Estimation of Groundwater Potential Zonation Map of Birahalla watershed, Thirthahalli Taluk of Shimoga District Using RS and GIS.

[1]Vasanth Patil S.B, [2]Venkataiah C, [3]Chandrakala

[1]Research Scholar, [2]Professor, [3]Student
Department of Applied Geology,
Vijayanagara Srikrishnadevaraya University, Sandur, India

Abstract : The water was occurring below the saturated zone in the subsurface (beneath the ground) is generally defined as groundwater. Groundwater is a vital natural resource that contributes to human health, economic development, and ecological diversity. Rapid industrialization, urbanization, and increased agricultural production have contributed to global freshwater scarcity. Remote sensing and geographic information system (GIS) techniques allow for quick and cost-effective natural resource surveys and management. Remote sensing data aids in the fairly accurate hydro geomorphological analysis as well as the identification and delineation of land features. Additionally, remotely sensed data is an important tool in groundwater prospecting. The present research study is on the Birahalla watershed in Thirthahalli Taluk of Shimoga district of Karnataka state. The study area's base map is created using SOI Toposheets and LISS III satellite images. Various thematic maps, such as slope maps and drainage network maps, were created using ArcGIS 10.1 software. Land use/land cover maps, geomorphology maps, soil maps, lithology maps, and other maps were created. The weighted overlay analysis method is used to integrate and prepare these thematic maps for the groundwater potential zonation map of the area. They are classified as very high, high, moderate, low, and very low. The groundwater potential zonation map provides local authorities, planners, and citizens with firsthand information about the location of wells/tube wells.

Keywords : Birahalla, Groundwater Potential Zone, RS, GIS.

I. INTRODUCTION

Groundwater occurs in permeable geologic formations known as 'Aquifers,' i.e., formations having open spaces, either crack, fractures, or intergranular spaces, which permit an appreciable amount of water to move through them under ordinary field conditions.

Groundwater is important because 75% of our drinking water comes from groundwater. Groundwater occurrence is influenced by the area's climate, physiography, drainage, and geology. Following the integration with the help of (the GIS) geographical information system to demarcate the groundwater potential zones, satellite remote sensing allows for better observation and more systematic analysis of various geomorphic units and lineament features. As a result, an integrated approach has been taken to properly assess groundwater potential in the study area, including studies of lithology, hydrogeology, and lineament, as well as remote sensing and GIS techniques. As a result, integrating remote sensing (RS) and geographic information systems (GIS) has proven to be an efficient, rapid, and cost-effective technique for producing valuable geology data.

II. AIM AND OBJECTIVES

The main aim of the present study is to evaluate and delineate groundwater potential in the Birahalla watershed of Thirthahalli Taluk in Shimoga District using GIS and Remote Sensing techniques. To full fill, the aim of the study, the Geomorphology, Drainage density, Surface water bodies, Land use/land cover, Lithology, Soil, Slope, Isohyetal, and Ground contour maps are prepared using Remote sensing data and SOI Toposheets on a 1:50,000 scale.

III. STUDY AREA

Birahalla watershed, which forms the study area, is bounded by the part of the Thirthahalli Taluk of Shimoga district. It covers about 96.40sq.km. The location map of the Birahalla watershed is shown in Fig 3.1.

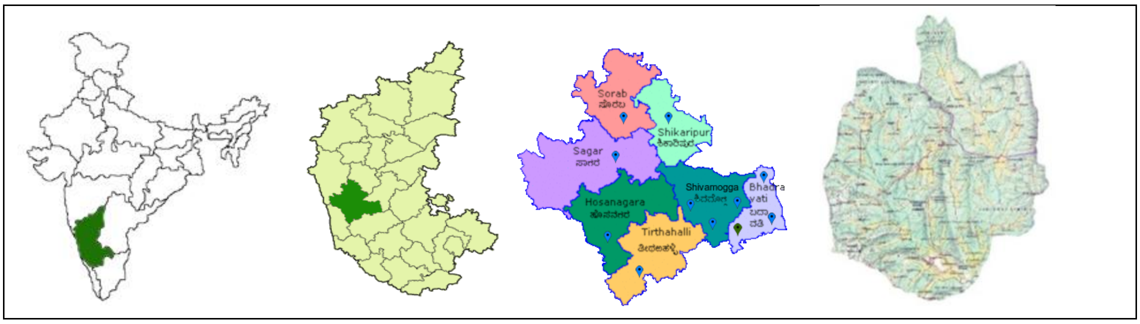

Fig 3.1- Location Map of the Study area.

