International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 04 | Apr 2023 www.irjet.net p-ISSN: 2395-0072

Integrated Water Resources Development And Management Of Suvarnamukhi Watershed In Tumkur District, Karnataka Using GIS And Remote Sensing

Mr. S.B. Gavhane[1], Prof. Mrs. Ghadge C.A. [2] , Prof. D.C. Poul [3], Prof. S.C.Wadne [4]

[1] Student Shri Tuljabhavani Engineering College, Tuljapur. Tuljapur,Osmanabad, Mahrashtra, India
[2,3,4] Professor Shri Tuljabhavani Engineering College, Tuljapur,Osmanabad, Mahrashtra, India

---

Abstract - *Water is a crucial natural resource and its availability is being threatened due to factors such as population growth, urbanization, industrialization, and deforestation. To develop and implement water resource projects effectively, it is important to have an accurate assessment of the quantity and quality of water resources at a watershed level. This can be achieved through the use of advanced technologies like Geographic Information System (GIS) and Remote Sensing (RS).*

In this context, a detailed study has been undertaken to assess the water resources of the Suvarnamukhi watershed in Tumkur district, Karnataka state. The area falls under a semi-arid climate zone and has no perennial streams. The region primarily relies on groundwater for drinking and irrigation purposes, and the failure or delay of monsoons has led to a significant depletion of dug wells and bore wells in many villages. Additionally, there is a lack of data on the availability of natural resources, demography, and infrastructure, which has hindered developmental activities in the region.

To address these challenges, an integrated hydrological study is necessary at the watershed level, using advanced scientific tools like GIS and RS.

Key Words: *Geographic Information System (GIS) and Remote Sensing (RS), Water Resources Development, watershed level etc.*

1.INTRODUCTION

Water is a crucial renewable natural resource, but its availability with good quality and quantity in the right location and time is crucial. Despite being widely available, only a small amount of water is useful for human needs, which highlights the importance of an accurate assessment of water resources at a watershed level. This requires studying and analyzing hydrological processes in the watershed over a long period, using advanced scientific technologies to develop accurate models. Geographic Information System (GIS) and Remote Sensing (RS) are powerful tools that can play a vital role in inventorying and analyzing various natural resources for decision-making on water resources development and management.

RS is particularly useful for deriving information about objects on the earth's surface without physical contact, and its high resolution and temporal data make it an essential tool for sustainable development of natural resources, including water resources. The Soil and Water Assessment Tool (SWAT) is a model used to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large, complex watersheds. The SWAT model uses hydrological parameters such as daily rainfall, temperature, solar radiation, wind speed, humidity, land use, soil characteristics, drainage network, and topography to simulate evapotranspiration, runoff, stream flow, sedimentation, and more at a watershed scale.

Therefore, a detailed study using advanced scientific tools like GIS, RS, and the SWAT model has been conducted to assess the status of water resources in the Suvarnamukhi watershed in Tumkur district, Karnataka state. The study provides an effective use of GIS and RS for analyzing the quantity and quality of both surface and groundwater at the watershed level, which can help optimize water resources development and management.

1.2 DEFINITION AND TERMINOLOGY

- **Geographic Information System (GIS)** is a tool for capturing, storing, manipulating, querying, analyzing and displaying data, which are spatially referenced to the earth87. GIS can play an important role in inventory and data base handling of various natural resources to carryout spatial analysis and overlay analysis of wide range of applications. GIS has the capability to integrate, superimpose, spatial query and analyse the various themes of the watershed for decision making on water resources development and management.

- **Remote Sensing (RS)** is the technology of deriving information about objects on the surface of the earth without physically coming in contact with them62. RS with its high platform sensing, synoptic view and spatial multi spectral characteristics has wide ranges of applications. It has become an integral part of Information Technology and provides solution to facilitate sustainable development of the natural resources in general and

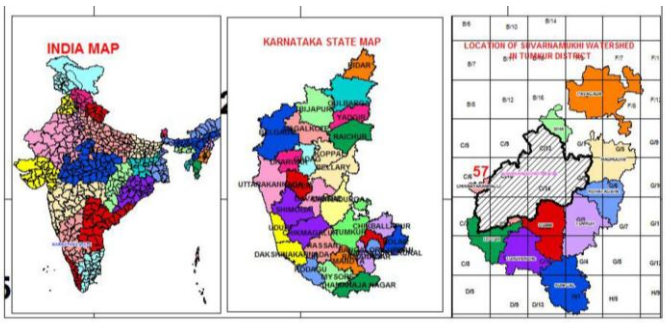
water resources in particular at varying scales by providing high resolution temporal data.

