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Integrating Remote Sensing and Machine Learning for Landslide Prediction and Early Detection

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Abstract

Landslides are the second largest natural hazard in Sri Lanka, causing a major impact after floods. The main focus of the study is to identify how remote sensing technologies (RSTs) and machine learning (ML) have enhanced landslide detection accuracy over the past decades. Information was collected on RSTs and ML methods for landslide prediction and their integration to achieve the objective of the study. This review examined articles from Google Scholar and Science Direct, assessing RST and ML advancements in landslide prediction from 2013 to 2023. The search strings included "landslide" and "Remote Sensing" OR "Machine Learning" with at least two of these search terms appearing in the title, Keywords, or abstract of English language documents related to landslide prediction. Only Full-text, open-access articles were considered, and after removing duplicates, 25 unique research communications were selected. This analysis examines how RSTS and ML can enhance landslide prediction accuracy and reduce associated risks. RSTs are primarily classified into satellite-based RTS and ground-based sensors. Satellite-based RSTs provide a broad view of landslides across different spatial and temporal scales, aiding in detecting and measuring displacement over large areas. Ground-based sensors, including interferometric radar, dapple radar and lidar allow real-time monitoring of the small area with high accuracy. These capabilities contribute to developing an effective early warning system. ML models such as support vector machines (SVM), binomial generalized additive models, cross-validation models, convolutional neural networks, and small sample-based learning models help identify, quantify, and effectively predict landslide-prone areas with greater accuracy. Integrating remote sensing technologies with machine learning models significantly enhances the high-resolution landslide vulnerable maps. This integration allows the application of advanced algorithms such as SVM for more accurate risk assessment and improves the automation and precision of early detection of landslides. Consequently, all stakeholders are in a position to make proactive decisions because they are aware of risks and their influence on disasters.

Keywords: *Early warning system, Ground-based sensors, Machine learning, Remote Sensing Technologies, Risk sssessment*