

Modelling Soil Erosion in Tropical Highland Region: A Case Study on Nuwara Eliya District, Sri Lanka

¹MHF. Nuskiya, ²S. Sawjanya, ³ Fareena Ruzaik, and ¹MHM. Rinos

¹Department of Geography, South Eastern University of Sri Lanka

²Research Assistant, Postgraduate Study, University of Colombo, Sri Lanka

³Department of Geography, University of Colombo, Sri Lanka

Correspondence: nuskiyahassan@seu.ac.lk

Abstract

Soil erosion remains a critical environmental issue in tropical highland regions, with significant implications for agricultural productivity, land erosion and ecological stability. The present study aims to model the risk of soil erosion in the Nuwara Eliya district of Sri Lanka, which is affected by hill land use practices, especially tea cultivation. The Revised Universal Soil Loss Equation (RUSLE) was employed in combination with geographical information system (GIS) and remote sensing techniques to determine spatial variations in annual soil loss. Key RUSLE parameters are: rainfall erosivity (R), soil erodibility (K), slope length and steepness (LS), cover management (C), and conservation support practices (P) were derived using 30-meter resolution Digital Elevation Models (DEMs), LANDSAT imagery, and localized soil and meteorological datasets. The model results reveal that the average annual soil loss in the district is 28.7 tons per hectare per year, with 45% of the land area exceeding the tolerable soil erosion threshold of 11 tons per hectare. Severe erosion hotspots, surpassing 52 tons per hectare annually, are predominantly concentrated in steep-sloped tea-growing zones (>30%), notably in the Ragala Tea Belt, Hakgala Slopes, and Moon Plains. In contrast, forested areas recorded minimal erosion rates (<5 tons per hectare). The LS-factor and C-factor emerged as the most influential determinants of soil loss. The study highlights the applicability of the RUSLE-GIS framework for erosion risk assessment in complex highland landscapes. It recommends site-specific soil conservation interventions such as contour terracing, agroforestry integration, and regulatory land-use policies. The outcomes contribute to a replicable methodological framework for regional-scale erosion modelling and sustainable land management planning in similar agro-ecological contexts.

Keywords: RUSLE, soil erosion, GIS, Nuwara Eliya, land degradation, tropical highlands, slope analysis