- **Soil and Water Assessment Tool (SWAT)** is a river basin or watershed scale model developed by the USDA Agricultural Research Service. SWAT was developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time. The SWAT model is being used to assess and simulate the Evapo-transpiration, PET, Run-off, Stream flow, Sedimentation etc, by using hydrological parameters such as daily rainfall, temperature, solar radiation, wind speed, humidity, land use, soil characteristics, drainage network, topography etc, at watershed scale88.

2. Suvarnamukhi Watershed:

Suvarnamukhi Watershed is spread across partly 7 taluks covering 733 revenue villages in Tumkur district. Out of total geographical area, 65% comes under Chikkanayakanahalli and Sira and remaining 35% of area comes under five taluks namely Tumkur, Tiptur, Gubbi, Madhugiri and Koratagere taluks.

The villages of the Watershed comes under 102 Grampanchayaths and 4 Town Panchayaths for administrative purpose as shown in figure 3.2. Out of 733 villages, C.N.Halli taluk has 213 villages, Sira taluk has 210 villages, Madhugiri taluk has 97 villages, Gubbi taluk has 91 villages, Tiptur has 68 villages , Tumkur taluk has 35 villages and Koratagere has 22 villages. The Watershed has 22 hoblies which are having Nada Kacheries for revenue administration purposes. The watershed comes under two partially covered Parliamentary Constituencies such as Tumkur PC and Chitrdurga PC and has 7 partially covered Legislative Assembly Constituencies.



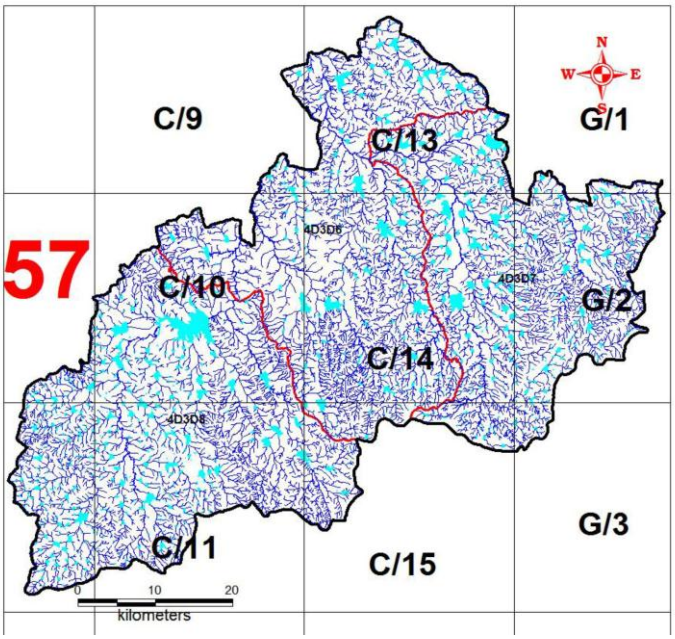


Fig 1. Geographical Location of Suvarnamukhi Watershed with SOI Toposheet Grids in Tumkur District, Karnataka State, India(Source: NRDMS/SOI)

3. LITERATURE REVIEW

A general overview of previous research work on Integrated Water Resources Development And Management.

1. **Zhou et al (2008),** undertook a study on surface water resources in Chaobaihe basin of Beijing using the micro satellite data to collect on surface water distributions both in the rainy and non-rainy seasons. It was observed that, the annual change of surface water area of the basin shows a decreasing trend from 1997 to 2007. The study concluded that satellite imageries can be successfully used in the assessment of surface water at micro level.

2. **Gauhar Mahmood and Shasikanth Chaudary (2004),** made an attempt to elaborate water crisis on domestic as well as commercial water demands of Lake Wood city, Haryana. It includes the importance of water balance method to obtain water development and water management which will augment the groundwater by artificial recharge through rain water.

3. **Jala Samavardhana Yojana Sangha (2004),** conducted rainfall-runoff simulation studies for the various tanks some districts of Karnataka using SCSCN method. The study concluded that, GIS and RS techniques have played important role in assessing the status of water bodies for improving the conditions of various tanks.

4. **Srishail Dolli (2006),** carried out a study on sustainability of natural resource management in watershed development in two taluks of Chitradurga district. The investigation was based on the information collected from six villages and 240 farmers. Hence, the generalization of findings has been made based on the sample study carried out during study.

