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Morphometric Analysis of Uma Oya Sub-Basin for Sustainable Soil and Water Resources Management Using Spatial Data

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Abstract

The Uma Oya sub-basin of the largest Mahaweli River Basin encompassing mainly Badulla District of Sri Lanka, plays a vital role in agriculture, irrigation, drinking water supply, and hydropower generation. This study utilizes spatial data obtained via GIS and RS platforms for morphometric analysis of linear, areal and relief aspects of Uma Oya sub-basin where Tea plantations dominate the land cover. Various morphometric parameters, including bifurcation ratio, drainage density, drainage texture, stream frequency, circularity ratio, elongation ratio, form factor and relief ratio, were analysed to understand the soil and hydrological characteristics of the sub-basin. The study identified total of 4,800 streams in the Uma Oya River network spanning 2,017.3 km flowing up to 7th order as per the Strahler's classification. The mean bifurcation ratio was 4.01, indicating that geological structures have minimal influence on the drainage pattern. The drainage density was 2.81 km/km² confirming the availability of highly permeable subsurface materials under dense vegetative cover. The drainage texture of 30.79, confirmed that the basin has a fine drainage texture. And the stream frequency 6.7 indicated that this sub-basin has a high infiltration capacity generating less runoff reducing soil erosion potential within the basin. The elongation ratio 0.64 confirmed that the sub-basin is more towards an elongated shape. The basin relief was 1.5 km, and the relief ratio was 0.05 reflecting a lower potential for soil erosion within the sub-basin. The findings of this study finally reveal that, Uma Oya sub-basin has a well-distributed stream network and the presence of highly permeable subsurface materials under dense vegetation cover within the watershed area suggest good potential for water infiltration resulting lower flood risk and soil erosion. Hence morphometrically strong hydrological and soil characteristics of this watershed would lead to a less risk for flooding and soil erosion if the natural setup is not intensively disturbed. Overall, the results of this comprehensive study provide a strong foundation for informed decision-making and sustainable soil and water resource management when development activities will be implemented in the Uma Oya sub-basin.

Keywords: Geographic Information System, Hydrological characteristics, Morphometric analysis, Soil erosion, Watershed management