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RESEARCH ARTICLE

ANALYSIS OF GROUNDWATER PROSPECTS IN THE STUDY AREA OF KALYANDURG, BRAHMASAMUDRAM AND SETTURU MANDALS OF ANANTAPUR DISTRICT, AP, INDIA: USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

The present Study Area of Kalyandurg, Brahmasamudram and Setturu mandals are located worst drought prone area of Rayalaseema Region of Andhra Pradesh. The Groundwater Resources are not exploited properly. The present study was under taken to analysis the groundwater potential zones by using IRS - P6 LISS IV FMX (False Colour Composite).Remote Sensing and geographical information system (GIS) has become one of the leading tools in the field of groundwater research, which helps in assessing, monitoring, and conserving groundwater resources, thematic maps such as geology, geomorphology, soil hydrological group, land use / land cover and drainage map were prepared for the study area Using Remote Sensing and GIS Techniques by analyzing the IRS Multiband data of LISS IV and Merged data. From the analysis of the groundwater potential zones with excellent, very good, good, moderate and poor prospects are observed in the three mandals of the study area, it is observed that high potential zones are mainly located along lineaments and in the floodplain areas, pediment areas, Alluvial fills, valley fills are good potential zones, the geomorphic units like buried pediplains, peniplains and denundational hills are moderate to good groundwater prospective zones. Undulating upland and buried pediments with intermontane valley, mainly confined in undulating upland, Inselberg are the regions of poor groundwater prospecting zones.

INTRODUCTION

Groundwater is a most valuable natural resource; ground water is the major source of drinking water in India and needs judicious use for sustainable groundwater management. Groundwater development programmes require large amount of multidisciplinary data from various sources. Groundwater occurrence being subsurface phenomenon, its assessment is based on indirect analysis of some directly observable terrain features like geological, geomorphological, structural features and their hydrological characteristics. Groundwater is a dynamic and replenish-able natural resource. But, in hard rock terrain availability of groundwater is limited. In such terrains ground water is essentially confined to fractured and weathered zones. Therefore, exploration and exploitation of ground water resources require thorough understanding of geology, hydrogeology and geomorphology of the area. Satellite remote sensing provides synoptic view, which is helpful in identification and delineation of various land forms, linear features, structural elements and terrain characteristics being significant indicators of groundwater potentiality. Analysis of various data and thematic maps such as Terrain features derived from Remote Sensing Images, hydro geomorphological details, Depth to Groundwater Table (DTW) and Geology, Soil map and Ground water Prospects map help identification of groundwater potential zones in the study area. The present study area which is hard rock terrain, having undulating topography and insufficient rainfall suffers from water scarcity for domestic and Agricultural purposes due to limited nature of aquifers. Taking into consideration the above scenario an attempt has been made for mapping of groundwater potential zones, by integrating and analysis of various thematic maps, as generated from processed and enhanced remote sensing multiple data, Digital Elevation Model (DEM) created from Carto DEM Image along other geo hydrological data in GIS environment.

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Study area

The present Study area of Kalyandurg, consisting of Kalyandurg, Brahmasamudram and Settur Mandals of Ananthapur district of Andhra Pradesh, India, Lies between 14^0 17' and 14^0 40' North Latitude and 76^0 50' and 77^0 24' East Longitude. It is located in the middle of the peninsular region and is confined to southwestern part of Andhra Pradesh. It is bounded by Gummagatta, Beluguppa, Atmakur, Kanaganapalli and Kambadur Kundurphi mandals of the same district and western side bounded by Karnataka state. The total

geographical area of the study area is 1101.25 Sq Km. According to 2011 census the total population is 1,76,297 of which urban population is 32,335 (18 %), with literacy rate of 60.92 % and the sex ratio of total population is 964.The Hagiri River flowing in Northern side and Penna River flowing in Eastern side of the study area of Kalyandurg, Bhairavanitippa Reservoir constructed across the Hagiri river in Brahmasamudram Mandal. Soil cover in the study area is predominantly red loamy soils followed by black soils and alluvial soils. Natural vegetation is very thin and scanty and mostly thorn scrub jungle type. The terrain is largely undulating and closely disclosing the characteristic feature of plateau topography.

