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Physical Characterization of a Watershed through Geographic information system

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Abstract- ***Remote sensing and geoprocessing play a crucial role in acquiring and preserving data pertaining to human activities in spatial domains across time. These techniques serve as the foundation for assessing land utilization, environmental disruptions, and regional advancements. An area of land that permits surface runoff to enter a specific drainage, stream, river, or channel at a certain location is called a watershed. The fundamental component of the water supply that changes throughout time is this. When it comes to drainage basins or a specific type of landform, morphometric analysis is a quantitative description and analysis of landforms used in geomorphology. The water resources management and planning process has found that the Geographic Information System (GIS) and Remote Sensing (RS) are effective tools for defining drainage patterns. For the purpose of identifying morphological features and examining their attributes within the watershed, the current study has utilized GIS and image processing techniques. Remote sensing and geoprocessing are fundamental methodologies utilized to acquire and preserve logs of human activities in space throughout history. These methodologies provide the foundation for identifying and diagnosing issues related to land use, environmental interference, and local development. The purpose of this article is to establish a foundation for a tool that facilitates the integrated environmental management of watersheds by identifying physical characteristics of the watershed, including land use and occupation, soil science, geology, climatology, and the extent and location of the watershed, among others. In order to facilitate the integrated environmental management of the watershed, its physical characteristics were determined through the use of climatological data from the watershed, field visits, a review of relevant literature and journals, and the application of geographic information systems (GIS) to obtain pedological and geological maps, as well as land use and occupation maps. GIS was integrated with the process of obtaining these data. It is imperative to perform an environmental assessment within this catchment in order to effectively manage the land and environment. Nevertheless, these evaluations fail to cover all watersheds, and even when they do occur, their frequency is inadequate to enable ongoing monitoring that would facilitate scenario modeling and prediction in order to formulate intermediate and long-term environmental protection measures.***

Key Word- GIS, Watershed characteristics, Watershed delineation, Watershed Characteristics.

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INTRODUCTION

The exponential increase in population and the rapid progression of lifestyle choices have significantly augmented the requirements for natural resources. The increasing demands are posing a significant threat to the resilience of the natural resource base. India, as a developing country, faces a deficiency in the existence of a proficient system for the constructed environment. (Verma, N.2022) The presence of inefficiency is evident in the misallocation of resources within the domain of resource management and the absence of adequate planning have led to the improper utilization of said resources. at a macroscopic level, the preservation, strategic organization, and administration of natural resources are of paramount importance. the availability of resources is of utmost importance.Watershed management involves the examination and analysis of pertinent characteristics. the concept of a watershed pertains to the sustainable allocation of its resources and the associated process. the development and execution of strategies, initiatives, and undertakings aimed at ensuring the long-term viability and improvement of a watershed. the functions that exert an impact on the plant, animal, and human communities encompassed within the confines of a watershed boundary. In order to promote the conservation of resources, it is imperative to consider both vertical and horizontal expansion of production. (singh S 2021)

Watershed-based development is a very successful strategy. An approach that is widely used to manage, evaluate, and simulate these significant natural resources is the study of water resources at

the watershed scale. A GIS platform has been used to conduct watershed studies shown that the secret to bettering watersheds is to use GIS's spatial analysis capabilities methods for modeling. With readily available digital resources and the analytical power of GIS elevation information, which can be utilized to both automate the process of watershed modeling and offer a visual portrayal of the watershed's response to the current situation and suggested enhancement situational. (Asfaw, D.,2019)

GEOGRAPHIC INFORMATION SYSTEM

Geographic Information System is referred to as GIS. A new multidisciplinary field is geographic information science. GIS is an amalgam of various fields such as mathematics, computer science, geography, and cartography.

"A system for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data which are spatially referenced to the earth" is the definition of a geographic information system (GIS). A crucial first step in the planning and management of a watershed is the characterization of the watershed. Determining the geographical limits of watersheds and sub-watersheds facilitates the collection and analysis of data needed for managing watersheds. Government-drawn watershed boundaries are frequently only available at the "macro level," which is completely unsuitable for "micro level" watershed management. (Pareta K. 2019) As a result, micro-watershed watershed delineation is a crucial task for the efficient planning and xecution of watershed management programs. Furthermore, knowledge of the watershed's topography aids in estimating runoff and sedimentation at the watershed's outlet. For instance, compared to flat terrain, a sub-watershed with steep slopes may add more sediment loads to the water body. To gain insight into the location and connectivity of stream networks, it is imperative to visualize them while characterizing a watershed. (Kulimushi, L. 2021)

CONCEPT AND DEFINITION OF WATERSHED

The term "watershed" has several definitions. It refers to a ridge line, or a line with two distinct slopes on either side, in British English. Another name for a ridge line in a terrain is the line that joins the highest points. Ridge lines are therefore also referred to as "watershed lines" or "surface water divides." A path-breaking event is referred to as a "watershed" in casual speech.