IV. RESEARCH METHODOLOGY

Remote Sensing and Geographic Information System (GIS) techniques are effectively used to determine the quantitative description of basin geometry, Groundwater potential analysis, and Hydro geomorphology. Methodologies adopted for preparing base maps using SOI topographical maps, delineating different resource themes using remote sensing approach, and generating attribute data in part of the Tunga river basin of Thirthahalli Taluk. To fulfill the objective of the present study, the methodology followed is given in Fig.4.0 in the Flow chart. The primary and secondary data sources used in the present study are discussed below.

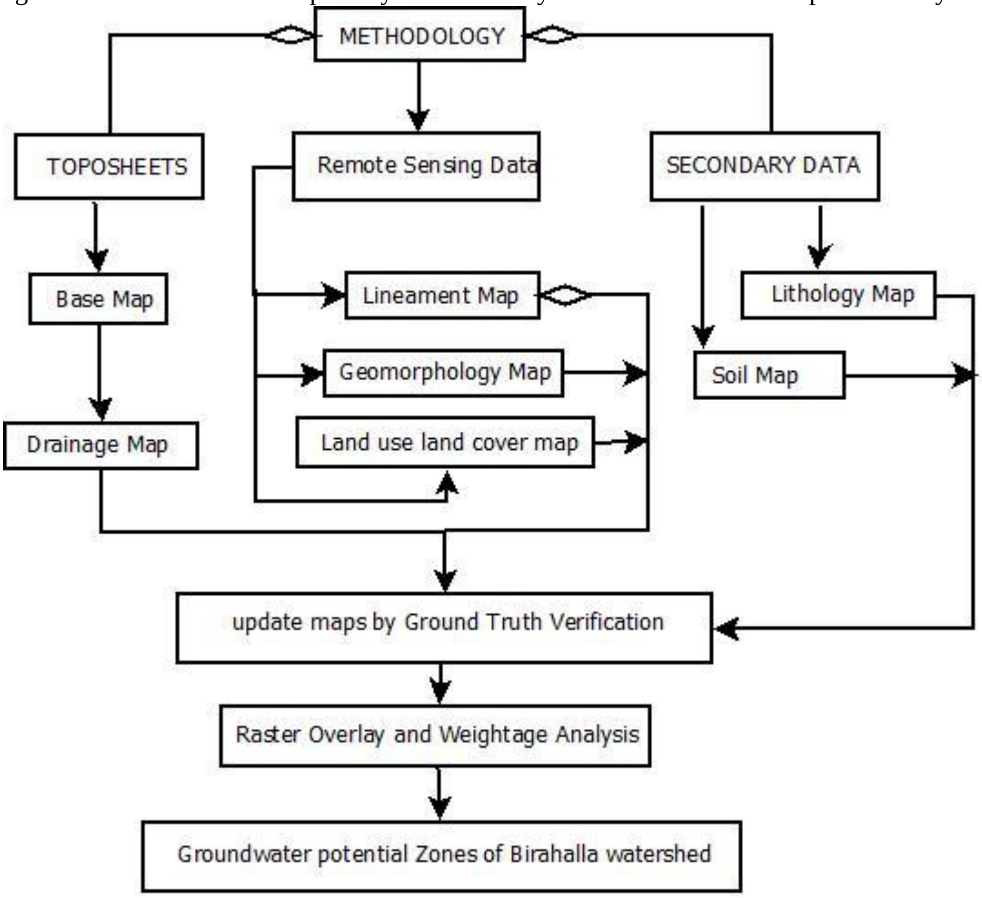

Fig 4.0: Flow Chart Showing the Methodology Adopted for this Project Work.

PRIMARY DATA (COLLATERAL AND REMOTE SENSING DATA):

Satellite data of high-resolution - SPOT images are downloaded from the study area's Google Earth and IRS LISS-III satellite imagery. The Survey of India (SOI) topographical sheet number 48 0/5 on the scale of 1:50,000 is used for the preparation of a base map and basic information in the form of the drainage network, water bodies like tanks and ponds, and land use land cover in the Birahalla watershed are prepared and updated using IRS LISS-III satellite image. A digital elevation model (DEM) with a 30m resolution is also used in the present study to prepare a slope map of the study area.

4.1 Drainage map:

The drainage area is the land area where precipitation falls off into creeks, streams, rivers, lakes, and reservoirs. It is a land feature that can be identified on a map by tracing a line along the highest elevation between two areas, usually a ridge. The drainage network and water body features were digitized using ARC-GIS 10.2 and saved as shape files. These features extracted from the Survey of India topo sheet are updated using satellite (IRS LISS III and Google earth 2016 image) data. The map showing the systematic arrangement of the drainage path is called drainage. The ordering is given to each stream following Strahler's (1952) stream ordering technique. The highest order of the stream in the Birahalla watershed is the 5th order.