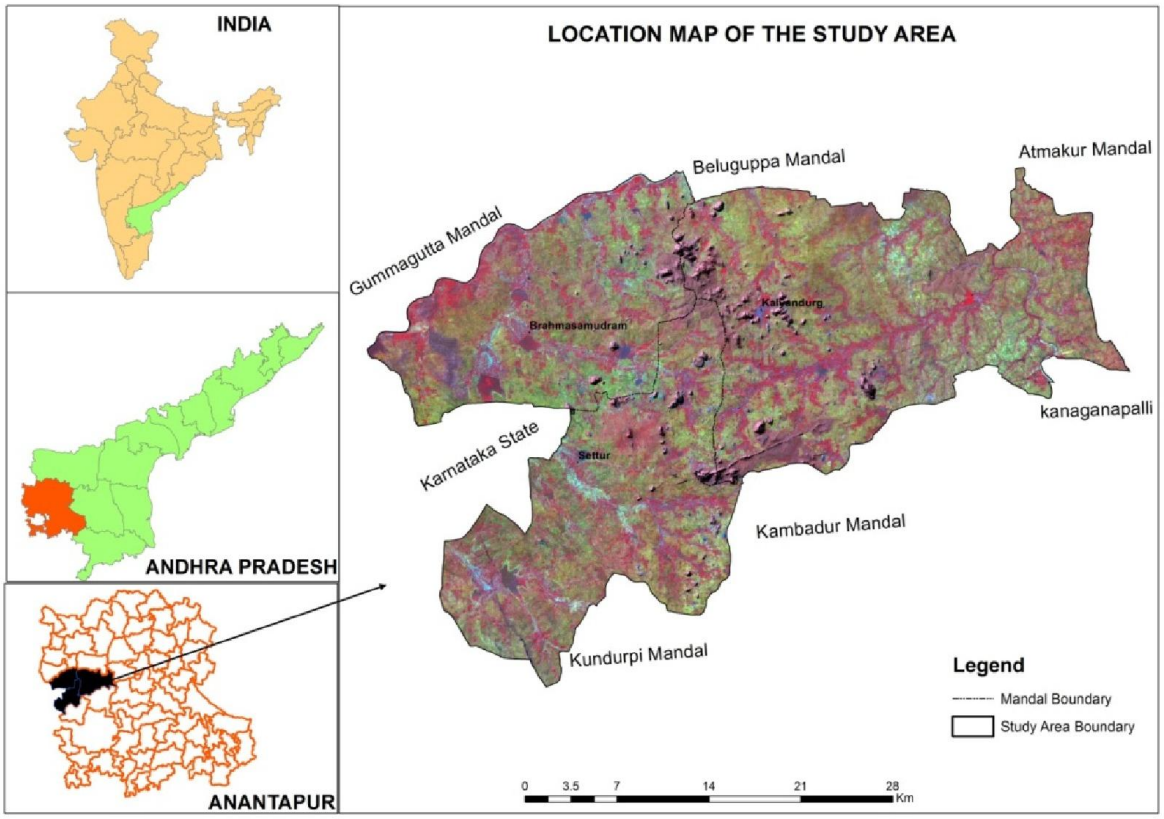

Fig.1. Location Map of the Study Area of FCC Image of Kalyandurg

MATERIALS AND METHODS

Survey of India (SOI) topo sheet no. D43 K14, K15, L2, L3, L6 and L7 of 1: 50,000 scales (latest series of topo sheets procured from Survey of India and Scanned) were used for the preparation of base Layers of Roads, Railways, Settlements and Forest boundaries of the study Area. The drainage, Canal and Water body layers were initially derived from SOI toposheet and subsequently updated using IRS FCC data. All thematic layers of Hydro geomorphology, Soil, Land Use/Land Cover of the area Interprepated based on image interpretation keys and geotechnical elements such as tone, texture, size, shape, association, pattern, drainage, erosion etc. The geological Map of the study area procured from the Geological Survey of India (GSI, 2001) and Analyzed. Groundwater Prospects Map procured from NRSA) and Analyzed, Cartosat-1 and LISS-IV data for 2012 (procured from NRSA, Hyderabad India) were fused using ERDAS imagine and Bilinear Interpolation resampling algorithm to generate the merged image. This merged image was used for interpretation/ analysis of, Land Use/Land Cover etc. Depth to Groundwater level (DTW) maps prepared based on Ground water samples collected from Groundwater department, initially this excel table joined into spatial data and using Spline with Barriers tool prepared DTW mps (Interpolates a raster surface, using barriers, from points using a minimum curvature spline technique. The barriers are entered as either polygon or polyline features), ERDAS Imagine 9.6 and Arc GIS 10.1 Software were used for the preparation of all thematic layers and Maps.

