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Full Length Research Article

Water resource management for the sustainable development of Cauvery watersheds in Salem District, Tamil Nadu, India using spatial Technology

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Abstract

The present study area (Cauvery river basin) lies between. 77^{o} 43' 54'' E to 79^{o} 35' 55'' E longititude and Latitude 10^{o} 10' 0'' N to 11^{o} 10' 6'' N. The basin area is demarcated from the survey of Indian topographical map No.58 I/2 (1:50,000,1972), and cover and area about 3397 s.qkm. Morphometric analysis and their relative parameters have been quantitatively carried out for the auvery basin, Salem district, Tamilnadu, India. Triangulated Irregular Network (TIN) model used for the identification landscape to determine the objectives such as to establish the dam or related to water resource studies are useful and effective method. Scattered hydrological models clearly suggest (reveal) the spatial variability of the physical properties of basins and it allows spatial assessment of modeled hydrological variables. TIN model for net work analysis of the stream, Hot spot analysis, existing and proposed dams were identified in this study.

Key words: Cauvery river, Remote sensing, Triangulated Irregular Network (TIN), Water shed and Hot spot.

INTRODUCTION

Water is one of the most important renewable natural resources. By the term "exploitation of a region's water resources" we refer to the activities that aim in rational exploitation of these resources within the quantity limits of the annual fluctuation of water resources and in combination with works and activities with the lowest cost possible, not only financially but also environmentally. Braga and Lotufo [1] evaluated their plan actually as an initial landmark: seeking basin sustainable development is principally seen as a process of activation and channelling of the social forces, an exercise of initiative and creativity, and an improvement of the cooperation and interaction skills of the different players who live in the basin. Water is valuable natural resources that essential to human survive and the ecosystems health [4]. Water are comprises of coastal water bodies and fresh water bodies (lakes, river and groundwater). Since the past few decades, the increasing of drought activities in some parts of Salem district has effects to ground water level. This is the global issues which happening throughout the world on below average of rainfall. Recent approaches for sustainable water management at the basin scale are using the framework of an integrated water resources management (IWRM) by combining surface, groundwater, and unsaturated flow modeling as tools for the decision making, the development of decision support systems, e.g., to improve planning and management in large irrigation schemes, the involvement of multiple decision tools to find conflict resolutions, or the integration of multi-discipline aspects into a web-enabled spatial Decision Support System (DSS). The researchers focused on the analysis of irrigation and environmental quality impact at the basin level, and adopted multi scale modeling tools for solving conflicts in rural basins with irrigation water uses. Therefore sustainable water resources management for irrigation is not only an objective on the farm level but also an overall goal at the district level, which means in general at the basin scale. Possible outliers or "hot spots" (clusters of high or low water-use values) that may relate to variations in aquifer yield, stream flow availability, soil type, crop patterns, rainfall and topography, requiring further identification and study [7] with use of GIS. The GIS applications for hydrological analyses in accordance with the principles of sustainable development, will contribute to the development of infrastructural objects of water resources. In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency a complete action plan for the development of land and water resources has been suggested. In conclusion remote sensing and GIS technologies coupled with computer modelling are useful tools in providing a solution for future water resources planning and management to government especially in formulating policy related to water quality.

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Hence the present study is focused on Triangulated Irregular Network (TIN) model for water resource management for the sustainable development of Cauvery watersheds in Salem district, Tamilnadu, India using spatial technology.

Objectives of the study

1)To reveal the hydrological models of physical characteristics of the basin and allow the positional assessment of hydrological variables. Determination of sub-basin borders by Triangulated Irregular Network Model (TIN).
2) To prepare Hot spot analysis from spatial cluster.
3)Mapping the existing Tanks and proposed Dams.

