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Soil erosion and sediment yield estimation using GIS-based RUSLE model in Attanagalu Oya watershed, Sri Lanka

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Soil erosion is considered a significant cause of land degradation that negatively impacts natural resources and socioeconomic activities across the globe. Hence, estimating the spatial distribution of soil erosion is essential for making successful policies and implementing proper land conservation and management practices. The present study was designed to estimate the soil erosion and sediment yield in the Attanagalu Oya Watershed, one of the major watersheds located in the low-country wet zone in Sri Lanka, which acts as an important natural ecological zone and a source of surface water for the area. The Revised Universal Soil Loss Equation (RUSLE) model integrated with the Geographic Information System and Remote Sensing was used to quantify soil erosion and map the spatial variation of the soil erosion hazard over a 20-year period. The Sediment Delivery Ratio (SDR) was utilized to estimate the sediment yield generated in the Attanagalu Oya watershed. Land use land cover derived from Landsat 7 ETM and Landsat 8 OLI imagery and Digital Elevation Model (DEM) were integrated into the model. The results indicated that the average annual soil erosion in the Attanagalu Oya watershed has substantially increased from 1.58 t ha⁻¹ yr⁻¹ in 2001 to 2.3 t ha⁻¹ yr⁻¹ in 2020, an increment of about 45.6%. The spatial distribution of soil erosion reflected that the moderate to extremely high erosion levels increased from 2001 to 2020, and the extremely erosion-prone areas (>60 t ha⁻¹ yr⁻¹) were distributed in the eastern part of the watershed. Furthermore, the average annual sediment yield in the Attanagalu Oya watershed was estimated as 0.39 t ha⁻¹ yr⁻¹ with a range of 0 to 124.4 t ha⁻¹ yr⁻¹ in 2001 and 0.57 t ha⁻¹ yr⁻¹ with a range of 0 to 87.4 t ha⁻¹ yr⁻¹ in 2020. The spatial distribution of sediment yield revealed that the high sediment yield was also generated in the eastern part of the watershed as soil erosion. The spatial analysis further revealed that steep slopes (>10.41%), high mean annual rainfall levels (>2500mm), erosion-prone soil types and land use land cover changes, contributed to the high soil erosion and sediment yield in the Attanagalu Oya watershed. The soil erosion hazard information obtained through this study on the Attanagalu Oya watershed can be utilized to design proper erosion conservation and land management practices for improving the sustainability of the watershed.

Keywords: GIS, RUSLE, Sediment yield, Soil erosion, Tropical watershed