4.2 Slope Map:

Slope estimation using contour lines on a topographic map. A map indicates an area's topography and analysis of topographic features as they have influenced and may continue to influence land development. The slope is the measure of steepness or the degree of inclination of a feature relative to the horizontal plane. Gradient, grade, incline, and pitch are used interchangeably with slope. The topo sheet used for the study shows contours of 20 meters intervals implying an elevation difference of 20 meters between any two Successive contour lines. The vertical drop was measured from the contour interval, and the horizontal distance between the contours was measured by multiplying the map distance with the scale factor.

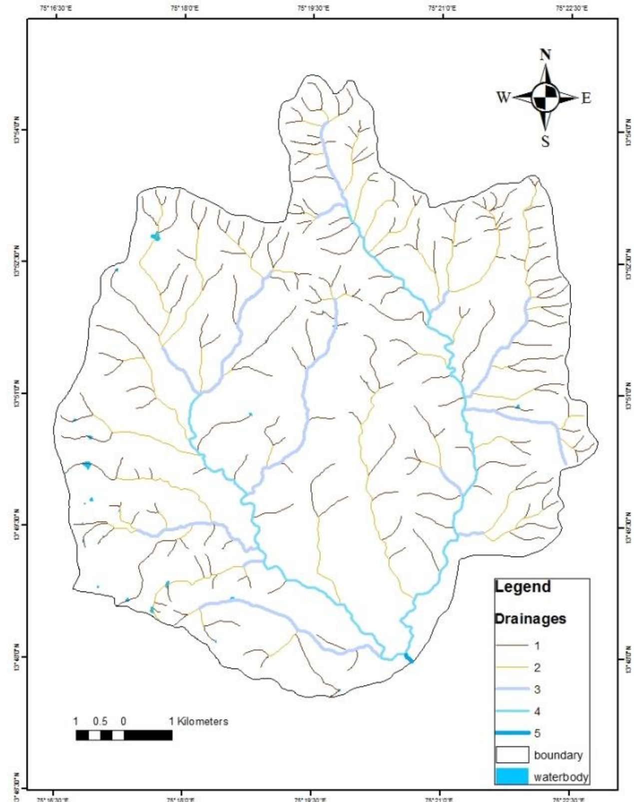

Fig:4.1. Drainage Map of Birahalla Watershed
Thirthahalli taluk, Shimoga District

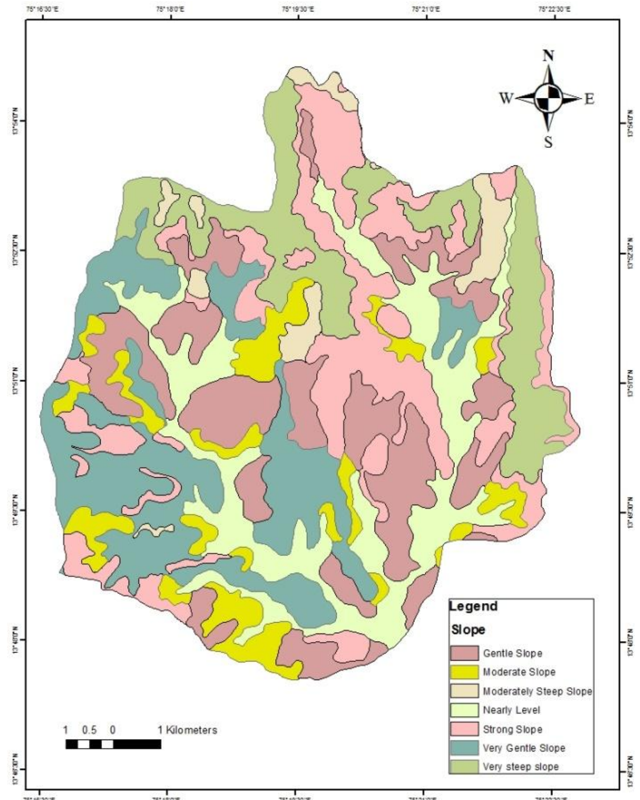

Fig:4.2. Slope Map of Birahalla Watershed
Thirthahalli taluk, Shimoga District

4.3 Soil Map:

The weathering of rocks and minerals forms soil, an important unit in controlling rainwater infiltration and surface flow patterns. Soil consists of organic and inorganic materials, water, and air. Soils are essential in controlling rainwater infiltration and surface flow patterns. On the other hand, the interpretation of soil and land conditions for irrigation is primarily concerned with predicting the behavior of soils under the greatly altered water regime brought about by the introduction of irrigation.