5. **Keshab Das(2005)** , carried out the study on Harvesting for domestic use; Potential and Relevance of village tanks at desert region . The findings suggest that village ponds remain important sources of domestic water and these can be substantive use, especially during summer and suggests that community management is a useful strategy to protect and improvise the systems by community participation.

6. **Madhavi Ganesan(2007)**, studied the status of Madrass, India; Rehabitation of Ancient Technique for multipurpose water study an attempt has been made to evaluate appropriate strategies to conserve the rainwater in the existing urban temple tanks. The study found the reason for the dryness of urban tanks. It also revealed the methods to rehabilitate and re-establish the hydrological role of the tanks.

7. **GOI(1994),** developed a manual of national use/land cover mapping using satellite imageries. The object of this manual is to familiarize the users with the classification, definition, methodology and interpretation techniques, steps involved for identification and mapping land use/ land cover categories. These techniques have been incorporated in the present research work.

8. **Minor et al (1994),** attempted to present a unique methodology for groundwater exploration using RS and GIS, particularly in developing countries like Ghana. The study concludes that, interpretation strategies that integrate various data types are useful to characterize groundwater resources for locating a well point.

9. **Asadi et al (2007)**, evaluated the quality of groundwater in Municipal corporation of Hyderabad, by conducting physico-chemical analysis for twenty five groundwater samples. Water quality Index (WQI) was calculated.

10. **Shankar (2007),** evaluated the water quality indices for groundwater of Whitefield industrial area in Bangalore which was determined by collecting 35 samples in and around the industrial area. Water quality index was calculated based on 10 parameters. The WQI ranged from 11.58 to 495.07 with an average of 69.95. The analysis revealed that the groundwater samples in general can be considered to be fit for human consumption.

3.2 Objectives of the study:-

Keeping detailed quantitative and qualitative study of the water resources at watershed level in view, the study has been taken with the following objectives.

- Assessment of the detailed hydrological status of selected Surface Water Bodies and Traditional Water Harvesting systems along with water quality.
- Assessment of Ground Water Recharge, Discharge, Storage, Water balance, Water demand and Mapping the depth to ground water level and seasonal ground water table fluctuation.
- Ground water quality analysis for drinking and irrigation purposes.
- To suggest the various measures for conservation of water and soil for sustainable development and management of water resources.

3.3 Methodology For Integrated Water Resources Development And Management:

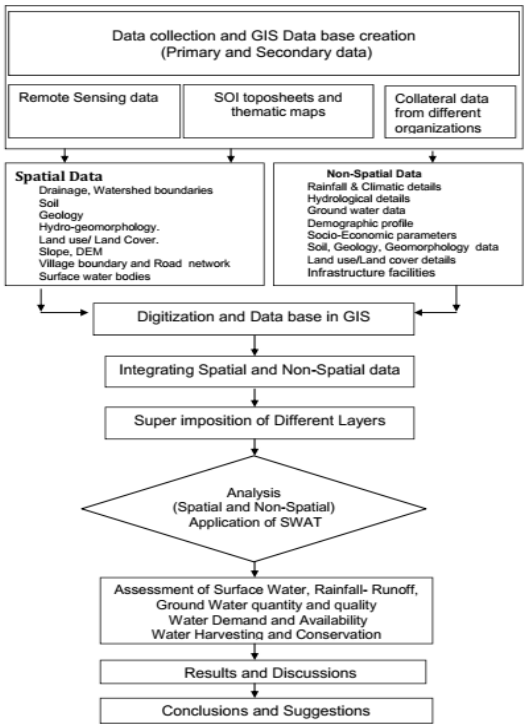


Fig 2 : The Flow Chart Showing the Methodology of the Study

- **Scanning**

A scanner is a hardware used for converting an analogue source document into digital raster format. Scanning is a method of automatic digitizing. Scanning has been carried out in the study to convert some analogue maps into digital mode and used for further analysis in GIS environment.

- **Digitization**

Digitization is the process of converting features on a paper map into the digital format. When digitization is started, the X and Y coordinates of the feature are automatically recorded and stored in a spatial data. The features of interest on a geo-referenced toposheets and other maps are digitized as different layers in the study.

- **Geo-registration**

It is important that all spatial data in GIS analysis should be located with respect to a common frame of reference which is known as geo-referencing or geo-registration. As the toposheet is being used as the base map, it needs to be geo-registered before carrying out any further analysis. Geo-registration has been carried out for all the features extracted from toposheets in GIS environment using Mapinfo and Arc GIS software in the study. This georegistered image of the toposheet is further used as the base map for digitization and geo-registration of satellite imageries.

