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GROUNDWATER POTENTIAL ZONATION MAP OF ANEBIDDA HALLA WATERSHED CHIKMAGALUR DISTRICT - RS AND GIS APPROACH

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Abstract: Groundwater is an important natural resource that supports human health, economic development, and ecological diversity. Rapid industrial development, urbanization, and increase in agricultural production have led to freshwater shortages in many parts of the world. Remote sensing and GIS methods permit rapid and cost-effective natural resource survey and management. Moreover, remotely sensed data serve as a vital tool in groundwater prospecting. The remote sensing data helps in fairly accurate hydro geomorphological analysis and identification and delineation of land features. The present research study is on the Anebidda Halla watershed in Chikmagalur district of Karnataka state falls in Survey of India toposheets numbers 48 O/11 and 48 O/12. The base map of the study area was prepared using SOI Toposheets and LISS III satellite images. Using ArcGIS 10.1 software, various thematic maps like slope map, Drainage network map. Land use/land cover map, Geomorphology map, Soil map, Lithology map, etc. were prepared. These thematic maps are integrated and prepared the groundwater potential zonation map of the area by weighted overlay analysis method and classified as very high, high, moderate, low, and very low. The groundwater potential zonation map gives first-hand information to local authorities, planners, and local peoples as well as the official to locate a suitable site for location for wells/tube wells.

Keywords **– GIS, RS, Anebidda Halla, Groundwater Potential Zone**

I. INTRODUCTION

Groundwater is water located under the ground surface in soil pore spaces and the fractures of rock formations. groundwater occurrence is influenced by the climate, physiography, drainage, and geology of the area. Groundwater is important because 75% of us get our drinking water from groundwater. Groundwater occurrence is being a subsurface phenomenon, its identification and location are based on indirect analysis of some directly observed terrain features like geological and geomorphic features and their hydrologic characters. Satellite remote sensing provides an opportunity for better observation and more systematic analysis of various geomorphic units, lineament features, following the integration with the help of (GIS) geographical information system to demarcate the groundwater potential zones. therefore, an integrated approach, including studies of lithology. Hydro geomorphology and lineament have been taken up, using remote sensing and GIS techniques, to be a proper assessment of groundwater potential in the study area. Consequently, integration of remote sensing (RS) and geographic information system (GIS) has proven to be an efficient, rapid, and cost-effective technique producing valuable data on geology.

II. AIM AND OBJECTIVES

The main aim of the present study is to evaluate and delineate groundwater potential in the Anebidda Halla watershed in Chikmagalur District using GIS and Remote Sensing techniques.to full fill, the aim of the study is the Geomorphology, Density, Surface water bodies, Land use/land cover, Lithology, Soil, Slope, Isohyetal, and Ground contour maps are prepared on a 1:50,000 scale.

III. STUDY AREA

Anebidda Halla watershed which forms the study area is bounded in between 13° 21' 15", 13° 17' 29" N latitude and 75° 30' 20" and 75° 39' 50" E longitude and falls in Survey of India toposheets no 48 O/11 and 48 O/12. The area forms a part of the Chikmagalur district, covering about 178 sq. km of Bhadra River. The elevation varies from 672 to 1397m above the mean sea level. The location map of the study area is shown in Fig.1.

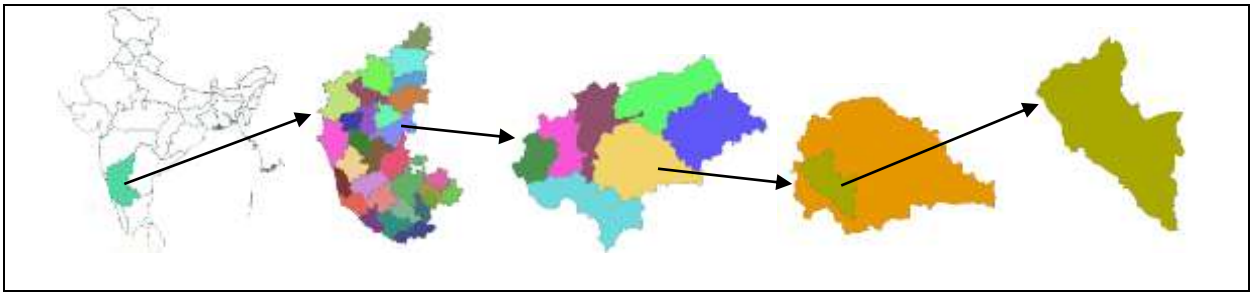

Figure 1- Location Map of the Study area

IV. RESEARCH METHODOLOGY

To fulfill the aim, the following steps were involved; -Satellite data has been geo-referenced with the topo map. An optimized image was generated for visual/onscreen interpretation. As per available and published maps, a broad-level lithological map was prepared. The Geomorphological map was prepared to emphasize the genetic classification of landforms, the major groups are Denudational hill, pediment, structural hill, and Pediplain. A pre-field map was prepared using satellite data. Ground validation out with emphasis on selective ground checks ground observation was incorporated at appropriate places to finalize post field map. All below themes maps have been integrated with the GIS environment to generate a groundwater potential zone development map for the study area.

