Article ID 240202034

Balancing Natural Resources: The Science behind Watershed Conservation

Dileep K. C.[1], Hanamantappa Meti[2], Sindhushree T. S.[3] and Supriya S.[4]
[1]Department of Agronomy, College of Agriculture V. C. Farm, Mandya
[2]Deparment of Soil Science and Agricultural Chemistry, College of Agriculture, V. C. Farm, Mandya
[3]Department of Soil Science and Agricultural Chemistry, College of Agriculture, GKVK Bangalore
[4] Department of Plant Pathology, College of Agriculture V. C. Farm, Mandya
*Corresponding Author: hmeti784@gmail.com

Abstract

The scarcity of natural resources and their widespread use in the face of rising population are key concerns. Natural resource conservation is critical for long-term growth and reducing the demand-supply gap. Rivers are a key source of water. Morphometric study of watersheds includes drainage networks and factors such as drainage area, gradient, and relief, and is useful for predicting floods, soil erosion, and sediment yields. Watershed delineation, flow accumulation, flow direction, flow length, and stream ordering were estimated using geospatial techniques such as the Hydrology tool in ArcGIS Software, the Advanced space-borne Thermal Emission and Reflection Radiometer (ASTER) and Shuttle Radar Topographic Mission (SRTM), and the Digital Elevation Model (DEM) for preparing linear aspects of morphometric parameters. Prioritizing sub-watersheds is an important part of watershed management because it may be impossible to implement development programs for whole watersheds in a basin at once due to a lack of financial resources. Such features are particularly beneficial for planning rainwater harvesting, such as the construction of a check dam, the deployment of water harvesting systems, the identification of artificial recharge sites, and watershed management.

Introduction

Management of water resources is a challenge in developing countries such as India. Water resource development requires addressing essential concerns such as surface and subsurface water storage, conservation, and exploitation. Space technology plays an important part in developing a comprehensive management plan for the appropriate protection and use of a country's available water resources. Combining traditional groundwater measuring techniques with remote sensing (RS) methodologies paves the way for optimal planning and implementation of water resource projects. Synoptic and repetitive information can enhance conventional data. Sustainable development is primarily concerned with effective and efficient natural resource planning and management. Drainage basins, catchments, and sub-catchments are the basic units used to manage land and water resources. Watersheds are natural hydrologic bodies that cover a finite amount of land and direct rainwater to a single gully, river, or stream (Kumar & Kumar, 2011).

Morphometric analysis requires measurement of three important aspects – linear, aerial and slope of drainage basin (Nautiyal, 1994). And watershed prioritization may be described as the process of identifying environmentally stressed sub-watersheds or pockets, for taking steps for soil conservation on a priority basis. Several scientific criteria based on soil loss, sediment yield, topographic or morphological factors have been applied individually in the past to identify environmentally stressed sub-watersheds/areas (Pandal *et al.*, 2005; Shrimali *et al.*, 2001). It is essential to properly plan the developmental activities on a priority basis keeping in mind the huge investment involved, in order to achieve beneficial results. This resource-based, integrated approach is realistic and helps in addressing precarious areas to arrive at an appropriate solution. Each parameter was divided into different categories and weightage was assigned based on their relative importance.

Morphometry is a mathematical analysis of earth surface consists of shape, size, dimension and landform. Drainage basin analysis by Morphometric parameters that are classified into Linear aspects (one dimensional), Aerial aspects (two dimensional) and Relief aspects (three dimensional). Drainage basin is important to find the characteristics like soil conditions, surface water potential, topography, slope and runoff characteristics. The morphometric parameters are divided into three types and they are basic parameters, derived parameters, shape parameters. Morphometric is the science that deals with quantitative measurement like shape, geometry of any natural landforms. It denotes the measurement of 3dimensional geometrical properties of land surface. Catchment area or drainage basin is an area drained by river system which includes all areas of land that collect precipitation of water and drain off into stream, lake, body of water. Watershed Management is a method to protect and improve the quality of water and also control erosion in the catchment area in a broad manner. Watersheds are classified into Mini watershed (1 to 100 ha), micro watershed (100 to 1000 ha), Milli watershed (1000 to 10000 ha), Sub watershed (10000 to 50000 ha) and Macro watershed (> 50000 ha).

