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Ground water potential zone of Kushavathi watershed in Kolar district

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Abstract: ***Groundwater is an important natural resource in present day, but of limited use due to frequent failures in monsoon, undependable surface water, and rapid urbanization and industrialization have created a major threat to this valuable resource. A groundwater development program needs a large volume of multi disciplinary data from various sources. In order to ensure a judicious use of groundwater, its proper evaluation is required for optimal utilization. With groundwater occurrence being a subsurface phenomenon, its identification and location are based on indirect analysis of some direct observable terrain features like geology, geomorphology and their hydrologic characters. The present work is an attempt to integrate RS and GIS based analysis and methodology in groundwater potential zone identification in the study area, , Kushavathi watershed occupies the south eastern corner of the Kolar district which is situated in the south - eastern part of Karnataka at a distance of 70 km east of Bangalore city. 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.***

Keywords— geology, geomorphology, groundwater potential zone, land use/land cover, GIS platform

I. INTRODUCTION

Geographical area of the districtis 8223 sq.Kms and has a population of15.41lakh(2011 census). The area forms aplain to undulating land and drained by north Pinakini, south Pinakini and Palar rivers which are ephemeral in nature. There are no surface water irrigation and no surface water irrigation projects except minor irrigation tanks. Ground water is practically the sole source of domestic, irrigation and industrial requirement. Net sown area is 3604 sq.km(43.8% of total area) and net irrigated area 918.05 sq.km(25.5% of net sown area). Vegetables ragi, jowar, mulberry, mango and paddy are the main crops.

The district falling in the eastern Agro climatic zone has a semi-arid climate. The normal rainfall (IMD 1971-2000) of the district is 727.3 mm.(table 1) South-west monsoon is predominant, contributing about 55% of the annual rainfall and north –wast monsoon contributes 30%. Rainfall gradually increases from the north-western part of the south-eastern part.

TABLE 1: NORMAL RAINFALL OF KOLAR DISTRICT (1971-2010) [STUDY AREA: KUSHAVATHI WATERSHED (BAGEPALLI, CHIKBALLAPUR& GUDIBANDE)] (SOURCE: IMD)

Sl.No	Taluk	Normal Rainfall (mm)	Coefficient of variability (Cv) (%)		Drought type
			Seasonal	Annual	Drought Prone
1	Bagepalli	705.9	42.6	29.8	-do-
2	Bangarpet	710.7	44.1	28.0	-do-
3	Chikballapur	849.2	32.5	32.3	-do-
4	Chintamani	749.0	32.2	31.6	-do-
5	Gauribidanur	650.3	35.8	30.4	-do-
6	Gudibanda	653.0	44.1	31.1	-do-
7	Kolar	717.5	39.6	27.6	-do-
8	Malur	685.7	27.9	22.5	-do-
9	Mulbagal	764.2	35.7	22.5	-do-
10	Sidlaghatta	769.9	33.7	24.0	-do-
11	Srinivaspur	745.3	32.6	21.7	-do-
	Av.	**727.3**	**36.4**	**27.4**	

Though the rainfall is 750 mm or more, as the Cv is in excess of 30 percent, drought conditions prevail in the district and all the taluks are classified as 'Drought Prone'. The district is underlain by granites, gneisses and schists of Archaean age intruded by basic dykes of later period. Major part of the district is occupied by granites and gneisses. Schists are mostly confined to two places i.e. one around Kolar Gold Fields and the other in the northwestern part of Gauribidanur taluk. Laterites occur as capping at sporadic locations of small areal extent in Kolar, Srinivaspura and Sidlaghatta taluks. (Fig.1)