Collateral and Remote sensing data used

Survey of India (SOI) topographical map Nos. 48 O/11 and 48 O/12(1:50,000) are used for the preparation of the below base maps and later updated using IRS LISS III satellite image Cartosat DEM image.

4.1 Slope Map

Different slope categories are derived based on 1:50,000 scale topographic maps at 20-meter contour intervals. The slope map of the study area shows the major area is covered by the very steep slope category. It covers an area of about 68.28 sq km and a strong slope covers an area of about 38.81 sq km of the total area (Fig.2).

4.2 Soil Map

Soils are essential units in controlling the infiltration of rainwater and surface flow patterns. In the watershed, mainly three types of soil are identified. They are Fine, Fine-loamy, and Loamy skeletal (Fig.3).

4.3 Land Use/Land Cover Map

In the watershed, seven classes of LULC classes have been identified. They are Forest, Plantation, Scrub Land, Agriculture land, built-up land, etc. The major portion of the watershed is covered by the Forest and followed by agricultural land (Fig.4).. For this study secondary data has been collected.

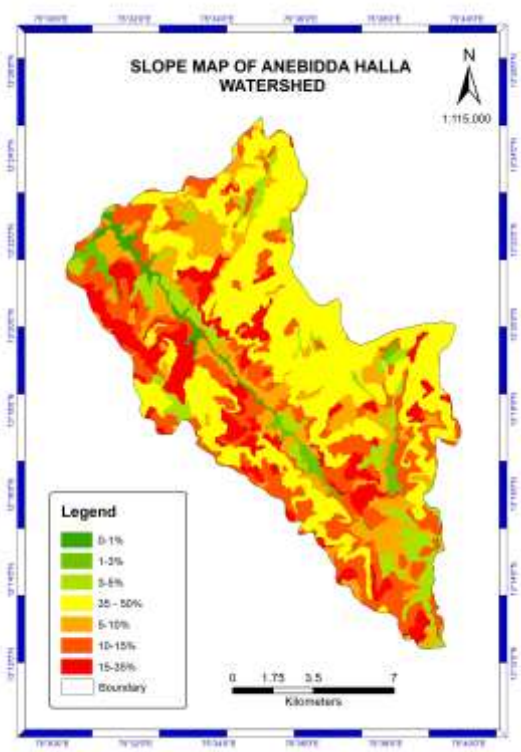

Figure 2-Slope Map of the Study area

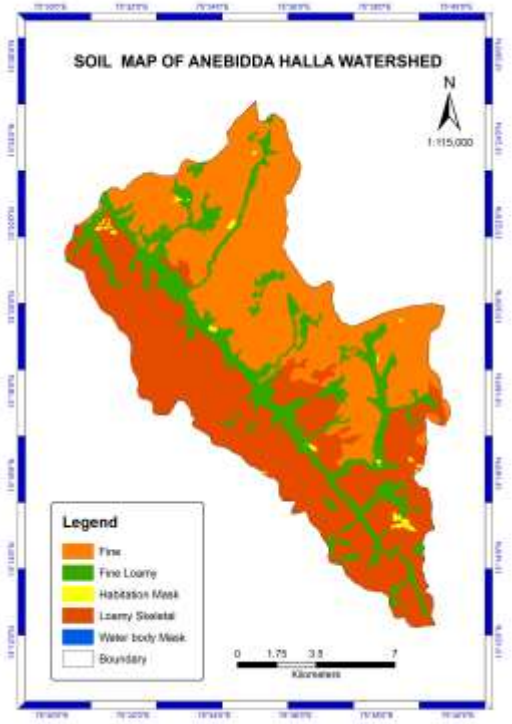

Figure 3- Soil Map of the Study area

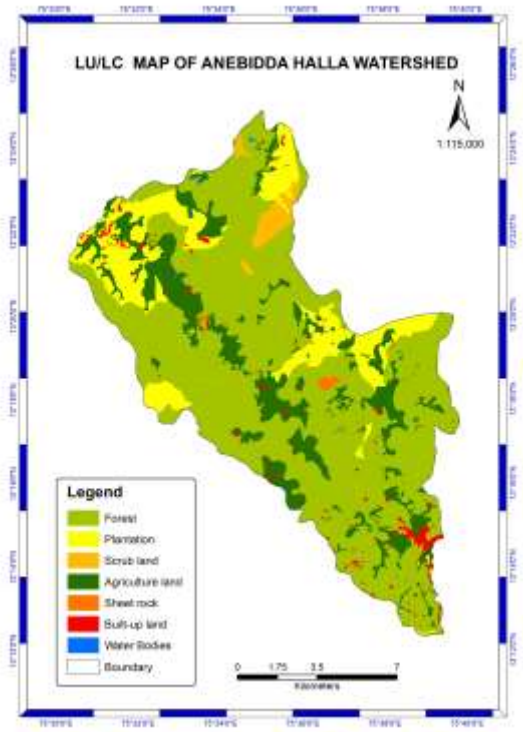

Figure 4 -LU/LC Map of the Study area

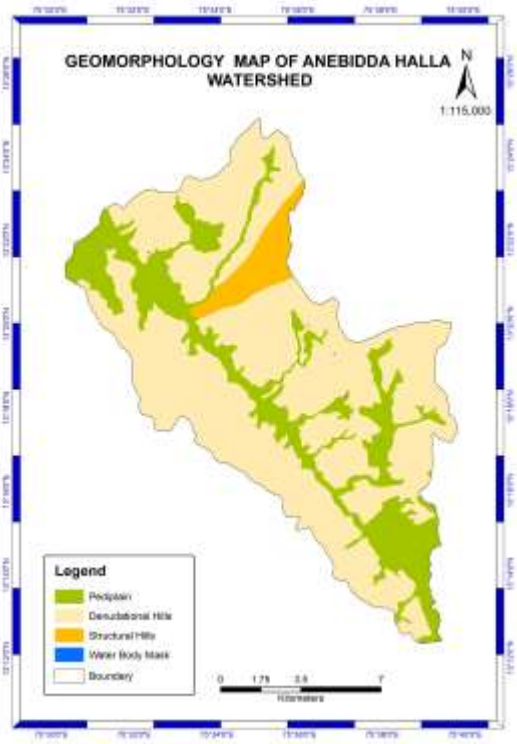

Figure 5 -Geomorphology Map of the Study area

4.4 Isohyetal Map