Watershed Prioritization is the scientific process of watershed delineation and monitoring. Morphometric analysis is an satisfactory method for analysis for river basin also because it gives relationship between various aspects like stream order, stream length within drainage basin. A comparative elevation observed in different drainage basins develops in geomorphology and topographical situations the quantitative analysis of drainage system is in an important aspect characterization of watershed. Prioritizing the watersheds of appropriate scale has been mostly based on the morphometric characteristics and quantitative measurements. Attention has also been focused on the natural resources (such as soil and water) based conservation of watersheds. Watershed prioritization is the ranking of different sub-watersheds of watershed according to the order it is used treatment through water and soil conservation measures and water prioritization based on morphomeric analysis universal soil equation, land cover geomorphology and sediment yield index through remote sensing techniques, GIS techniques. The concept of prioritization plays an important role between soil and water to development of watershed and planning a watershed a watershed is an ideal unit for management like natural resources like land and water for mitigation of impact of natural disaster for achieving sustainable development.

Remote sensing is the gathering information of an object without any physical contact with an object. GIS is designed to analyze, capture, store, manage, manipulate and present all types of spatial data in the geographical formats in the computer itself. It as a tool for analyzing the spatially distributed information's Arc GIS and ERADAS IMAGINE powerful software's. The inherent coincidence of data sets of various river basin characteristics, since they are depend on the same satellite images, has provided the most economical inventories. Dynamic phenomena, such as changes of land use, can be better captured using multi temporal satellite data to arrive at the most accurate estimates. The GIS has proven to be a useful tool in the creation of spatial databases, to make the data compatible from one format to another and the recovery of data according to the requirements. Since the input data is geographic in nature, GIS proved to be a potential tool when conducting spatial analyzes based on criteria for the optimal management of natural resources. It is found that natural phenomena such as the hydrological response of the selected area of the river basin to precipitation and its propensity to water erosion can be better simulated through the GIS. From downloading the required satellite images for website USGS with 30M resolutions and that image should be analysis Arc GIS software the spatial analytic tools that are to hydrology and consider watershed parameters like fill, flow direction, flow accumulation, Basin In the present paper an challenge has been made to describe various physical features of drainage basin and accepting the relationship between them and ASTER and SRTM. Digital Elevation Model (DEM) have been used for preparation of Linear, Areal and Relief Morphometric parameters helpful to know about lithology and geologic structures in development of drainage pattern. Watershed prioritization has also been performed for a no of watersheds using parameters such as linear and shape components of the basin and slope contribution, modeling of herbal phenomena such as hydrologic response of watershed to precipitation and phenomenon to erosion hazard due to runoff can be best simulated by using GIS. Effective use of area based totally RS facts suitably built-in with collateral, hydrological and meteorological statistics using GIS options with cloud services can help to evolve alternate prescriptions to obtain sustainable improvement of natural resources.

Most of Sub watersheds are ranked on the basis of watershed prioritization order is taken according to their treatment and soil conservation measures. Morphometric analysis could be used for prioritization of sub watersheds by studying different parameters like linear, aerial and relief aspects of the basin and slope contribution. This analysis can be achieved through measurement of linear and areal parameters of the watershed even without the availability of soil maps.