4.4 Land Use/Land Cover Map:

The land use/land cover analysis is essential to know the spatial distribution of land resources. Land use/Land cover mapping of the study area was carried out by visual interpretation techniques using IRS LISS III and Google earth -2014 images based on image characteristics like tone, size, shape, pattern, texture, association, etc. The details were then ground-checked to verify the doubtful areas. Based on the ground verification, the land use/land cover units' boundaries were finalized using ARC-GIS 10.2.

The major LULC classes in the study area are Agricultural land, Forest, Wastelands, and Water Bodies consisting of rural fringe landscapes. The rural landscape essentially consisted of settlements. Statistical data of the community-wise built-up area was generated and analyzed.

4.5 Isohyetal Map:

Isohyetal maps were prepared using the rainfall data collected from District Statistical Office, Shivamogga. Fifteen Years of Monthly Rainfall data for the Period 2000-2015were obtained and input into the corresponding meteorological stations. Average annual rainfall was calculated and used in preparing the Isohyetal map for the watershed using ArcGIS 10.2.

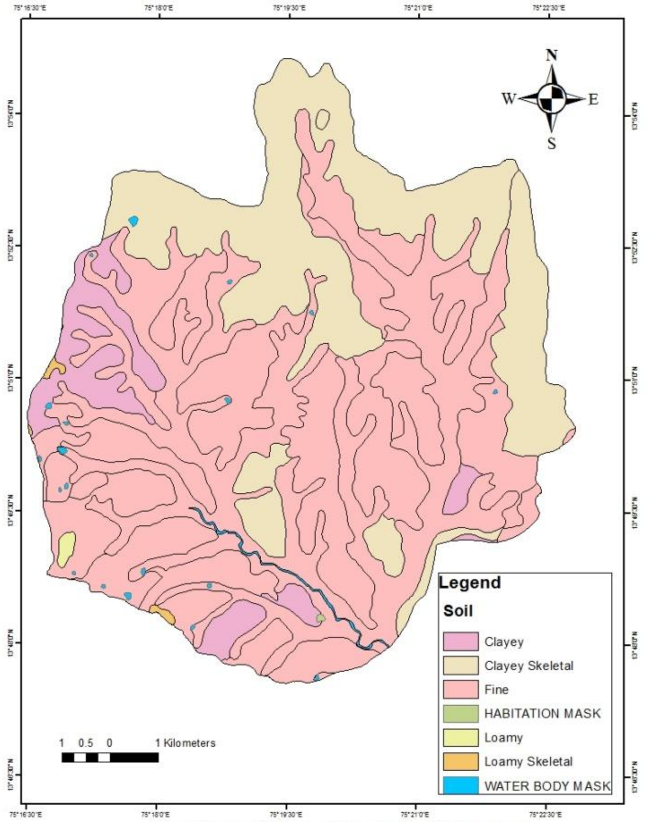

Fig:4.3. Soil Map of Birahalla Watershed
Thirthahalli taluk, Shimoga District

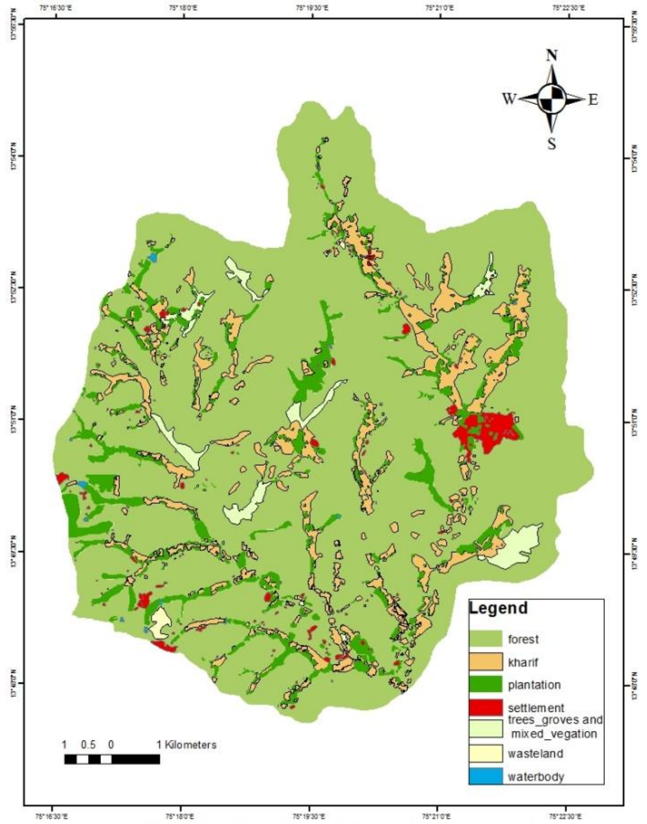

Fig:4.4. LULC Map of Birahalla Watershed
Thirthahalli taluk, Shimoga District

4.6 Geomorphology Map:

These geomorphic units interpreted from the satellite image have to be verified during the field visit to collect information on the depth of weathering, the nature of weathered material, the thickness of deposition, the nature of deposited material, etc. The final geomorphic map has been prepared by incorporating these details in the pre-field interpretation map.

4.7 Lithology Map:

The geo-referenced satellite digital data was used to carry out 'on screen' vectorization of geological parameters. Three vector layers were generated. The first vectors consist of geological structure attributes with length-based classification, and the second vector consists of geomorphic attributes. The third vector consists of a broad lithological map.