Study Area

Salem is an interior district of Tamil Nadu in India with an area of 8634.23 Km2 (Fig.1) and is bounded by Dharmapuri district on the North, Coimbatore on the West, South Arcot on the northeast and Tiruchirapalli on the South and South-West. The district lying between latitudes N 11°00' and 12°00 and longitudes E 77°40' and 78°50'. The major source for groundwater in the study area is rainfall during monsoonal season. The average 10 years annual rainfall is about 759.03 mm. Salem district is underlain entirely by Archaean Crystalline formations with Recent alluvial and Colluvial deposits of limited areal extents along the courses of major rivers and foothills respectively. Weathered and fractured crystalline rocks and the Recent Colluvial deposits constitute the important aquifer systems in the district. Colluvial deposits represent the porous formations in the district. These deposits comprise boulders, cobbles, gravels, sands and silts and are seen in the foothills of all the major hill ranges. The thickness of these aquifers ranges from a few meters to as much as 25 m. Ground water occurs under phreatic conditions and is developed by means of dug wells. They are important from ground water development point of view in the hilly terrain. The soils of Salem District can be assorted into the main types viz., Red Calcareous, Red non-calcareous, brown soil calcareous, Red collurial careareous, Red collurial non calcreous, Black soils, Alluvial calcareous, Brown soil non calcareous. The District has a hot tropical climate with temperature ranging from 18.9° C (Minimum) to 37.9° C (Maximum) and the relative humidity is high at 79% with an average ranging from 80% to 90%. Yercaud situated 1,515 metres high in the Shevaroy Hills, in salem district, Tamil Nadu, Yercaud is quiet little hill station on the Eastern Ghats is the only one of its kind in northern Tamil Nadu. While the rest of this region is generally dry, Yercaud presents a welcome contrast with its cool climate where temperature never rises above 30^0c. Granite Gneiss, Charnockite, Granites and other associates represent the hard consolidated crystalline rocks. Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fractured zones. These rocks are devoid of primary porosity but are rendered porous and permeable with the development of secondary openings by fracturing and their interconnection. The thickness of weathered zone in the district ranges from <1m to more than 25 m. The depth of the dug wells tapping weathered residuum ranged from 10 to 38 m bgl

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METHODOLOGY

SRTM-WRS-2 Tiles image having, path 143 and row 52, GLCF acquired in 2000 (Fig.2). georeferenced to UTM map projection (Zone 43, North) and WGS84 ellipsoid, was used for the image analysis. Dispersed hydrological models clearly reveal positional changeability of physical characteristics of basins and allow positional assessment of hydrological variables. TIN model was prepared using ERDAS imagine 9.1 has been used to identify the basin, flow direction stream order and water shed. Then prepared Hot spot from spatial cluster. Finally existing and proposed tanks are located in the map.

Analysis

(i) TIN model

The TIN model represents a surface as a set of contiguous, non-overlapping triangles. Within each triangle the surface is represented by a plane. The triangles are made from a set of points called mass points. Mass points can occur at any location, the more carefully selected, the more accurate the model of the surface. Well-placed mass points occur where there is a major change in the shape of the surface, for example, at the peak of a mountain, the floor of a valley, or at the edge (top and bottom) of cliffs. The TIN model is attractive because of its simplicity and economy and is a significant alternative to the regular raster of the GRID model. Polygon features are integrated into the triangulation as closed sequences of three or more triangle edges. Including break lines and polygons in a TIN gives you more control over the shape of the TIN surface. To get a sense of the difference that break lines can make in a TIN, compare the surface created from mass points alone to the surface created from mass points and break lines. The graphic on the left shows a TIN created from mass points; the graphic on the below shows a TIN of the study area created from mass points and break lines.

The TIN-based model has a vector-based data structure, but it can be converted into grid cells. In the TIN model, each point has defined x, y, and z coordinates. The coordinate z represents the height. These points are connected by their edges to form a network of overlapping triangles (finite surfaces) that represent the terrain surface [6]. The basis of TIN-based DTM is that a large series of these finite surfaces, sharing common horizontal edges, can be linked together and used to interpolate the XYZ coordinate of any point, even though actual measurements have not been obtained at that point (Fig.3).This good visual impact clearly expresses that the elevation ranges from 200 mts to 1444 mts with rugged to pography. Flow direction also easily identified that North-east to South –west direction.