RESULTS AND DISCUSSION

Hydro geomorphology

According to chambers dictionary the meaning of Geomorphology is “the scientific study of the nature and history of the landforms on the surface of the Earth and other planets, and of the processes that create them. The geomorphic study was carried out in the study area and the Hydro geomorphological map was prepared (Fig.2). The study area geomorphic features have been observed, namely Inselberg occupied about 1506.58 ha (1.37%), Moderately weathered pediplain occupied 14164.62 ha (12.86%), Pediment Inselberg complex occupy about 24407.14 ha (22.16 %), Shallow weathered Pediplain occupy major area in the study area about 61152.81 ha (55.53%) and Shallow dissected Pediplain occupy about 8895.09 ha (8.08%) as shown in the Figure.2.

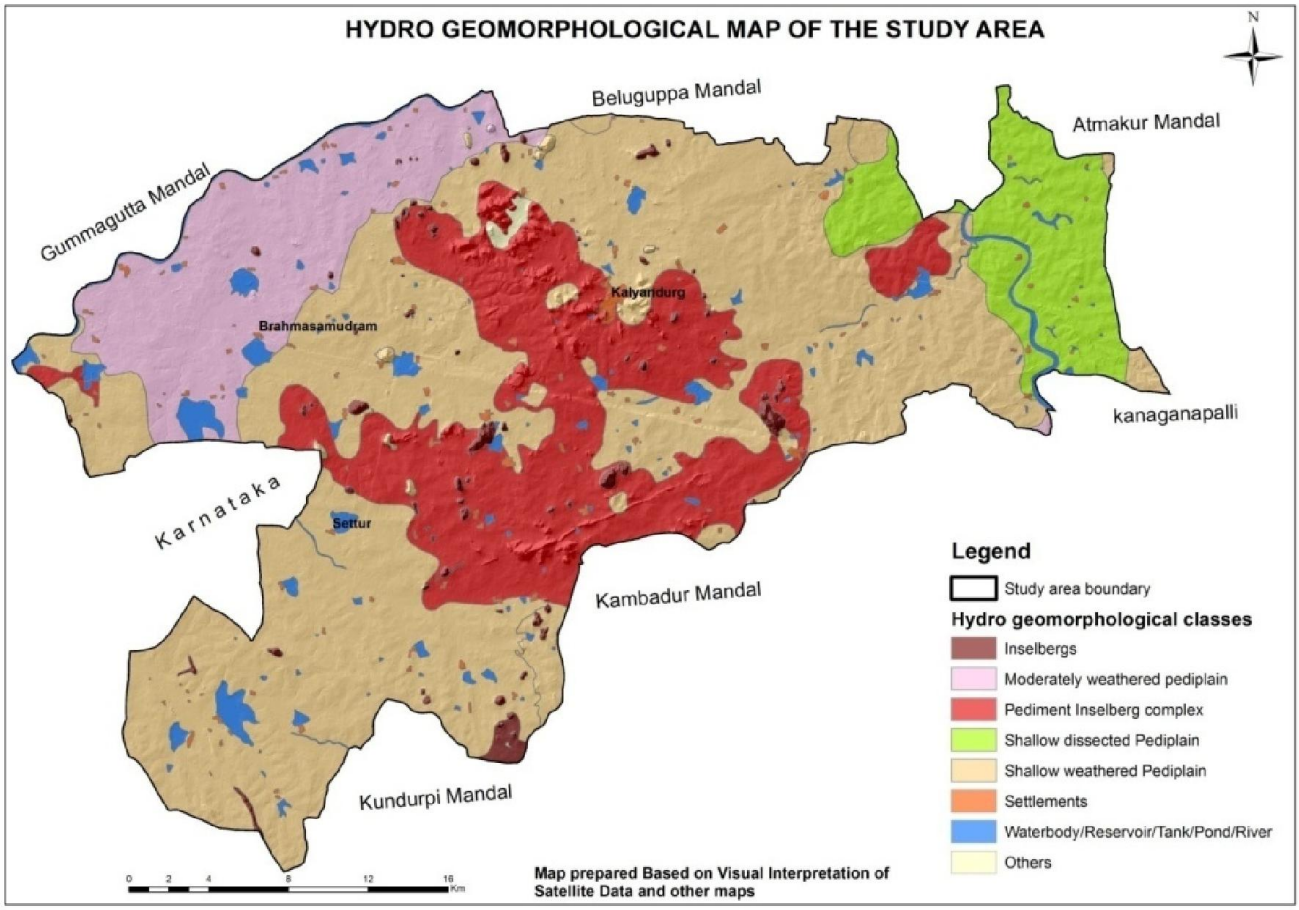

Fig.2. Hydro geomorphological Map of the Study Area of Kalyandurg

Geology and Soils

Kalyandurg has an undulating topography with a general slope towards north and east. The Geology of the mandal (see FIGURE 4) is comprised of Archean rocks which consist of gneisses, Schists, younger granites, quartz veins and basic dykes. The Archaen rocks have suffered a Considerable degree of tectonic disturbance as a result of which the rocks have been Metamorphosed and recrystallised (AP GWD, 1999a). The granite rocks may be separated into two distinct groups namely the massive and foliated types. The massive grey granites give rise to elevated features while the foliated types are found below the plains and also occur as low dome hillocks. Dharwar rocks, occurring as a linear schist belt within the gneissic complex, form linear hills in the eastern part of the mandal. Numerous basic dykes, which are essentially dolerite in composition, traverse the older rocks and these are exposed as long narrow and generally persistent ridges. The length of the dykes varies from 0.5 to 9 km and the width from 50 to 500 m. In addition to the above, alluvium of 1-7 m thickness occurs along the course of the Hagiri and Pennar River and in the vicinity of minor streams and tanks.

1. Alluvio-colluvial clayey soils: This type of soils distributed only south western (SW) part of the study area of settur mandal at Mulakaledu Village, small streams are flowing in this area and Mulakaledu Cheruvu is the Big Tank in this area
