Morphometric analysis of river basins in different climatic and geological settings

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Abstract

Drainage basin morphometric characteristics and river longitudinal profile shape are governed by geological and climatic processes that have occurred in the past. The spatial variability in the above-mentioned aspects have significant bearing on modern day geomorphic processes. Hence quantitative analysis of river basin on morphological characteristics and river longitudinal profile shapes are important to get an estimate of this variability. This study primarily focused on the longitudinal profile shape and morphometric analysis for 6 major river basins of Peninsular India namely – the Mahanadi, Narmada, Tapi, Godavari, Krishna, and the Cauvery river sub-basins. Further, SWAT model has been set up for the Kantamal watershed of Mahanadi River. The main objective of this study is to compare river longitudinal profile shape with different lithological settings, the correlation between basin shape and river longitudinal profile shape, and to know the relationship between basin morphometric parameters and SWAT output parameters.

In the first part, I have calculated values for Normalized Concavity Index (NCI), NCI (Area Under Curve), Concavity Index (Integral approach) for analyzing the longitudinal profile shape, and steepness index (K_{sn}) for analyzing the geometry of river longitudinal profile. Here I found that sub-basins with longitudinal profiles which are convex up generally have lower value of steepness index (K_{sn}) compared to longitudinal profiles with concave up shape. Further exponential curve fitting based decay rate value is 16 % higher for river long profiles developed in basalt compared to granite-gneiss and 45% higher compared to limestones.

The second part of this study aims towards calculating the morphometric parameters for identifying the relationship between various physiographic characteristics of the peninsular India. The morphometric analysis of the watershed gives an idea about the aspects of linear, areal and relief aspect. This has been quantitatively estimated using

Horton’s ratios. Here all six rivers were divided into 45 subbasins. Here I found drainage texture (R_t) for river sub-basins has a very coarse-grained texture owing to presence of resistant rocks. Further, the elongation ratio value of the river sub-basins suggests that the sub-basins are more elongated in shape.

In the next part, I have setup the SWAT model for the drainage basin at Kantamal gauging station of Mahanadi River basin and integrated with morphometric parameters of the sub-basins. This helps to know the relationship between basin morphometric parameters and the SWAT output parameters. Here I found a strong correlation value of surface runoff and sediment yield with basin relief value.