4.8 Groundwater Contour Map:

The groundwater contour map for the Birahalla Watershed in Thirthahalli taluk of Shimoga district is prepared based on water table fluctuation data collected from the Department of Mines and Geology, Government of Karnataka. Average water table fluctuation data is used to prepare the Ground Water table Contour Map in Arc GIS 10.2.

4.9 Lineament Map:

The mapping and interpretation of lineaments must be made with care and a proper understanding of their applications and limitations. In the present study, a lineament map was prepared using linear drainage patterns, which are very important features in identifying the potential zone for groundwater.

4.10 Generation of Ground Water Potential Map:

The Thematic layers of Lithology, Geomorphology, Soil, Slope, Land use and Land cover, surface water bodies, groundwater contour, and drainage were used to delineate Groundwater potential zones in the study area. All these thematic layers were integrated using Arc GIS 10.2 software to demarcate potential zones. The weights assigned to the various themes were determined by their impact on groundwater potential. Weights were assigned to various features of each theme based on their relative influence on groundwater potential. Based on this evaluation, different features of a given theme were performed: poor, moderate, good, very good, and excellent. After assigning weights, all the thematic layers were integrated to demarcate groundwater potential zones. The important factors responsible for groundwater occurrence area were assigned numerical values (rank) on a 1 to 5 scale in order of importance. Where ever higher weights(1) are assigned, it indicates a greater susceptibility to groundwater occurrence.

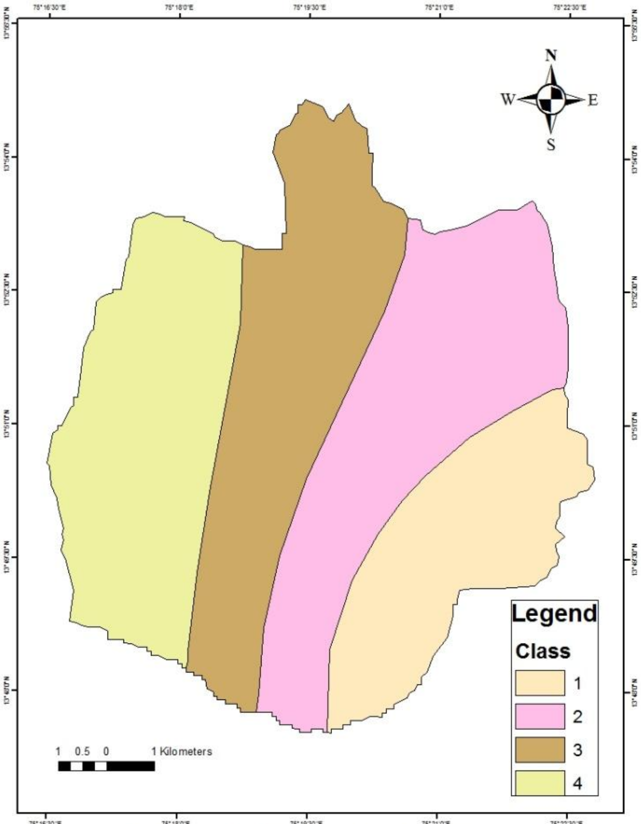

Fig:4.5.Isohyetal Map of Birahalla Watershed Thirthahalli taluk, Shimoga District

