

Demarcation of Groundwater Prospect Zones in T G Halli Watershed, Using RS & GIS

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ABSTRACT:The present work is an attempt to integrate RS and GIS based analysis and methodology in groundwater potential zone identification in the study area with an aerial extent of 1448.64km². The information on geology, geomorphology, soil, slope, rainfall, water level and land use/land cover was gathered, in addition, GIS platform was used for the integration of various themes. The composite map generated was further classified according to the spatial variation of the groundwater potential. Four categories of groundwater potential zones namely poor, moderate, good and very good were identified and delineated.

KEYWORDS:remote Sensing & GIS, thematic maps, rainfall, runoff, watershed, Groundwater, Potential zones.

I. INTRODUCTION

Groundwater is dynamic and replenishing natural resource. Groundwater plays a vital role in the rapidly expanding Urban, industrial, and agricultural water requirements, in the study area. Therefore, the quantification of the current rate of groundwater recharge is a necessity for the efficient and sustainable groundwater resource management. Groundwater recharge is generally considered as that amount of water, which contributes to the temporary or permanent increase of groundwater resources. The actual recharge reaching the water table may be considerably less than the potential recharge due to the influence of the unsaturated zone. The factors which control the ground water occurrence include rock type, landforms and soil type, recharge characteristic of soils/overburden material etc., in crystalline hard rock integrated terrain analysis for identifying suitable site for groundwater planning & development studies.

Geophysical methods are conventionally employed for groundwater prospecting though there are several methodologies to locate and map the occurrence and distribution of groundwater. The advent and development of new technologies, such as remote sensing with its advantages of spatial, spectral and temporal availability of data have proved to be useful for quick and useful baseline information about the factors controlling the occurrence and movement of groundwater like geology, geomorphology, land use/cover, drainage patterns, lineaments etc [1]. Further, remote sensing techniques provide a synoptic view of large areas, facilitating better and quicker assessment, development and management of water resources with collateral information

II. LITERATURE SURVEY

Excellent reviews of remote sensing applications in groundwater hydrology are presented in Farnsworth, et al. [2], Waters et al. [3] and Engman and Gurney [4], which concluded that remote sensing has been widely used as a tool, mostly to complement standard geophysical techniques. In the recent years, modern technologies like Geographic Information System (GIS) is being used for various purposes such as groundwater investigations and many authors have attempted to delineate groundwater potential zones [5] & [6]. GIS techniques facilitate integration and analysis of large volumes of data, whereas, field studies help to further validate results. Krishnamurthy et al. [7] applied digital enhancement techniques for groundwater in a hard rock terrain of parts of the Raichur district, Karnataka. The geological structures were highlighted by filtering. Band subtraction brought out the vegetation along valley fills and

moisture-laden lineaments. Based on the results, a package was suggested which could be used on an operational basis for groundwater targeting in typical hard-rock crystalline formations.

Kamaraju et al. [8] evaluated groundwater potential of west Godavari district, Andhra Pradesh state, India. Information on the parameters controlling groundwater such as lithology, geomorphology, structure and recharge condition of the study area was analyzed using Arc Info GIS software. An evaluation of groundwater potential and generation of a map showing three hydro geological conditions with district groundwater prospects which would serve as a basic tool in exploitation of groundwater resources of the district was presented. Saraf and Choudhury [9] utilized IRS-LISS-II data along with other data sets extract information on the hydrogeomorphic features of a hard rock terrain in the Sironj area of Vidisha district of Madhya Pradesh, India. Pankaj K. et. al.,[10] delineated various groundwater potential zones for the assessment of groundwater availability in hard rock terrain with the help of hydro-geological parameters using satellite IRS-1B LISS-II digital data. Gopinath and Seralathan [11] investigated the role of hydrogeomorphological units and lineaments in the storage of groundwater from the Muvattupuzha river basin using IRS 1D-LISS III data. Asadi et al.,[12] carried out a model study to increase groundwater levels in part Medak and Hyderabad districts of A.P. Delineation of groundwater prospect /ones was done using IRS-ID PAN and LISS-III geocoded data on 1:50000 scale. Information on base, drainage, lithology, structure, landuse/ landcover, slope, geomorphology and hydrology maps are generated and integrated to prepare groundwater prospect map for the study area. The study area had a complex geomorphology. Four categories of groundwater potential zones: good-good, good-moderate, poor-nil and nil were delineated.