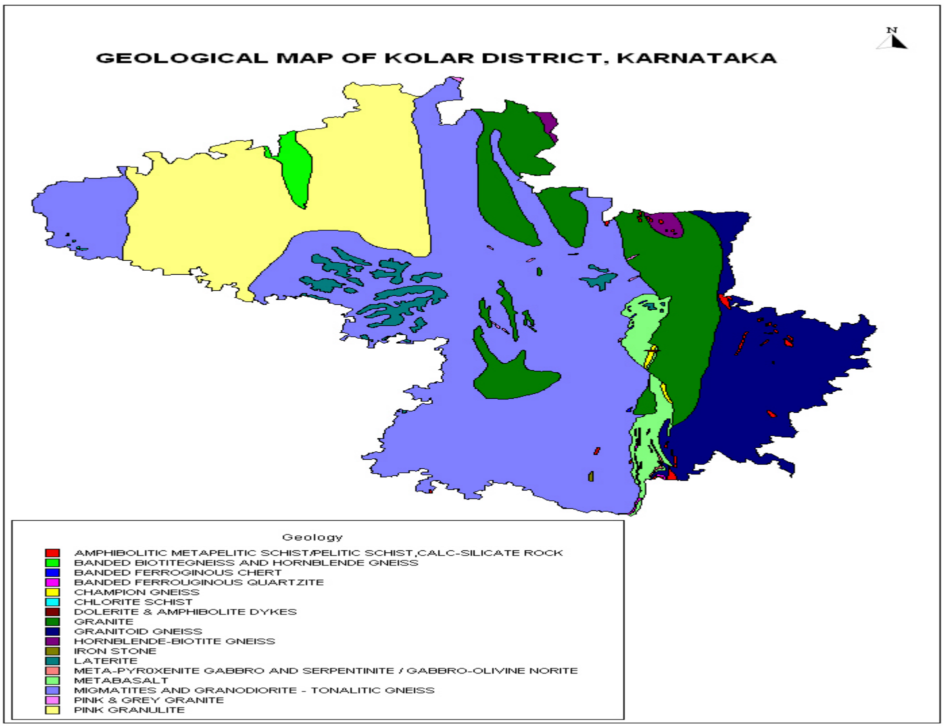

Fig. 1: Geological Map of Kolar district, Karnataka

(Source: Geological Survey of India)

In the district, ground water occurs in phreatic condition in the weathered zone and alluvium. It is under semi-confined to confined conditions below the phreatic zone. The pre-monsoon (May 2009) water level (dug wells) varies from 0.89 mbgl to 14.31 mbgl and during post-monsoon (Nov.2009) it ranges from 0.13 mbgl to 0.13 mbgl to 14.21 mbgl. The depth of water level in Piezometers (Shallow borewells in weathered zone maintained by CGWB) generally ranges from 1.2 to 49.52 mbgl during pre-monsoon period. Appreciable change in ground water levels was noticed closer to over-exploited areas, forming groundwater troughs. Modes of ground water extraction are dug wells, dug-cum-bore wells and bore wells. Among these abstraction structures, bore wells are predominant.

In the study area, there are no perennial rivers that can cater to the drinking water needs and support the irrigated agriculture. High groundwater exploitation has resulted in fast decline in water levels over the years. The long term (decadal) water trend of the observation wells (CGWB) shows a fall in 62% of the wells in the range of 0.02 m to 3.47 m/year (Fig. 2a&2b).

