**TERRAINIQ: INTELLIGENT MAPPING OF LANDSLIDE-PRONE ZONES USING PSO–KMEANS OPTIMIZATION**

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**ABSTRACT**

Soil erosion, landslides, and land degradation represent escalating environmental challenges that continue to intensify under the combined influence of deforestation, unplanned urban expansion, and climate change. These processes not only reduce agricultural productivity but also disrupt delicate ecosystems, diminish biodiversity, and endanger infrastructure as well as human lives. Conventional monitoring techniques, which often depend on manual field surveys and ground-based observations, are limited in their scope, labor-intensive, time-consuming, and poorly suited for large-scale or continuous environmental assessments.  
  
The Western Ghats, recognized as a UNESCO World Heritage Site and one of the most important biodiversity hotspots in the world, are particularly vulnerable to these threats. Spanning six Indian states, this mountain chain plays a vital role in regulating the Indian monsoon, recharging rivers, sustaining agriculture, and preserving unique flora and fauna. However, rapid deforestation, extensive quarrying, and unplanned developmental activities have accelerated ecosystem fragility, intensifying risks of erosion and landslides.  
  
With advancements in geospatial technology, remote sensing combined with machine learning has emerged as a highly efficient alternative. This study proposes an integrated framework utilizing satellite imagery and K-Means clustering to classify soil and rock characteristics, detect vulnerable zones, and provide a scientific basis for proactive land management and disaster risk mitigation. The proposed PSO–KMeans hybrid model achieved an accuracy of 82%, demonstrating strong reliability in identifying high-risk erosion and landslide-prone regions.