The term "watershed" is used interchangeably with "catchment" or "basin" in American English, referring to a location where rainwater or storm water is gathered from a ridge line. This water eventually travels through the different drainage channels, merging to form one or, very infrequently, multiple stream outfalls. Thus, an area contained within a watershed line is defined as a "watershed." Throughout this course, a small basin or catchment that serves as a hydrological unit and empties all of its precipitation into a stream is referred to as a "watershed." As a result, it has no control over its water in general or surface water specifically. (Charizopoulos, N 2019)

WATERSHED MANAGEMENT

A watershed is defined as a geographical region or area where all water sources discharge into a shared body of surface water. It is delineated by a divide along its periphery and ultimately empties into a designated watercourse or body of water. Water and land are the two primary vital and indispensable resources that serve as the foundation of all life and constitute critical resources. across the entire spectrum of economic activities, from agriculture to industry. Soil and water conservationists no longer possess exclusive jurisdiction over watershed management. (Bogale,A. 2021) It now requires researchers and social scientists to contribute equally.

THE PRIMARY OBJECTIVES OF WATERSHED MANAGEMENT INCLUDE

- To propose potential utilization of resources within the boundaries of acceptable thresholds.
- Preservation of Water and Soil.
- The land's increased capacity to hold the water.
- Sustaining sufficient vegetative covering to prevent soil erosion.
- Collecting rainwater and groundwater to replenish water supplies, Planning and managing watersheds are greatly aided by the mapping of watersheds, which provides information about the resources present in each particular watershed.Watershed approach is holistic, linking upstream and downstream areas.

Watershed management requires a three-tier management strategy focusing on:

- A micro-regional planning approach,
- The analysis and appraisal of the biophysical and socio-economic environs.
- Agro-ecological zoning.

The main reason why a micro-regional approach to planning is required is that the real conditions of watersheds differ based on local biophysical conditions, population pressure, and natural resource availability and circumstances. It attempts to reduce habitat and resident poverty by using a comprehensive approach that balances sustainable resource exploitation with conservation in a way that promotes peaceful coexistence. (Rai,P. K.2018) Land resources are an essential component of the area development program. Development programs are implemented based on the micro-watershed level, taking into account the watershed's shape and regulating the soil, water, and land productivity for successful application of forestry, agriculture, and other micro-level development in every hectare of the village, which turns into the most versatile unit by

watersheding the micro-watershed. Regarding regional, the most feasible units for planning and management are villages and micro watersheds. (Mahala, A. (2020).

The management of natural and human resources will require maps of land use/cover, drainage, soil, and more, which can be generated using satellite data and GIS technology. Since 1974, the notion of land and water resource development according to watersheds has been recognized as significant in India.

India is presently one of the world's leading providers of earth observation data. a range of temporal, spectral, and spatial resolutions to accommodate numerous applications pertaining to matters of national development significance. The watershed approach is being implemented more frequently in numerous development initiatives to oversee the management of land and water resources such as soil and the conservation of water. Our nations come first A Watershed Atlas is a deliverable of the undertaking. (Bharath, A.2021))

“Generation of Database and Implementation of Web enabled Water Resources Information System in the Country" abbreviated India-WRIS, was implemented in collaboration with the Central Water Commission (CWC) and National Remote Sensing Centre (NRSC) Indian Space Research organization (ISRO).

Table1: Physical Characteristics of Watershed Management

S. No.	Physical Characteristics	Parameters	Applicability
1.	Size	Area	Available rainfall Runoff, sedimentation
2.	Shape	Geometric form, shape index, form factor	Run-off & sedimentation
3.	Physiography & slope	Mean elevation, av. Slope, relief length	Run-off & sedimentation, Drainage
4.	Drainage	Drainage pattern & density, stream order	Run-off & sedimentation
5.	Geology	Rock types	land degradation, production potential, Run-off & sedimentation
6.	Land use	Present LU, wasteland, surface water	Run-off & sedimentation
7.	Groundwater	Potential	Recharge & irrigation

PHYSICAL CHARACTERIZATION OF WATERSHED

The main natural and human characteristics of a watershed are outlined in the Watershed Characterization. To do this, a background information about a watershed can be compiled that includes both natural features, like topography, soils, and hydrology, as well as human features, like population, land use, and water uses/systems.