- **Topology Building**

In GIS, topology is the term used to describe the geometric characteristics of objects. The topological characteristics of an object are also independent of scale of measurement. Topology, as it relates to spatial data, consists of three elements: adjacency, containment and connectivity. Topology has been built to all various thematic layers created in the study under GIS environment.

4.1 Experimental set-up

Plate 1: Suvarnamukhi River as seen During Pre-monsoon Season

Plate 2 : Suvarnamukhi River as seen During Post-monsoon Season

5. Expected Outcome:-

Suvarnamukhi watershed is elongated in the east-west direction. The maximum length of Suvarnamukhi watershed is 72.5 km along North-South and the maximum width is 77.5 km along E-W. The linear aspects have been evaluated using GIS as described below.

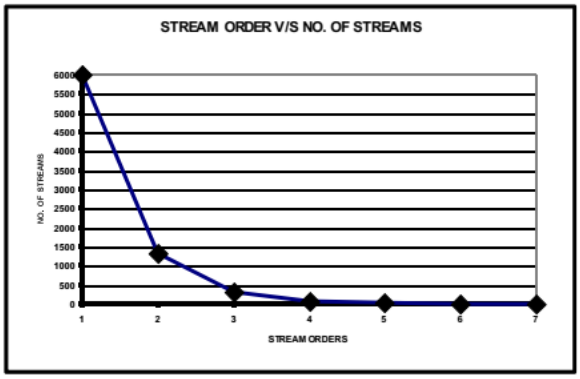
(a) Stream Order(U)

Designation of the stream order is important to index the size and scale of the basin and it forms an approximate index of the amount of stream flow. The main stream Suvarnamukhi is found to be at 7th order stream as per Strahler's (1957) method of stream ordering as shown in figure 6.3.

(b) Stream Length(Lu)

After classifying the streams of the drainage network into orders, each segments order U are computed(Strahler,1957) as shown in table 6.1. streams of each of the different orders tends closely to approximate a direct geometric pattern. Hence, a plot of stream length on ordinate & the function of order on abscissa should yield a set of points lying essentially along a straight line as shown in figure 6.1.

Table 2.1: Stream Length and Number of Streams



From the table 6.1, it is clear that the length of streams varied with reference to the stream orders as suggested by Horton(1945).

Sr. No.	No. of streams of each order Nu	Total length of each order in km lu	Mean length in km Lu= lu / Nu	Total length of all streams in km Lu
1	5989	3314	0.55	**5867**
2	1334	1244	0.93	
3	328	652	14.18	
4	72	326	4.53	
5	26	188	7.24	
6	4	103	25.75	
7	1	40	40	

Fig. : Stream Order v/s Number of Streams of Each Order

a) Length Ratio(RL)

RL is defined as the ratio of mean length of an order to that of the lower order(Horton,1945) which is calculated and shown in table 6.3.

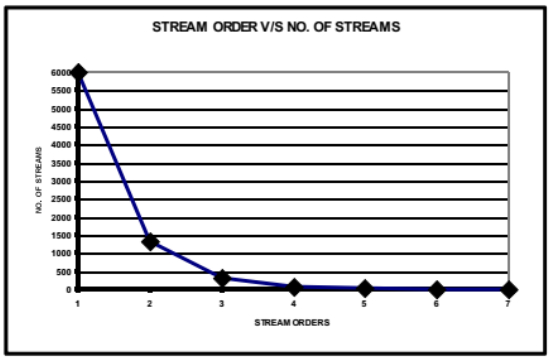


Table 6.3: Length Ratio of the Watershed

Stream order (U)

Stream order (U)	Mean length of streams (Lu)	Length ratio of streams (RL)
1	0.55	0.93
2	0.93	0.06
3	14.18	3.13
4	4.53	0.63
5	7.24	0.28
6	25.75	0.64
7	40	0

Stream numbers and lengths supports the theory i.e., geometrical similarity is preserved in the basin of increasing order as depicted in figure 6.2.