(ii) Hot spot analysis

The output from the Hot Spot Analysis tool is a Z score and p-value for each feature. These values represent the statistical significance of the spatial clustering of values, given the conceptualization of spatial relationships and the scale of analysis (distance parameter). A high Z score and small p-value (probability) for a feature indicates a spatial clustering of high values. A low negative Z score and small p-value indicates a spatial clustering of low values. The higher (or lower) the Z score, the more intense the clustering. A - Z score near zero indicates no apparent spatial clustering. As mentioned above, the object of Hotspot Analysis is to identify priority areas. There are two types of areas to be considered, environmental hotspots and sensitive areas. According to the *Guidelines and Template for Hotspot Analysis*, an environmental Hot spot is a geographically defined area, which may include the receiving coastal areas and other areas of the sea (IWRM recognizes ridge to reef linkages and management approaches), of national, regional, or global significance, where conditions are such as to adversely affect health, threaten ecosystem functioning, reduce biodiversity and/or compromise resources and amenities of economic importance in a manner that would appear to warrant priority management attention.

A sensitive area, on the other hand, is characterized as a geographically defined area, of national, regional, or global significance, which, although not degraded at present, is threatened with future degradation either because of sensitivity of the receptor or the magnitude of the anthropogenic activity posing the threat[5]. Hotspot mapping is used to help identify where soil pollution exists and comes from. Recently, Kernel density estimation (KDE) is one of the methods for analyzing the first order properties of a point event distribution [8] in part because it is easy to understand and implement. KDE has been widely used for hotspot analysis and detection. The output from the Hot Spot Analysis tool is a Z score and p-value for each feature. These values represent the statistical significance of the spatial clustering of values, given the conceptualization of spatial relationships and the scale of analysis (distance parameter). A high Z score and small p-value (probability) for a feature indicates a spatial clustering of high values. A low negative Z score and small p-value indicates a spatial clustering of low values. The higher (or lower) the Z score, the more intense the clustering. A - Z score near zero indicates no apparent spatial clustering [2], (Fig.4).

(iii) Proposed Dam

Changes in land cover, water use and management of the land have occurred throughout history in Mediterranean regions and other parts of the world. Land use and climate changes have a potential effect on hydrological cycles, on flow damages, groundwater consequences or impacts of such changes on risk or resource reliability depend not only on biophysical changes in landscapes, water recharge and water quality but also on the characteristics of the water management system. Based on the study of Hot spot analysis the researcher is suggested or proposed Dam is marked. This identification is based on agriculture, population density, water scarcity and based on slope of the research area. The proposed dams surrounded by the populated areas are (1-Green coloured) Vel-mattupaliyam, Manickampalayam, Ammapattai and Anthiyur and the geographical location is 77°43’55” E to 11° 30’N. (2 –Red coloured) is 77°51’ E to 11.34’N which is surrounded by Iddapadi, Poolampatti ,Morasampatti, Tanner Thasanur and Arasiramani. The distance between existing dams are 42 kms and 36 kms respectively. The distance between these proposed (suggested) two Dams/Reservoir is 15 kms(Fig.5).

Conclusion

The Triangulated Irregular Network (TIN) model of study area was developed with this study. The region's water flow directions were determined from defined this model and drainage map according to these directions were made. Hot spot analysis and proposed Dam were marked and identified based on agriculture, population density, water scarcity and based on slope of the research area. Based on the study of Hot spot analysis the proposed Dam could be marked. This identification is based on agriculture, population density, water scarcity and based on slope of the research area. The proposed dams surrounded by the populated areas are (1-Greencoloured) Vel-mattupaliyam, Manickampalayam, Ammapattai and Anthiyur and the geographical location is 77°43’55” E to 11° 30’N. (2 –Red coloured) is 77°51’ E to 11.34’N which is surrounded by Iddapadi, Poolampatti ,Morasampatti, Tanner Thasanur and Arasiramani. The distance between existing dams are 42 kms and 36 kms respectively. The distance between these proposed (suggested) two Dams/Reservoir is 15 kms which may be assumed to be a ideal to survive in the existing and development of agriculture too for the steaming population and urbanization Usually the plan and actions are not in the same intensity by the authorities of implementing due to various reasons if at least they could certain extend really its useful. The Same case García [3] examined in his paper for the implementation of IWRM in Latin America. Most of these efforts have been focused at the constitutional level and even if they are strong in concepts, few actions meaningful for the end-user have resulted so far. There is a tendency to be heavy on diagnostics but weak in solutions and a gap still exists between papers and actions. This framework and study area forms a basis for both further studies and for other researchers too.

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