2. Medium calcareous black soils: Very small portion of the study area of Kalyandurg mandal covered in this type of soils, 121.6 ha covered in the study area. This area is Located near Golla village, and part of the Hagiri or Vedavathi River basin area.
3. Red gravelly clay soils: This type of soils distributed all over the study area, most of the Kalyandurg mandal area and eastern part of the Brahmasamudram mandal in Hagiri River basin and small portion of the southern part of the Settur mandal near Anumapalle village covered in this type of soil. About 42175 ha. (38.30 %) of the area covered Red gravelly clay soils in the study area.

Table 1. Distribution of Soils in the study area of Kalyandurg

S.No	SOIL TYPE	Area in hectares	Percentage %
1	Alluvio-colluvial clayey soils	3261.71	2.96
2	Medium calcareous black soils	582.24	0.53
3	Red gravelly clay soils	42175.00	38.30
4	Red gravelly loamy soils	8432.76	7.66
5	Red shallow gravelly clay soils	29789.48	27.05
6	Red shallow gravelly loamy soils	8276.73	7.52
7	Red shallow loamy soils	4399.32	3.99
8	Saline-sodic soils	13209.01	11.99
	Total	110126.24	100.00

4. Red gravelly loamy soils: These soils situated at middle portion of the study area and 8432.76 ha. (7.66%) covered in Kalyandurg and Settur mandals. Majority of the area

covered in Kalyandurg mandal surrounded by Kalyandurg town and Penneru Drainage basin area.

5. Red shallow gravelly clay soils: Covered in western part of the study area, about 29789.48 ha (27.05%) area covered in Settur and Brahmasamudram mandals. predominantly Hagiri River basin area of Brahmasamudram and Setturu mandals covered in this type of soil.
6. Red shallow gravelly loamy soils: Northern part of the study area covered in this type of soils, predominantly in kalyandurg mandal and small portion of the North Eastern part of the Brahmasamudram mandal covered about 8276.73 ha (7.52 %). Hagiri or Vedavathi River basin covered.
7. Red shallow loamy soils: North and North Western portion (NW) of the study area covered in this type of soils covered in Brahmasamudram and Kalyandurg mandals about 4399.32 ha (3.99 %). Reserved Forest area of Kalyandurg mandal covered in this type of soils.
8. Saline-sodic soils: This type of soils covered along the Hagiri or Vedavathi River of Brahmasamudram mandal and Nomagadda vanka area of the settur mandals covered in this type of soils.

