwestern Taiwan is located at the convergence of the Eurasian and Philippine Sea Plates, characterized by active tectonics and significant crustal deformation. The region's badlands are primarily composed of Late Miocene to Early Pleistocene Gutingkeng Mudstone, which includes thin sandy layers and shales. The thickness of the Gutingkeng Mudstone reaches 3 to 4 kilometers. The landscape is shaped by a fold-and-thrust belt, characterized by anticlines, reverse faults, and geomorphic features such as prominent gullies, as well as rills and underground pipes, contributing to its complex morphology. Ground-based geodetic techniques, including GPS and leveling, are utilized to detect active uplift zones and assess ongoing deformation. The study aims to quantify long-term deformation processes by analyzing geomorphic indices indicative of tectonic uplift and erosion. Stream networks are analyzed using UAV-derived Digital Surface Model (DSM) data from uplift areas to investigate their connection to tectonic uplift and the relationship between geomorphic indices across various basins. High-resolution UAV-derived DSMs and a 1-meter Digital Elevation Model (DEM) provide detailed landscape analysis. Three geomorphic indices basin relief, hypsometric integral (HI), and hypsometric curve are utilized to assess the relationship between tectonic forces and landscape morphology. Basin relief indicates active uplift in steeper slopes, while HI suggests active tectonics with higher values. The hypsometric curve shows that steeper slopes indicate active tectonics, whereas gentle slopes suggest stability. Data processing is conducted with ArcGIS and Excel, with future analyses planned using MATLAB for efficiency. This research enhances the understanding of tectonic influences on landscape evolution in Southwestern Taiwan.

Keywords: Tectonic uplift, Geomorphic indices, Shale tectonics, Fold-and-thrust belt, Gutingkeng Mudstone, Long-term deformation.