For groundwater recharge in this area, rainfall is a primary source of water. Ten years' average rainfall data of Alduru, Attigundi, Balehonnur rain gauge stations are collected and plotted in the GIS platform for both pre and post-monsoon seasons using Arc GIS 10.1. Table 1 and Table 2 show the rainfall at different stations and area statistics.

Table 1 Rainfall in different rain gauge stations in and around the watershed

Station	Alduru	Attigundi	Balehonnur
1999	0	322	168
2000	0	126.98	174.1
2001	0	163.08	158.65
2002	0	94.125	141.33
2003	103.13	98.51	125.57
2004	138.5	227.7	162.25
2005	130.56	130.6	210
2006	115.46	118.72	171.7
2007	166.5	173.125	185.25
2008	142.31	187.6	204.6
Average	135.56	157.22	169.04

Table 2 Area Statistics of Rainfall of the Study Area

Rainfall	Area in Sq. Km	Percentage
High	44.06	24.81
Low	33.83	19.05
Moderate	25.15	14.16
Very High	30.38	17.11
Very Low	44.16	24.87
Total	**177.58**	**100**

4.5 Geomorphology Map

The Geomorphology map shows different classes like Denudation hill, Peneplain, and Structural hill. Among these Features, Denudational Hills cover a larger area of 126.47 sq km. Pediplain covers about an area of 42.76sq km and Structural Hills cover about 8.32 sq. km (Fig.5).

4.6 Lithology Map

The lithology map of the study area reveals three types of rocks and they are Migmatites and Granodiorite, Metabasalt & Tuff, and Tonalitic Gneisses (Fig.6).

4.7 Groundwater Contour Map

The groundwater contour map for the Anebidda Halla watershed is prepared based on the water level in the bore wells in the watershed (Fig.7).