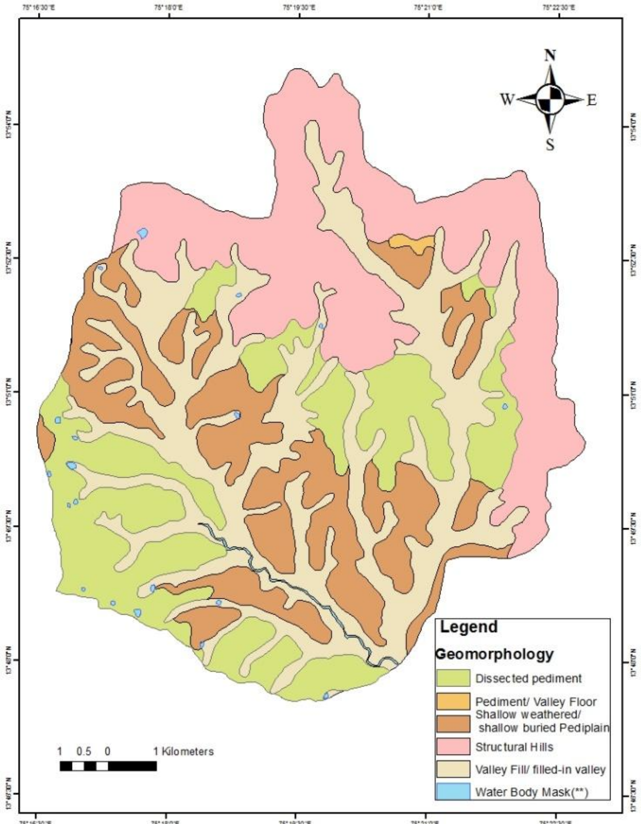

Fig:4.6.Geomorphology Map of Birahalla Watershed Thirthahalli taluk, Shimoga District

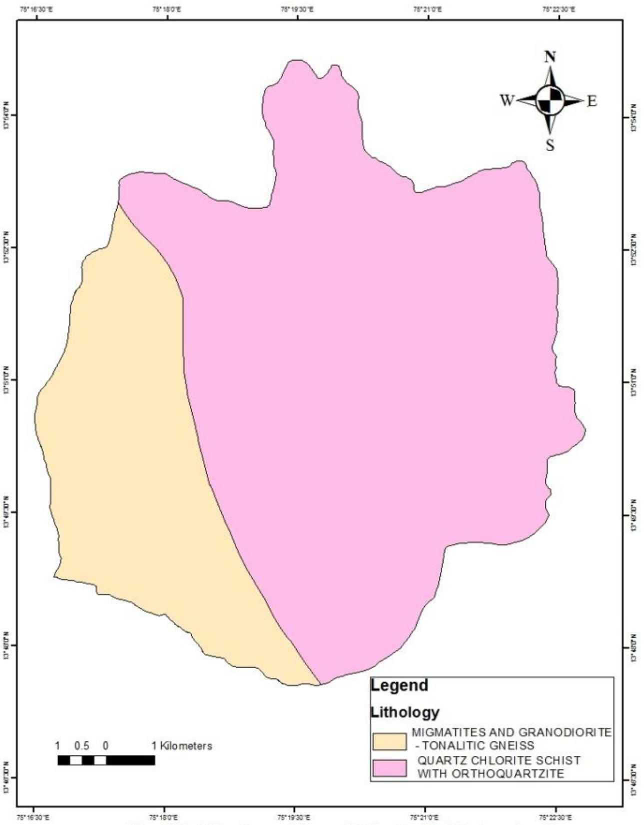

Fig:4.7.Lithology Map of Birahalla Watershed Thirthahalli taluk, Shimoga District