III. STUDY AREA

The study area chosen for the present study was Thippagondana Halli (T G Halli) catchment, Arkavathy river basin comprising Bangalore urban, Bangalore rural and Chikkaballapur district. The study area stretches geographically from 77°14' and 77°41' E longitude and 12°57' and 13° 24' N Latitude. The catchment comprises an area of 1448.64 Sq.km and is covered in the Survey of India (SOI) topo sheet numbers 57G/3, 57G/4, 57G/7, 57G/8, 57G/11, 57G/12, 57H/5 and 57H/9. The maximum length and width of the catchment were approximately 61.3 km and 36.8 km respectively. The main stem of the Arkavathy River has its headwaters in the Nandi Hills north of Bengaluru and is joined by its first major tributary, the Kumudvathy River at Thippagondanahalli (TG Halli) village (Figure.1.).

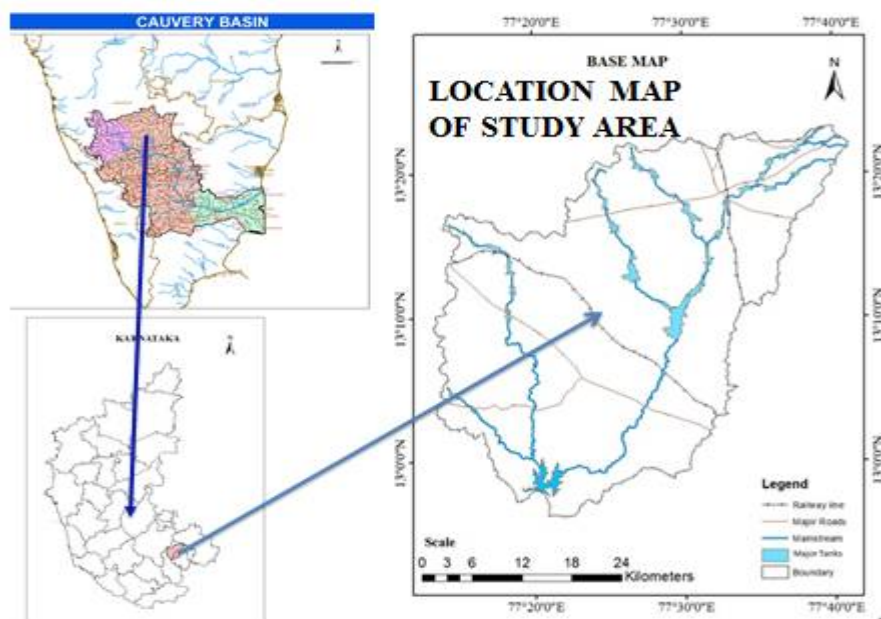


Figure.1: Location map of Study Area

IV. METHODOLOGY

In the present study, the choice among a set of zones for development of groundwater is based upon multi-criteria evaluation technique, which gives linear combination of probability weights for different themes taken for the study. The steps involved and the flow of data in overlay analyses is presented in the flow chart (Error! Reference source not found.ure.2.).