4.8 Drainage map

The drainage map is prepared using SOI topographical maps on a 1:50,000 scale and updated with satellite imagery and they show dendritic to parallel drainage patterns. The drainage map shows the watershed is a fifth-order stream. There are a 517-first order stream, 132-second order streams, 28-third order streams, 6-fourth order, and one fifth order stream (Fig.8).

4.9 Lineament Map

The lineament map shows linear features present in the study area (Fig.9). They are the indicators of groundwater potential zones. Lineament map was prepared from the Cartosat-1 DEM data.

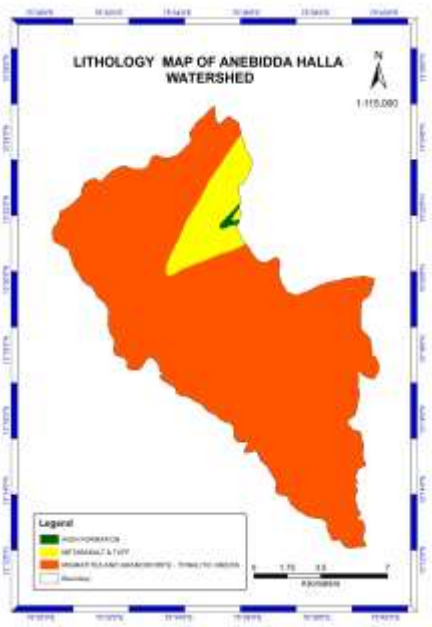

Figure 6 -Lithology Map of the Study area.

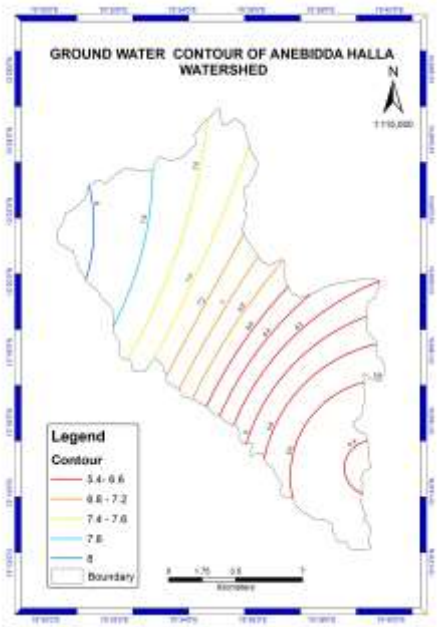

Figure 7 –Groundwater contour Map of the Study area

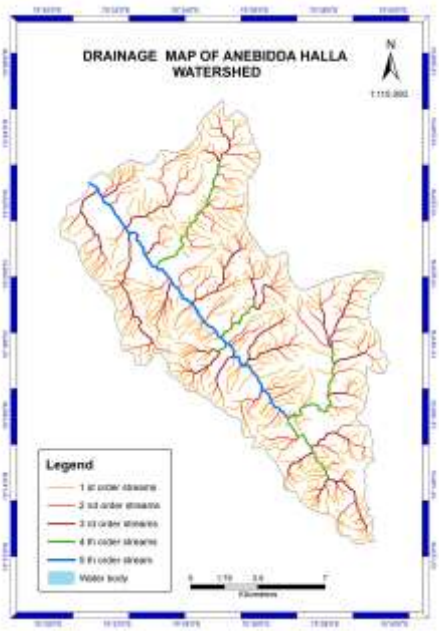

Figure 8 –Drainage network Map of the Study area.

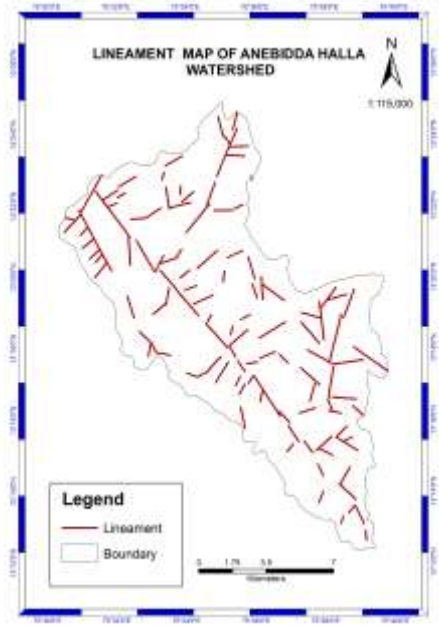

Figure 9 –Lineament Map of the Study area

5.0 Groundwater Potential Zonation Map

The above thematic layers of Lithology, geomorphology, soil, Slope, land use/land cover, groundwater contour, drainage, and Isohyetal map were the generation of groundwater potential zones for the study area. The suitable weightage and ranks (Rank 1 -Very High, Rank 2-High, Rank 3 –Moderate, Rank 4- Low, Rank 5-Very Low, Rank 98-Nil) are assigned(as shown in Table 3) to the individual features, All the thematic layers are integrated and the final groundwater potential Zone map of the study area is prepared,(Fig 3). The Final integrated map is classified into five classes Very high, high, moderate, low, very low groundwater potential zones, Areal extent of groundwater potential zones is given in Table 4.