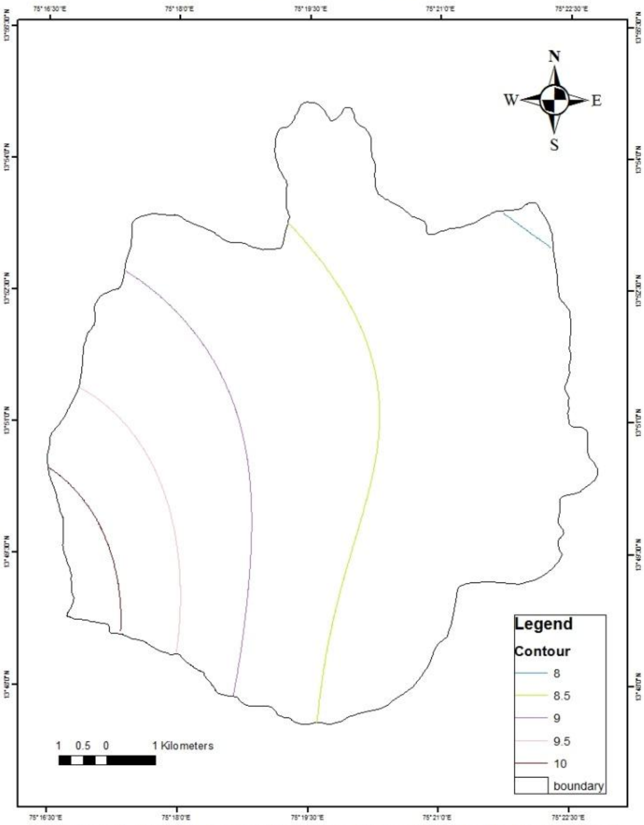

Fig:4.8..Groundwater Contour Map of Birahalla Watershed Thirthahalli taluk, Shimoga District

Table 1 The Rank Assigned to each Feature of Different Thematic Layers

Factor	Class	Weights/Rank (Wt)

Slope	Nearly level Gentle Slope Very Gentle Slope Moderate Slope Strong Slope Moderately Steep Slope Very Steep Slope	**1** **1** **2** **3** **4** **5** **5**
Soil Type	Loamy Skeletal Loamy Fine Clayey Skeletal Clayey	**1** **2** **3** **4** **5**
Land use /Land cover	Forest Plantation Trees, grooves, and mixed vegetation Kharif Wastelands	**1** **2** **3** **4** **5**
Isohyetal	187-203 (Very high} 171-186 (High) 155-170 (Moderate) 139-154 (Low)	**1** **2** **3** **4**
Geomorphology	Valley Fill /Filled in the valley Shallow weathered/shallow buried pediplane Pediment/Valley floor Dissected pediment Structural hills	**1** **2** **3** **4** **5**
Lithology	Migmatites and Granodiorite - Tonalitic Gneiss Quartz Chlorite Schist With Orthoquartzite	**1** **2**
Drainage-Buffer	5 (100m) 4 (50m) 3 (40m) 2 (30m) 1 (25m)	**1** **2** **3** **4** **5**
Grond Water Contour Map	7 8 9 10	**1** **2** **3** **4**

V. RESULTS AND DISCUSSION

In this study area, Ground Water Potential Map is Divided into five classes: Very Good, Good, Moderate, Poor, and Very Poor. These Categories are divided into an individual shape files. The Very Good groundwater potentiality area covers 0.7213 sq.km, Good groundwater potentiality area covers an area of 34.3883 sq. km. The moderate groundwater potentiality area covers 25.3117 sq. km. Poor groundwater potentiality area covers about 29.6687 sq. km. The remaining area that is Very Poor is the run-off zone covers an area of about 6.1827 sq. km. The groundwater potential map is useful for the Local people and the official to locate a suitable site for sinking a well.Fig.4.11 shows the Prepared Groundwater Potential Map of the Birahalla watershed.

Table 2: Area Statistics of Groundwater Potential Classes of the Study area.

GROUNDWATER POTENTIAL CLASS	Area in sq. km	Area in percentage
Very good	0.7213	0.749
Good	34.3883	35.719
Moderate	25.3117	26.291
Poor	29.6687	30.817
Very poor	6.1827	6.422