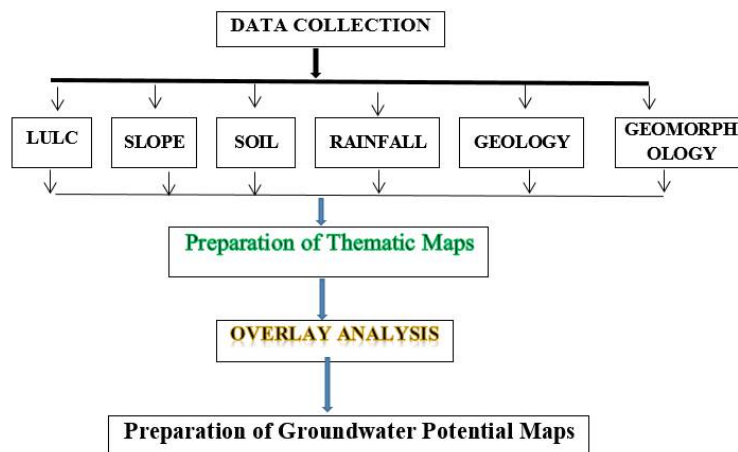


Figure-2.Flow Chart of Preparation of GWPM

In the first step of integration, Geomorphology layer and Lithology layer maps were integrated by intersect option and a new integrated layer (R1) is generated 636 polygons of layer L1 (geomorphology layer) and 1 polygon of layer L2 (geology layer) has resulted in the generation of integrated layer (R1) with 636 polygons. The minimum and maximum WCV are 20 and 40 respectively.

In the second step, the integrated layer R1 layer containing 636 polygons (the resultant of geomorphology and lithology) was intersected with the land use and land cover layer (L3) which has 266 polygons and it resulted in the generation of integrated layer R2 with 903 polygons. The minimum and maximum WCV are 25 and 65 respectively. In the third step, integrated layer R2 containing 903 polygons was intersected with the rainfall

In the fourth step, Slope layer was intersected with the integrated layer R3, this resulted in the generation of integrated layer R4. In the fifth step, Soil layer was intersected with the integrated layer R4. In the sixth step, Water level was intersected with the integrated layer R5 which resulted in the generation of integrated layer R6. Theoretically, if WCV of the all the layers which are integrated, a maximum of 145 and minimum of 45 WCV must be obtained. But practically maximum of 135 and minimum of 60 WCV are obtained. This shows that the overlap of some of higher weights polygons with one another in the integrated layer. Based on the total weights obtained by integration the study area has been delineated into Good, Good to Moderate, Moderate, Poor groundwater prospect zones.

V. EXPERIMENTAL RESULTS & DISCUSSIONS

The various thematic data derived for the analysis of groundwater potential zones and the resultant compositemap thus obtained (Figures 3, 4, 5 & 6) are:

- ✓ **Geomorphology Layer (L1):**The framework in which the ground water occurs is as varied as that of rock types, as intricate as their structural deformation and geomorphic history, and as complex as that of the balance among the Lithological, structural and geomorphic parameters. The hydro geomorphological map, as shown in figure 3, was prepared following the guidelines of Ground Water Prospect Mapping under Rajiv Gandhi National Drinking Water Mission by NRSC, Hyderabad (2012).
- ✓ **Geological/Lithological Layer (L2):**The study area forms a Bangalore urban district of Karnataka state. Lithologically the area is composed of gneiss, (Fig 4). Since the study area comprises gneiss litho unit the occurrence and movement of groundwater varies considerably and also has different percentage of porosity and permeability factors. Granites, granodiorites and diorites that are present in the area possess medium primary porosity, which is essential for storage of groundwater. Therefore gneisses are classified as very good category, having good water potential so they are classified to good category.
- ✓ **Land Use and Land Cover Layer (L3):**The land use land cover study area has been attempted in order to identify and map the various types of land use/land cover classes in the area. The classification system was developed by Remote sensing Agency; Land use refers to man's activities and various uses which are carried on land "Land cover refers" to

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“Natural vegetation, Water bodies, rock / soil, artificial cover and other resulted due to land transformation. The following are the different Land use/Land cover classes of the study area Built up land (town, village), crop land, fallow land, agriculture plantation, dense forest, fair dense forest, scrub forest, dense grass land forest plantation, land with scrub, barren rock, mining, waterlogged area, Industrial area, lakes/tank(Figure5).

- ✓ **Rainfall (L4):**The principal source of all surface and groundwater in the study area is precipitation. 30 years (1986-2016) monthly rainfall data from 5 stations (Doddaballapur, Doddabelavangala, Nelamangala, Solur, Manchenabele) situated within the basin are collected and Isohyetal map has been prepared. The average annual rainfall varies from 600 to 1100 mm (Fig 6) in the study area.