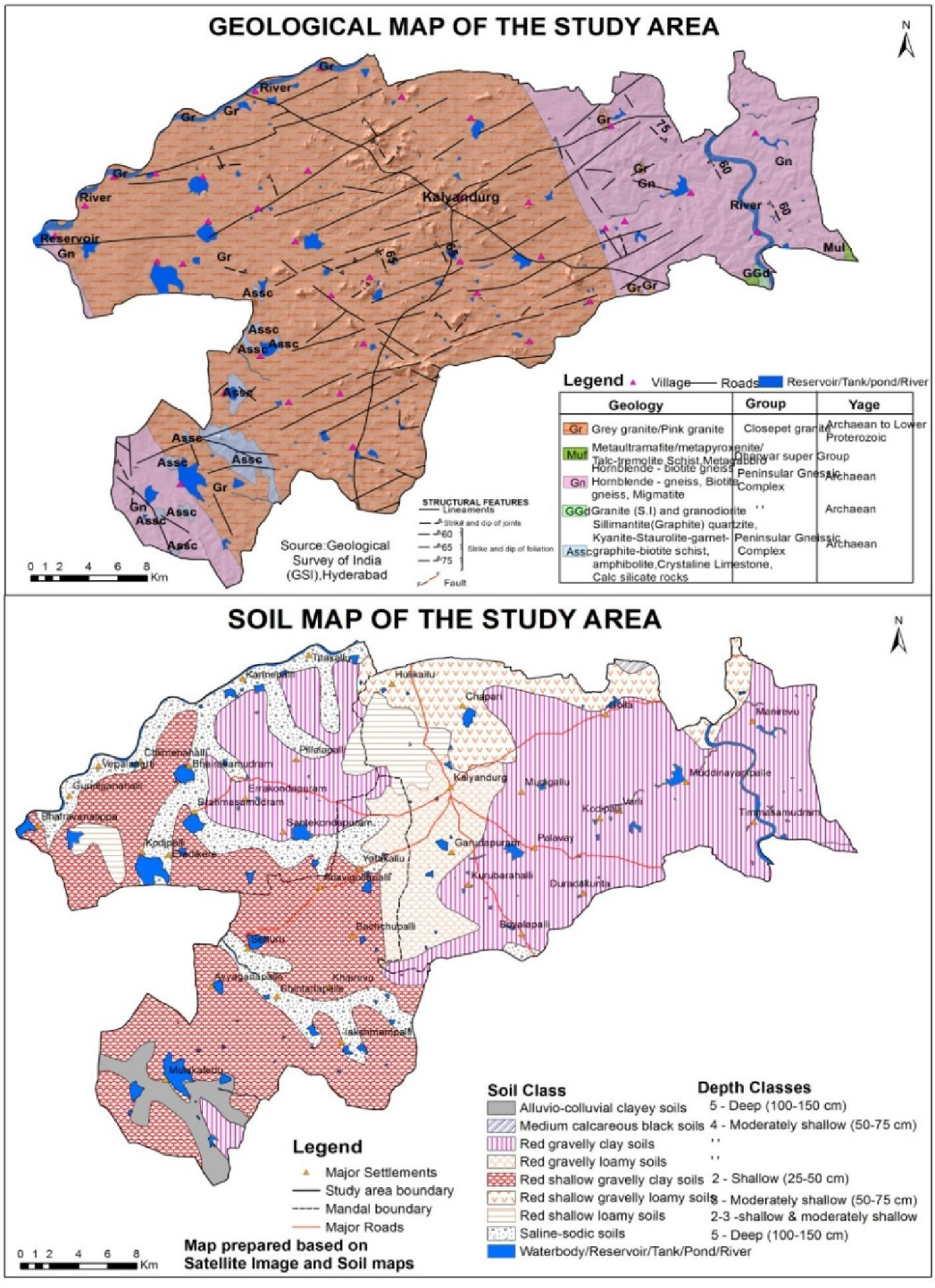

Fig.3. Geological and Soil Map of the Study Area of Kalyandurg

Drainage Density

The development of stream segments is affected by slope and local relief and these may produce differences in drainage density from place to place. Drainage pattern reflects the characteristic of surface as well as subsurface formation. Drainage density (in terms of km/km2) indicates closeness of spacing of channels as well as the nature of surface material. More the drainage density, higher would be runoff. Thus, the drainage density characterizes the runoff in an area or in other words, the quantum of relative rainwater that could have infiltrated. Hence lesser the drainage density, higher is the probability of recharge or potential groundwater zone. The drainage density in the area has been calculated after digitization of the entire drainage pattern. The high drainage density area indicates low-infiltration rate whereas the low-density areas are favorable for high infiltration rate.

The drainage density values thus obtained were reclassified to prepare a drainage density map and categorized into five categories, namely, Excellent, Very good, Good, Moderate, Poor where more than 50% of the study area belongs to good drainage density class (Fig.4).

Depth to Groundwater Levels (DTW)

Groundwater samples collected from Groundwater department, Anantapur, AP and Analyzed. Depth to Water levels for pre Monsoon period of 2012, Deep water levels observed in Anumpalli 7.62 m (bgl). Kannepalli 6.35 m (bgl) in Brahmasamudram mandal, Shallow groundwater zones with water levels <5m is observed in Golla 2.12 m (bgl) in Kalyndurg mandal and Vepulaparthi 3.25 m (bgl) was observed shown in Figure 5.