Table 3 the rank assigned to each feature of different thematic layers

Thematic Layers	Features	Weightage/Rank
Land use Landcover	forest	1
	Plantation	2
	Scrubland	3
	Agriculture land	4
	Sheetrock	5
	Built-up land	98
Geomorphology	Pediplain	1
	Denudational Hills	2
	Structural Hill	3
Soil	Loamy Skeletal	1
	Loamy	2
	Fine	3
	Clayey Skeletal	4
	Clay	5
	Habitation mask	99
	Waterbody mask	98
Slope	0-3%	1
	3-5%	2
	5-10%	3
	10-15%	4
	15-35% and >35%	5
Drainage	V order	1
	IV order	2
	III order	3
	II order	4
	I order	5
Lithology	Iron formation	2
	Metabasalt& tuff	3
	Migmatite sand	1
	granodiorite - tonalitic gneiss	
Groundwater contour	5.38-5.86 m	1
	5.87-6.47 m	2
	6.48-7.11 m	3
	7.12-7.63 m	4
	7.64-8.08 m	5
Isohyetal map	135.57-140.14 cm	5
	140.15-146.06 cm	4
	146.07-152.35 cm	3
	152.36-158.89 cm	2
	158.9-166.92 cm	1

V. RESULTS AND DISCUSSION

In the study area, Very high groundwater potential zones cover about 31.94 sq. km area, 62.48 sq. km area is covered by High, 50.08sq km area by moderate, 23.15 sq km area by low and 6.75sq km area shows very low groundwater potential. A northeast portion of the study area shows a moderate groundwater potential zone. North West margins of the study area show very high groundwater potential zones and the west south margin shows high groundwater potential zone. The groundwater potential map is useful for the Local people as well as the official to locate a suitable site for sinking a well.

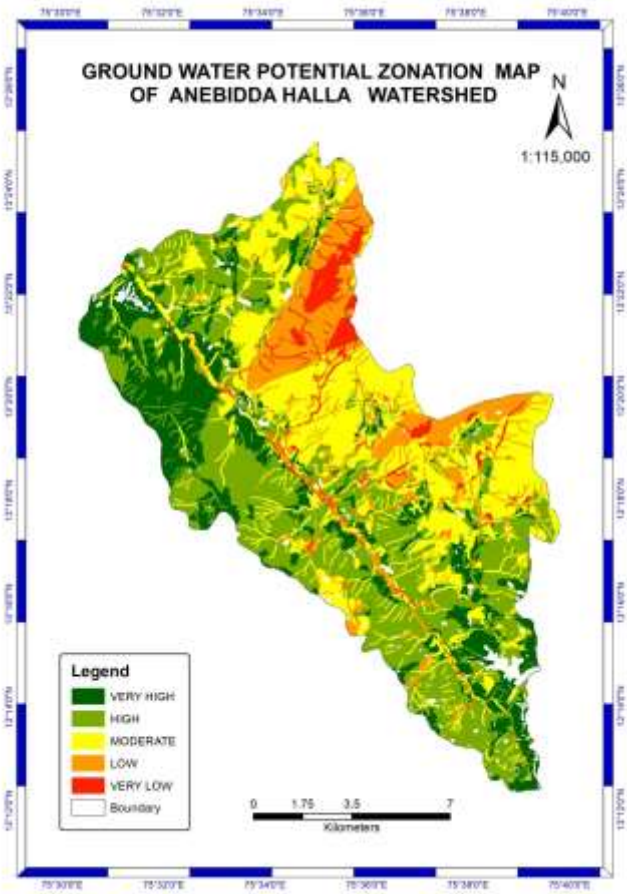

Figure 3 Ground Water Potential Zonation Map of Anebidda Halla Watershed

Table 4 Area Statistics of Groundwater Potential Map of the Study Area

Groundwater category	Area in sq. km	Percentage
Very high	31.9378	18.31
High	62.4766	35.83
Moderate	50.0803	28.72
Low	23.1486	13.27
Very low	6.7452	3.87

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