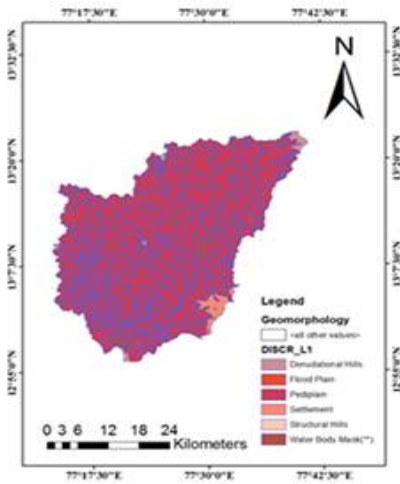


Fig 3. Geomorphology Map (L1)

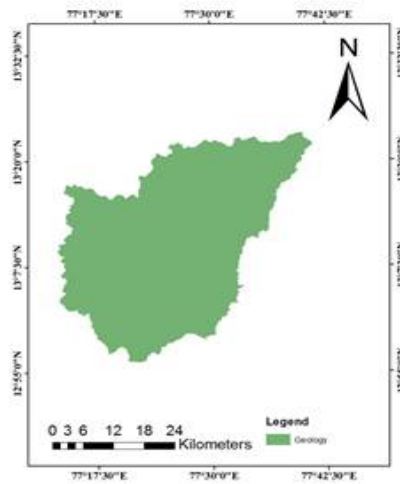


Fig 4. Geology/Lithology Map (L2)

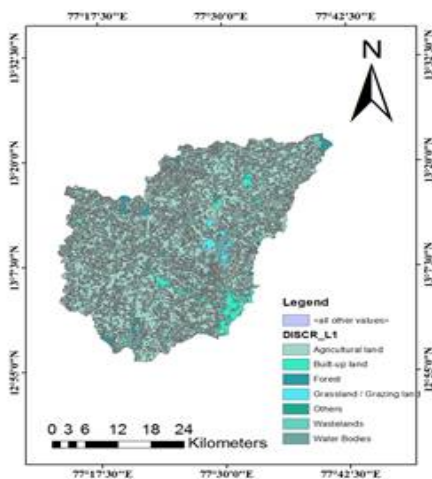


Fig 5. Land Use/Land Cover Map (L3)

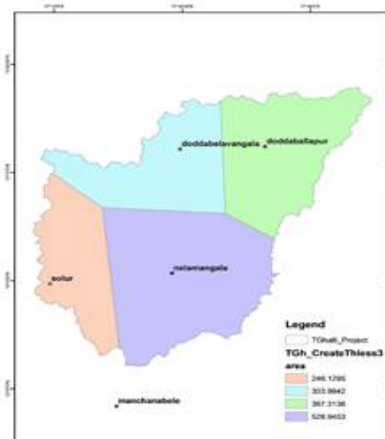


Fig 6. Rainfall Gauge stations

- ✓ **Slope (L5):** The slope of a surface refers to the maximum rate of change in height across a region of the surface. The following slope classes were mapped for the study area: nearly level, very gently sloping, gently sloping and moderately sloping, strong slope. The nearly level and very gently sloping areas support for