The Components of watershed Characterization are following

1. Drainage and its order
2. Watershed boundary
3. Area,
4. Perimeter
5. Area under various drainage order
6. Length of the stream, etc.
7. Morphometric Analysis
8. Laws of drainage
9. Calculation of various watershed character

Hydrologic Reserve Producing environmental indicators that can be paired with auxiliary data and social indicators is greatly aided by physical characterization. An overview viewpoint, Natural resource monitoring in both space and time can be accomplished quickly and objectively with the help of multi-resolution, multi-spectral, repetitive mapping. (Nookaratnam, K2020)

WATERSHED PHYSICAL CHARACTERIZATION AND ASSESSMENT THROUGH GIS

Whether using GIS technology or not, remote sensing has become a crucial scientific instrument for resource planning and mapping. It is becoming more and more important in the fields of hydrology and the development of sustainable water resources and oversight. GIS-based methods and remote sensing have been widely useful in almost all watershed-related domains, such as evapotranspiration estimation. modeling of rainfall runoff, soil erosion water and irrigation management, flood control. (Charizopoulos, N. 2019) GIS is frequently utilized in physical characterization and assessment research that call for a watershed-based methodology.

Fundamental physical features of a watershed, like the drainage. It is possible to derive network and flow paths from easily accessible Digital Elevation Models (DEMs) and the National Hydrography Dataset (NHD) initiative of the USGS. This combined with utilizing data from sources like the asEPA's water quality monitoring program and precipitation. The USGS and BASINS database facilitate the creation of a watershed action plan and determining

the watershed's current and possible pollution issues. Information obtained within a GIS, from environmental remote sensing systems and GPS surveys for the effective characterization and evaluation of the conditions and functions of watersheds. (Benzougagh, B. 2022)

Data gathered from evaluation and characterization studies, mostly in the form of Maps and charts can be paired with additional data sets to enhance comprehension of the intricate connections between human and natural systems in relation to resources and land usage inside of watersheds. GIS gives watersheds a standard framework for spatial location. management information gathered from multiple sources. Since watershed information and watershed GIS can be an effective tool for comprehending the spatial dimensions of biophysical processes. these procedures as well as for controlling any possible effects of human activity. Both the modeling and the modern GIS's visualization capabilities and the Internet's rapid expansion and the World Wide Web, provide radically new instruments to comprehend the procedures and dynamics that mold watersheds' biological, chemical, and physical environments. (Najia, F. 2021)

The integration of environmental databases, the Internet, and GIS is particularly useful in organizing research projects where timely feedback and information sharing are essential particularly when a number of agencies and stakeholders are involved. GIS offers a way to look into issues by enabling the modeling of different phenomena and functional in looking at the reasons and effects in a context that is specific to a given place, so we can examine intricate, interconnected problems at all levels, local to global. These systems are all helpful in addressing the evaluation, but their applicability can differ based on the component of progression but combining these spatial technologies with other analytical methods are frequently preferred to generate better data, so improving our comprehension for improved natural resource management. (Bogale, A.2021)

CONCLUSION

Discussions of the various geomorphometric parameters, as well as the tools and techniques used to characterize these parameters and water quality, make up the physical characterization of watersheds. Every morphometric parameter that can be computed for the physical characterization of watersheds is compiled in a table. The computation and interpretation of the form factor, relief ratio, density, drainage, and length of overland flow are discussed in detail. The hydrologic processes and water balance are covered before moving on to the topic of watershed instrumentation. Next, a list and description of the various instruments used to calculate water yield are provided. Descriptions of the biological, chemical, and physical components are then used to determine the quality of the water. (Pandey A. 2020) Exercises and sample calculations are given for both subjects. Planning authorities can better identify the aftereffects of an urban development by using geographic information system (GIS) tools to update the delineated watershed boundaries, which are used in the drainage delineation process. The runoff coefficient and average rainfall are combined to get the average surface runoff.

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