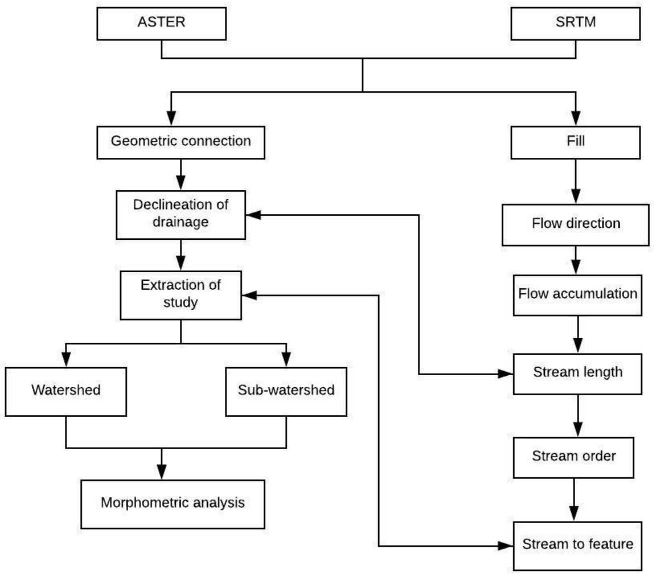

Fig.1. Flow chart of methodology adopted for morphometric analysis

Linear morphometric parameters: Linear aspects of morphometric analysis include stream order, stream number, stream length which are very close to the channel outlines of the drainage network which considers only the topological characteristics of the stream segments where the terms of open links of the drainage networks.

Stream order: Stream order terms to be the first and prior step in the drainage basin analysis, as per the standard scheme of orders the study**.**

Stream number: Stream number depends upon the terms like permeability and infiltration, which in results indicates that the higher stream order will have lesser permeability and lesser infiltration rate. Whereas stream frequency and stream order are noted as inversely proportional to each other which clearly indicates that where the stream order increases automatically it results in the decrease of stream frequency. Because of the dissimilarities in the structures of the rock, these variations are responsible for the variations and changes in stream frequency of each order where the streams regularly decrease in the geometric progression with an increase in the stream order, gradually which shows a negative correlation between the stream orders and the stream numbers.

Stream length: The total stream length is decreasing gradually as per the increase in stream order in the drainage basin, where this discrepancy is because of change in resolution and the differences in the relief and tectonic forces.

Mean Stream Length (Lsm): Mean stream length is related with the watershed in terms of surface flow, discharge and erosion. Because of the change in slope and topographic changes the values of mainstream length vary randomly, where it results in the change of main stream length from one order to another order. Lsm=Lu/Nu.

Stream length Ratio: Stream length ratio is defined as length of successive segments of the streams and it is the ratio of mean length of the order of the stream, stream length ratio is to estimate geometric sequence of stream length and average length of segments

$$RL=Lsmu/(Lsmu^{-1}).$$

Bifurcation Ratio: Bifurcation ratio is narrowly linked to the branching pattern of a drainage network. The bifurcation ratio values for the Watershed vary because of likelihood of variations in watershed geometry and lithology.

Conclusion

Prioritization of watershed analysis is the necessity analysis for determining the watersheds and the sub watersheds. Prioritization of watershed analysis is the based on the quantitative analysis which is required for the sustainable development. The quantitative analysis of the morphometric parameters is to utilize in the river basin evolution, watershed prioritization for the soil and also water conservation at micro watershed levels. Geology, relief and climate are the key determinants of running water through ecosystems and also about functioning at the basin scale. Morphometric descriptors represent the relatively simple approaches to describe the drainage basin processes and used to compare basin characteristics and enable an enhanced understanding the geological and geomorphic history of the drainage basin. Using Remote Sensing and GIS the information analysis is upgraded, morphometric analysis is analyzed by remote sensing because digital elevation models are generated according to the streams. The representation of remote sensing data in coexistence with enough real ground information which makes it to get possible and also to identify outline of various ground features such as geological structures, geomorphic features and their hydraulic characters. Watershed prioritization has also been conducted for various sub watersheds using parameters such as linear and shape aspects of the basin and slope contribution.

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