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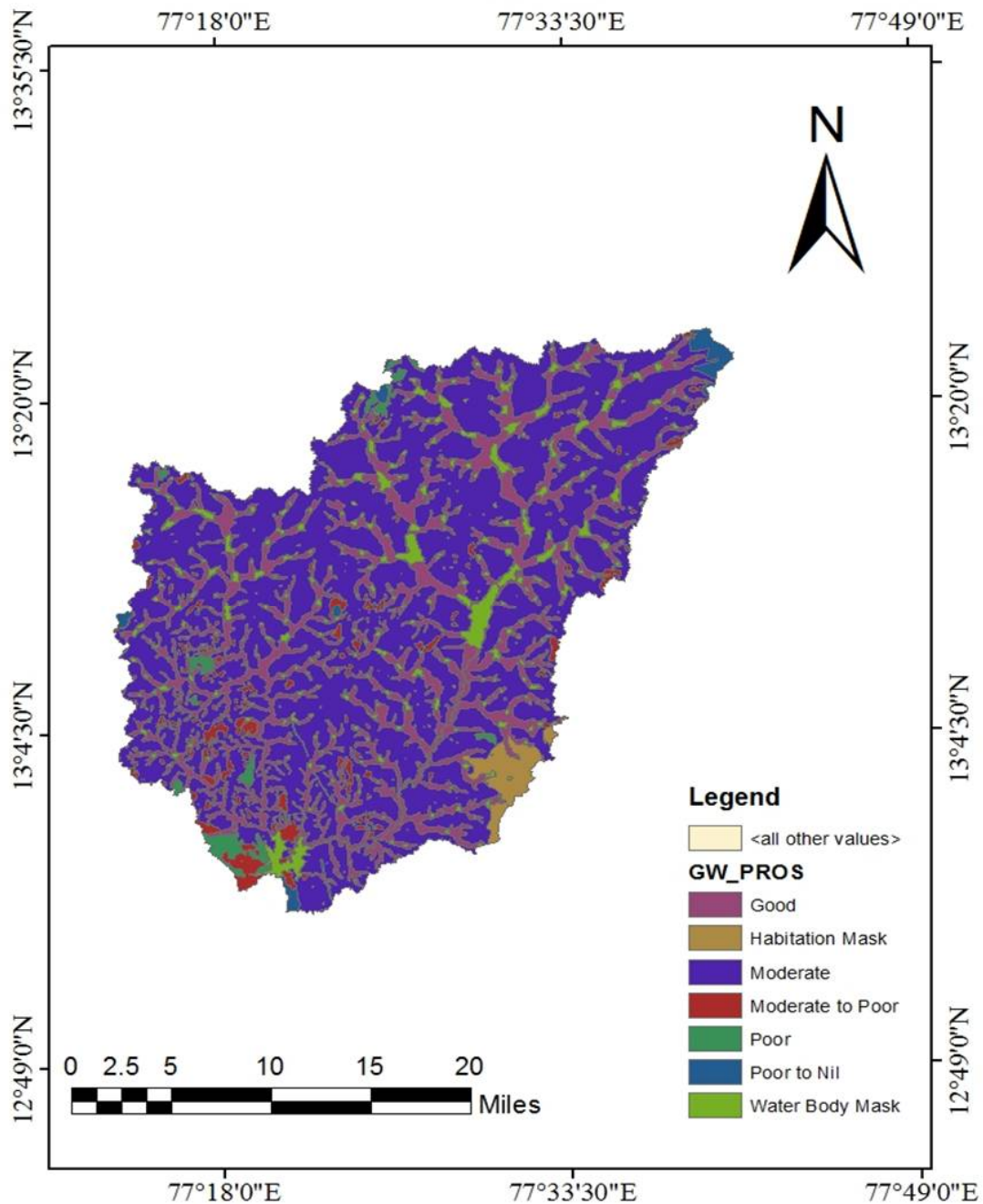


Figure-9: Groundwater Prospect Map of the Study Area

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Vol. 6, Issue 8, August 2017

Table 1: Integrated Groundwater Potential Zones

Sl No.	Ground water category	% of the total area	Higher Weightage value	Lower weightage value	Ground water structures feasible
1	Very Good	27.95	110	100	Dug wells fitted with low power pumps and tube wells fitted with hand pumps.
2	Good	2.44	100	85	Dug well, dug well cum bored well and tube well fitted with hand pump.
3	Moderate	2.73	85	70	Dug well, dug-cum bored well, with tube well.
4	Poor	6.52	70	55	Generally, groundwater structures will not be successful. Dug well dug-cum-bored well may be constructed. Surface water should be harnessed and roof top rainwater harvesting schemes may be adopted.
5	Very Poor	27.67	55	40	Generally, ground water structures will not be successful. Dug well dug well cumbered-bored well may be constructed.

VI. CONCLUSION

All the thematic maps were converted into grid (raster format) and analysed by weighted overlay method. From the results, the groundwater potential zones with poor, moderate, good, very good and excellent prospective zones were identified. The moderate groundwater potential zones are the result of the complex relations between geology, slope and landforms. The regions with poor groundwater potential are spread mainly along linear ridges and lateritic uplands. The overall results demonstrate that remote sensing and GIS provide potentially powerful tools for studying groundwater resources and designing a suitable exploration plan. The integrated map could be useful for various purposes such as sustainable development of groundwater as well as identification of priority areas for implementation of water conservation projects and programmes in the area.

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