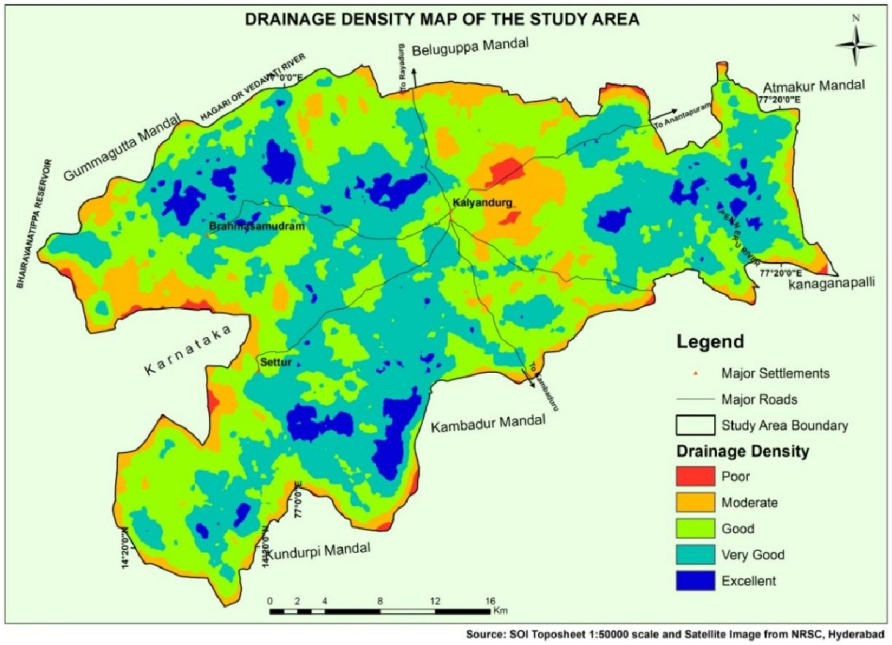

Fig.4. Drainage Density Map of the Study Area of Kalyandurg

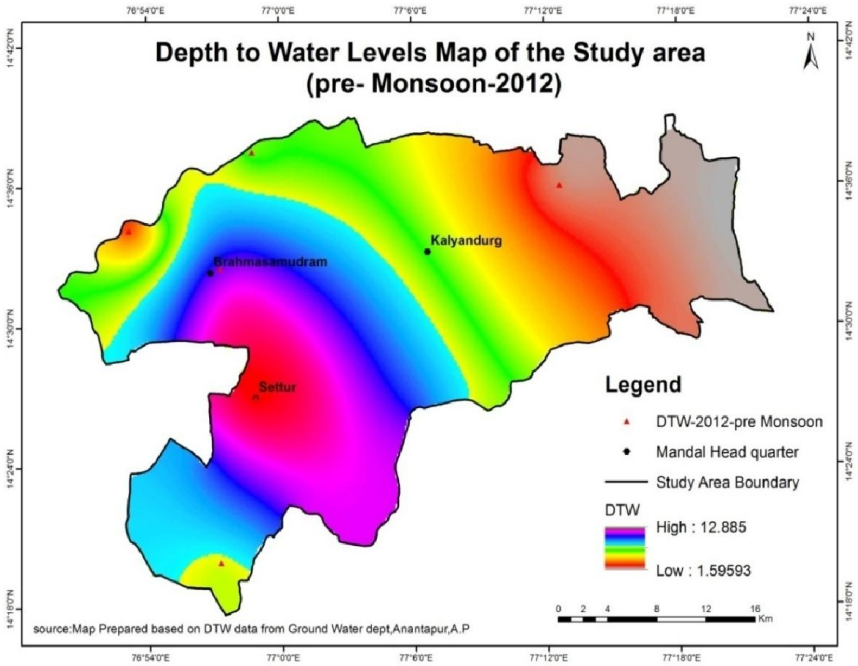

Fig.5. Depth to Groundwater Levels (DTW) Map of the Study Area of Kalyandurg

Ground Water Prospects

The occurrence and movement of groundwater is controlled by various factors such as litho logy, morphology, structure, land use, hydrological conditions etc. Depending upon the ground water capabilities of the aquifers as inferred from the remotely sensed data, keeping in view the geological and geomorphologic conditions, the entire study area is classified into different potential zones (Fig 6) the areas under different potential zones are shown in Fig 6.1 the brief account of them is as follows:

i. Very Good Yield Prospect Areas

Areas occupied by unconsolidated alluvial aquifer material with an average thickness of about 8-10 meter occurring in older flood-plain and flood-plain areas with very good hydrological conditions are demarcated as very good yield prospect areas. `These areas are observed to sustain good rates of pumping. From the hydro geological data collected, the observed well yields are about 20 cum. per hour or above. High concentration of filter points are noticed in this zone, most of them are providing 24 hours water supply during most of the year. Depth to water level in this area is 9 to 13 meters in pre and post monsoon period, forms good recharge with shallow aquifer due to repeated cycles of sand, silt and gravel casing is required up to 10 meters.

ii. Good Yield Prospects Area

The alluvial plain adjacent to flood-plain and the valleys filled with alluvial and colluvial material associated with good density of fractures with thick weathered zones and large catchment areas are demarcated as good yield prospects area. This zone is distributed in all the mandals.

iii. Moderate Yields Prospect Areas

The Pediplain areas with moderate weathered zone and good density of fractures are included in this zone. The narrow valleys filled with colluvial material. The Hagiri valley in Brahmasamudram mandal, forming pediment over slates and phullites, and granitic pediplain in Kalyandurg and Settur mandals. The yield range of wells in these areas would range between 100 to 150 lpm. The pediplain zone is Moderate for groundwater recharge.

iv. Poor Yield Prospect Areas

The areas occupied by rocky pediment and alluvial plain affected with alkalinity and salinity problem occurred areas demarcated as low yield prospect areas. The yield range of wells 10 to 50 lpm, in general would be less than 5 cum per hour. Though, the ground water prospects are moderate in saline/ alkaline plains, these are included here due to poor quality. The fractures in this zone possess moderate potentials.