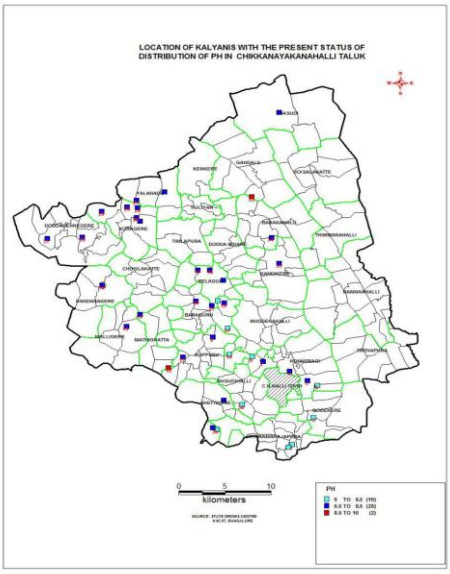


Fig 3. Variation of pH of Kalyanis in C.N.halli Taluk

CONCLUSION

Finally it may be concluded that, this study would be a gateway for further exploration of Surface and Groundwater in the watershed t meet the requirements of the area. The overall hydrological studies carried out in the present study is not only hoped to serve as a first hand information on Suvarnamukhi watershed using GIS and Remote sensing techniques, but also for further detailed research and planning for effective management and development of water resources.

REFERENCES

1. Abhijit M.Zende et al (2012): Prioritization of sub-watersheds in semi arid region, Wester Maharashtra, India using GIS, American Journal of Engineering Research (AJER), Volume-02, Issue-10, pp-128-135.

2. All India Soil and Land Use Survey (AISLUS)(1984): Ministry of Agriculture, Govt. of India, Watershed Atlas of India.

3. Allison Marie Valerio(2008): The study on Modelling Ground water and Surface water interactions in an operational setting by linking River ware with Modflow, a thesis submitted to the University of Colorado.

4. Amaranarayana,K.(2008): Ancient water harvesting system and its relevance today increasing Ground water A success story of Chitradurga city a paper presented during Rainwater harvesting workshop at NIAS, Bangalore.

5. Ameresh Krisingh and Raviprakash (2006): The study on suitable location for Groundwater exploration in hard rock areas, an integrated approach of Remote sensing and GIS, IJCE, Vol-84.

6. Amarinder Singh (2009): Application of SWAT Model to assess the runoff and sediment yield in a watershed of Himalayan region, a thesis submitted to Manipur University.

7. Anand Vadivelu.G.(2007): The impact of watershed development in rainfed areas using GIS and Remote sensing in Karnataka and Andhra Pradesh, a thesis submitted to Andhra University.

8. Anderson (1977): Investigation on the use of sat SAR imagery for mapping land use in arid environment of Denver, Colorado, USA, a thesis submitted to University of Colorado.

9. Anji Reddy (2001): Evaluation of impacts of Neeru-Meeru (Water and You) development programme, a report submitted to the Government of Andhra Pradesh.

10. Anuragh Mohan and Kirti Pandey(2005): The study on Groundwater quality in the industrial area of Bareilly in Uttar Pradesh a thesisi submitted to IIT, Khanpur.

11. Asadi et al (2007): Evaluation of the quality of Groundwater in Municipal corporation of Hyderabad a thesis submitted to University of Hyderabad.

12. Ashish Pandey (2003): Estimation of runoff for agricultural watershed using SCS curve number and GIS, Map India 2003

13. Basavaraddi.S.B. et al(2012): The study on Seasonal Variation of Ground Water Quality and its Suitability for Drinking in and around Tiptur Town, Tumkur District, Karnataka, India a thesis submitted to Tumkur University.

14. Baweja.B.K and Karanth.K.R(1980): Ground water recharge estimates in India, a Report by CGWB, Ministry of Water resources, GOI.

15. Bhuddhi et al (2004): The groundwater quality of the Pithampur area, International Journal on water resources.

16. Brown and Holf (1976): The use of Thermal infrared imagery to demonstrate the usefulness of the data for mapping different Land use/Land cover in an area covering a reservoir in great Lake Texas, International Journal on Earth sciences.

17. Carlston et.al(1967): Drainage characteristics of watersheds in hardrock area, American soc of hydrology, vol-24

19. Central Ground Water Board(1997): Ground Water Information Booklet, Tumkur District, a Report by CGWB, Ministry of Water resources, GOI

20. Central Ground Water Board(2008): Ground Water Information Booklet, Tumkur District, a Report by CGWB, Ministry of Water resources, GOI

21. Central Ground Water Board(2012): Karnataka, a Report by CGWB, Ministry of Water resources, GOI

22. Chandrasekhar.K.N(1988): Hydro-geological appraisal of Suvarnamukhi river basin .

23.Chandrmohan.T.and Durbude.D.G.(2001): Estimation of runoff using small watershed models, Hydrology Journal. 24 (2):45-53.

24.Collins and Ei-beik (1971): Utility of aerial photographs for Land use/Land cover categories on Commercial, Industrial or Residential for the city of Leeds, U.K., International Journal on Earth science.