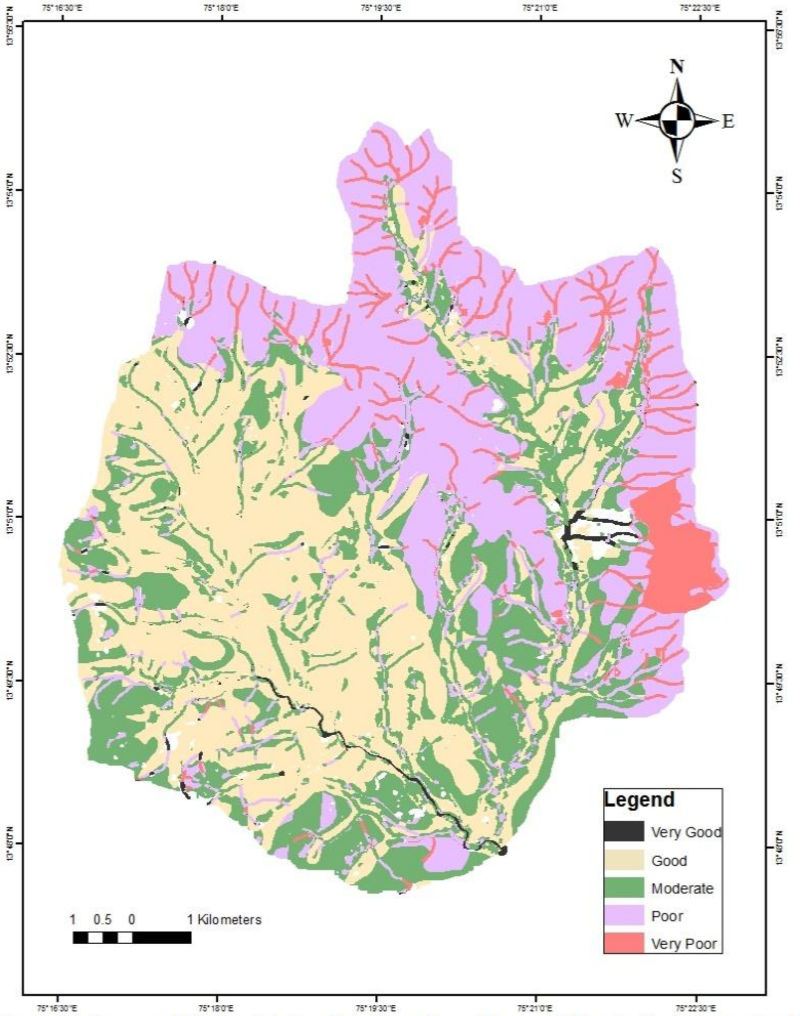

Fig:4.11.Ground Water Potential Zonation Map of Birahalla Watershed Thirthahalli taluk, Shimoga District

VI. ACKNOWLEDGEMENT

The authors gratefully acknowledge the Chairmen of Applied Geology, Vijayanagara Srikrishnadevaraya University, Ballari, for providing facilities for research and Karnataka State Economic and Statistical Department of Shimoga District for providing Rainfall data for Research work.

REFERENCES

1. Y. Yaswanth Kumar. "Identification Of Groundwater Potential Zones Using Remote Sensing And Geographical Information System." International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 3, March 2017, pp. 01-10 Article ID: IJCIET_08_03_001.
2. Vasudevan S, MUNGANYINKA Jeanne Paulin1vre, Balamurugan P, Sumanta Kumar Sahoo, and Ashis Kumar Swain. “Delineation of groundwater potential zones in Coimbatore district, Tamil Nadu, using Remote sensing and GIS techniques.” International Journal of Engineering Research and General Science Volume 3, Issue 6, November-December, 2015 ISSN 2091-2730.
3. BasavarajHutti, Nijagunappa. R. “Identification of Groundwater Potential Zone using Geoinformatics in Ghataprabha basin, North Karnataka, India.” International Journal of Geomatics and Geosciences Volume 2, No 1, 2011
4. Pandian.M and Kumanan. C. J. “Geomatics approach to demarcate groundwater potential zones using remote sensing and GIS techniques in part of Trichy and Karur district, Tamilnadu, India.” Archives of Applied Science Research, 2013, 5 (2):234-240
5. Ramamoorthy. P, Arjun. A Gobinath. K, Senthil Kumar. V Sudhakar . D. “Geo-Spatial Analysis Of Groundwater PotentialZone Using Remote Sensing AND GIS Techniques In Varahanadhi Sub Basin, Tamilnadu.” International Journal Of Science, Engineering And Technology, Volume 02 ISSUE 04 April-May 2014.
6. Sani Badamasia, B.A. Sawab, M.L. Garbac.” Groundwater Potential Zones Mapping Using Remote Sensing and Geographic Information System Techniques (GIS) in Zaria. Kaduna State, Nigeria”. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) (2016) Volume 24, No 1, pp 51-62.
7. Subin K. Jose, R. Jayasree, R. Santhosh Kumar, and S. Rajendran. Identification of Ground Water Potential Zones in Palakkad District, Kerala Through Multicriteria Analysis Techniques using Geoinformation Technology. Boring International Journal of Industrial Engineering and Management Science, Vol. 2, Special Issue 1, July 2012.
8. Muthamilselvan.” Delineation of groundwater potential zone in Sweta sub-watershed using remote sensing and GIS in parts of Perambalur district of Southern India.” Journal of Geomatics Vol 11 No. 1 April 2017.
9. Ramu, Mahalingam B, Vinay M. “Identification of groundwater potential zones using GIS and Remote Sensing Techniques: A case study of Mysore taluk -Karnataka.” International Journal of Geomatics and Geosciences Volume 5, No 3, 2014.
10. ShivajiGovindPatil. Dr. Nitin MahadeoMohite. Dr. Manoj Khare. “Identification of groundwater potential zones using Geoinformatics in upper Bhima basin, Pune, Maharashtra, India.” International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May 2013 1178 ISSN 2229-5518.