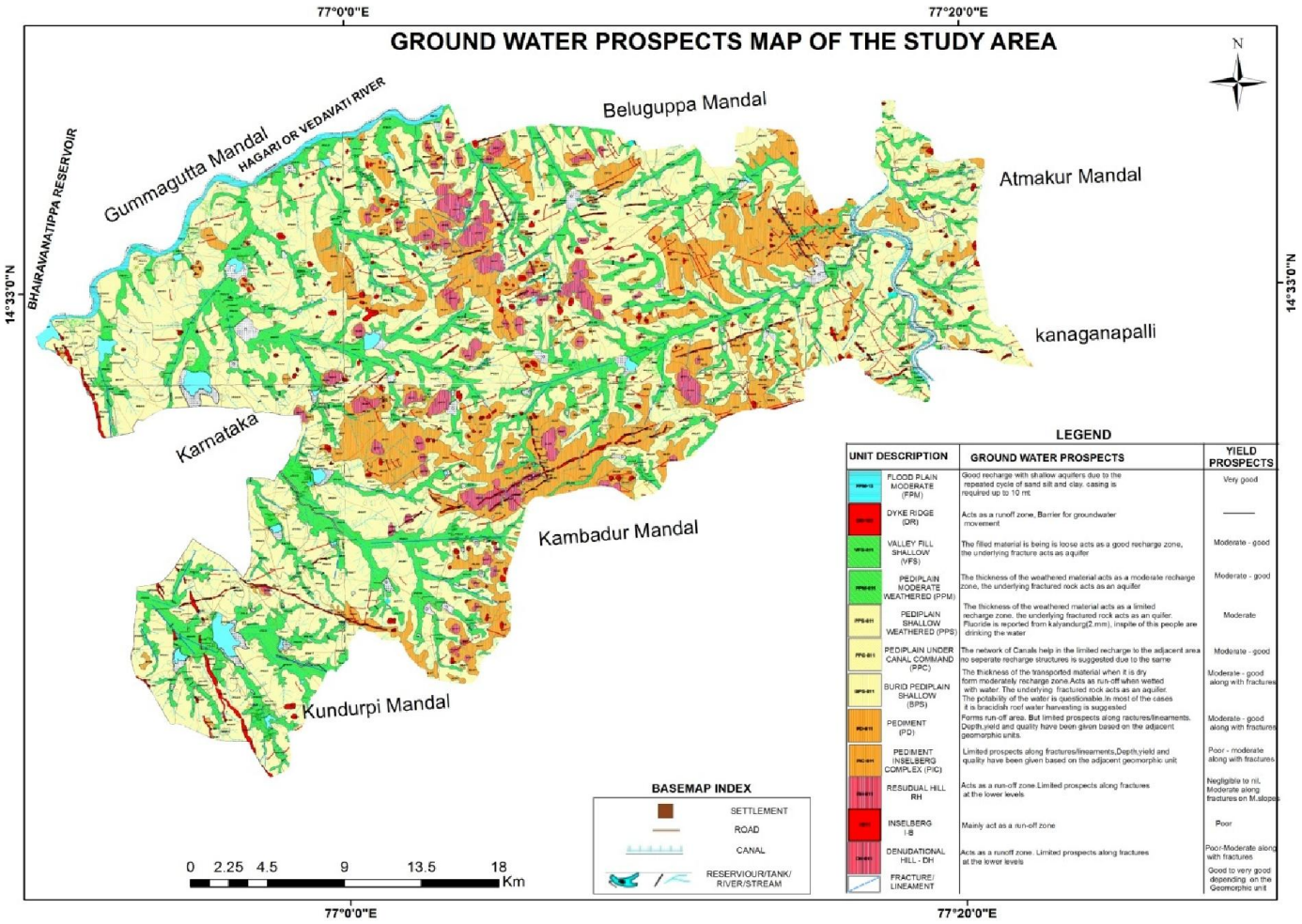

Fig.6. Groundwater Prospects Map of the Study Area of Kalyandurg

v. Negligible –Nil Yield Prospect areas

The areas occupied by residual and structural hills, inselbergs and dykes associated with steep slopes are demarcated as negligible to nil yield prospects areas. Under this category distributed in all the mandals of the study area. The fractures in this zone possess moderate potentials. In general the western part is comparatively better with respect to the groundwater yield than the eastern part of the study area.

Conclusion

Remote sensing and Geographic Information System (GIS) approach is very constructive because this integrates various geospatial informations especially for groundwater potential zone mapping. Study has focused on the effectiveness of remote sensing and GIS in the identification and delineation of groundwater potential zones of study area. From the analysis the groundwater potential zones with excellent, very good, good, moderate and poor prospects are observed in the three mandals of the study area, it is observed that high potential zones are mainly located along lineaments and in the floodplain areas, pediment areas. Alluvial fills, valley fills are good potential zones. The geomorphic units like buried pediplains, peniplains and denundational hills are moderate to good groundwater prospective zones. Undulating upland and buried pediments with intermontane valley, mainly confined in undulating upland, Inselbergs are the regions of poor groundwater prospecting zones.

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