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Watershed Prioritisation for Soil and Water Conservation of Bichhiya River Basin, Central India Using Remote Sensing and GIS

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Abstract

Watershed prioritization has become increasingly important in watershed management, providing many benefits such as soil conservation, groundwater development, and the implementation of artificial recharge schemes. Morphometric analysis is often used to determine watershed priority. This study focuses on the morphometric analysis of the Bichhiya River Sub-basin, Central India to evaluate and understand its hydrological significance. The prioritized watershed is based on morphometric parameters using the Geographic Information System and principal component analysis techniques. ASTER DEM with a 30 meters spatial resolution is used for morphometric analysis as well as the creation of drainage maps. Various parameters, such as linear, areal, as well as relief aspects, are analysed for each sub-watershed. When groundwater and pertinent data sets are insufficient, morphometric analysis is an appropriate technique for conservation of soil and water. The status of each sub-watershed is determined based on these relationships to calculate the final ranking. PCA technique is employed to delineate and analyse morphometric characteristics which may be useful for the conservation of soil and water. Ranks were given to watersheds based on calculated morphometric parameters in terms of soil erosion potential. PCA minimizes the dimensionality of the input data set. The drainage order is 1 to 6, and are divided into six sub-watersheds, labelled sub-watershed I to VI. These sub-watersheds are categorized in various ranks from 1 to 6 based on morphometric analysis using PCA Technique. First rank is given to SW-III, while SW-VI is ranked sixth. So, SW-III should be given high priority for soil and water conservation measures. Studies on the morphometry of the Bichhiya River Sub-basin focused on prioritizing watersheds and correlating morphometric characteristics, highlighting high-priority areas due to significant erosion. The study may be extremely useful for academicians and planners for management of soil conservation, water conservation and groundwater resource development of the area.

Keywords: GIS, DEM, Morphometric analysis, Bichhiya River Sub-basin, Principal Component Analysis, Priority Zone

Introduction

Groundwater is a precious and reliable natural resource that plays a vital role in fulfilling the demand for water supply arising due to inadequate surface water resources throughout the world (Tiwari and Kushwaha, 2018). Watershed management is essential for the conservation of the environment and the sustainable use of water resources. Prioritizing sub-watersheds according to their attributes is a crucial part of managing watersheds, as it helps in resource allocation and conservation effort implementation. Prioritization of watershed is helpful for the conservation of soil and water as well as groundwater development (Tiwari *et al.,* 2016). Morphometric parameters (linear, aerial and relief parameters) allow researchers to examine the condition of a watershed, its hydrological behaviour and propensity for erosion.

Various researchers have demonstrated effectiveness of morphometric analysis in watershed prioritization (Tiwari, 2016; Tiwari, 2017; Tiwari, 2018; Sarino *et al.,* 2019; Sharma *et al.,* 2023; Ali *et al.,* 2024). Subbulakshmi and Nanda (2024) carried out a morphometric analysis to prioritize the sub-watersheds within the Chinar Watershed. In the upper Jhelum sub-catchment of India, Ali *et al.* (2024) prioritized watersheds according to morphometric factors associated with soil erosion risk. Tiwari and Kushwaha (2021) prioritized watershed based on morphometric analysis and principal component analysis technique in Deonar river sub basin, India. Nanda *et al.* (2021) focused on prioritizing watershed in Vishav Kashmir Valley using morphometric and land use criterion. Their study highlighted the importance of integrating morphometric analysis with land use data for holistic watershed management. Sharma *et al.* (2023) used geospatial technologies for watershed prioritization in context of lower Sutlej River Basin for land and water management. A crucial component of effective watershed management and planning is the prioritizing of watersheds using morphometric parameters (Amaliah *et al.,* 2021). Recently morphometric analysis has been used for watershed prioritization various researchers (Ahn and Kim,

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