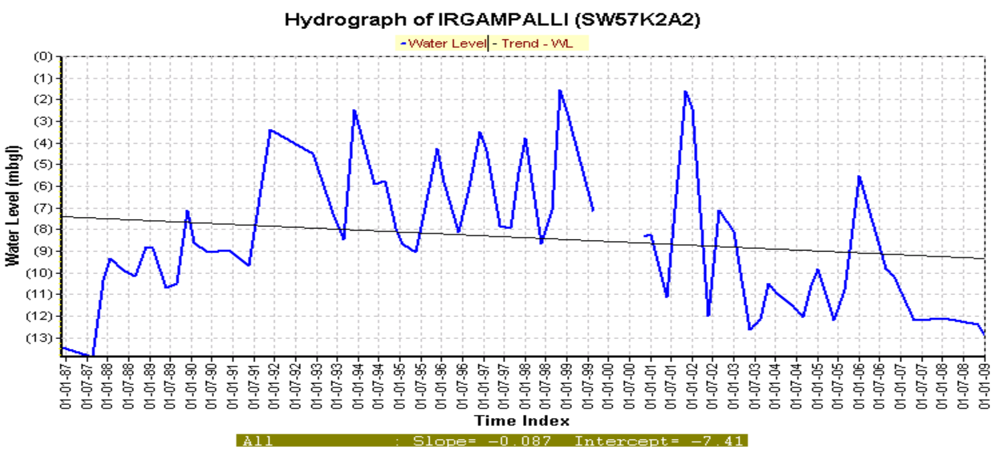

Fig.2 a: Hydrograph of Irgampalli monitoring station

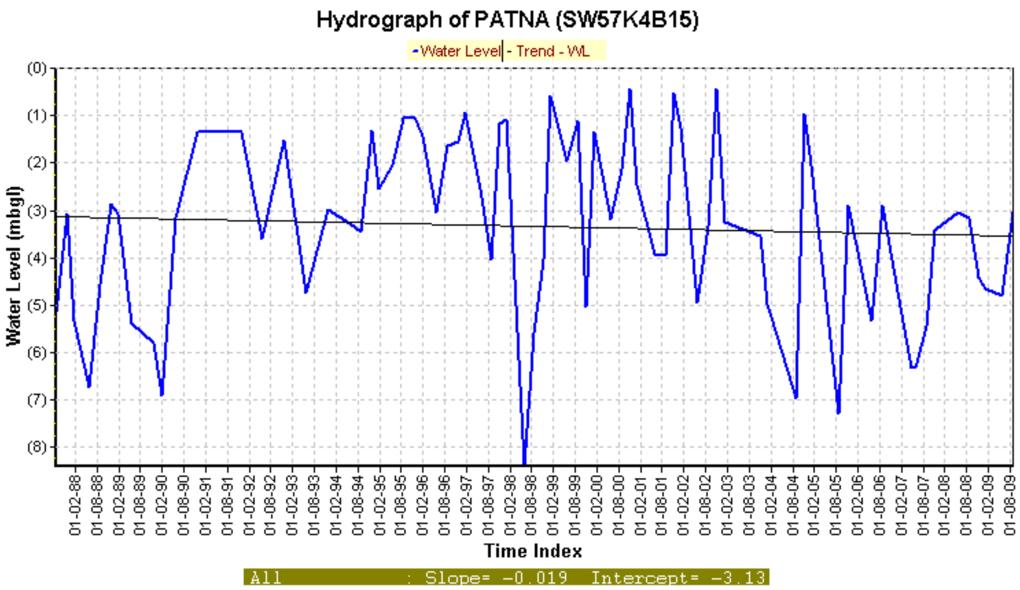

Fig. 2 b: Hydrograph of Patna monitoring station

The absence of perennial rivers or surface irrigation projects in district, the irrigated agriculture is wholly groundwater dependent. In addition to the afore said reasons, poverty and tradition have compelled the farmer community to resort to agriculture. As per MI Survey (2001), 10,435 dug wells, 310 shallow bore wells and 226 deep bore wells have gone dry causing a huge financial burden to the farmers' community. There are at present 1, 23, 000 bore wells in the district.

The first phase of drilling in the drought prone Kolar district was taken up between 1996 and 1998. General depth of drilling during 1960 was 30 mbgl, which increased to 60-100 mbgl during the year 1970 and it varied from 100 to 300m from the year 1980 onwards. The depth drilled in the first phase in Kolar district varied from 22.0 mbgl to 300.7mbgl. The salient details of the wells drilled are given in the following Table 2.

Deep Groundwater Exploration Programme of Central Ground Water Board, with an objective to explore the possibility of existence of deeper potential zones, a 500 m capacity DTH rig has been deployed in Kolar district, Karnataka, since 2004.

Table 2: Salient Details Of The Exploratory Wells During Phase –I In Kolar District [Study Area: Kushavathi Watershed (Bagepalli, Chikballapur& Gudibande)]

Taluk	No of wells drilled	Depth range (m bgl)	Discharge range (lps)	Zone depth (m bgl)	Casing (m)
Shrinivaspur	3	203.27 - 300.70	Neg – 0.43	32.5-124	7.22-27.72
Mulbagal	3	192.0 – 200.0	0.4 – 5.41	11.5-153	10.7-21.0
Kolar	9	36.0 – 200.0	2.4 – 16.0	15-170	8.07-18.0
Malur	3	134.0 – 300.0	2.4 – 9.9	20.4-125	12.0 -22.0
Bangarpet	3	146.0 – 227.0	2.4 – 9.9	22.4-144	18.0 -24.0
Chintamani	3	150.0 - 200.0	2.07-8.2	14.8-129	8.0-14.0
Sidlaghatta	2	106.0 – 250.0	1.0-16.0	18.8-172	5.0 -9.0
Chikballapur	3	150.0 – 260.6	<1.0	12.7-61	15-19.5
Bagepalli	3	157.5 – 200.0	1.1-4.0	10-144	3.3- 7.0
Gudibanda	3	22.0 – 200.0	1.0-9.0	12-123	1.6-24.2
Gauribidanur	2	222.0 – 226.0	4.8-5.5	9-172	6.75-23.4
Total/ Range	**37**	**22.0 – 300.7**	**<1 – 16.0**	**11.5 – 172.0**	**1.6 – 27.2**

Groundwater in the hard rock generally occurs under phreatic condition in the uppermost layer comprising weathered formation. This constitutes a good repository of groundwater and is tapped by dug dug-cum-bore wells. Thickness of this zone in Kolar district varies in from 10 m to 93.0m depending upon the local topographical situation. Based on the depth of bed rock (casing depth) data, it can be seen that the average depth of this zone is 30 to 35m. This zone has become dry or depleted in major part of the district causing failures of dug wells. This is further evident from the water level monitoring stations maintained by CGWB. Out of 113 stations, during May 2010 periodical water level data collection, only 15% of the wells had water. Hence, it is clear, the phreatic zone in the district is almost depleted except in topographic lows at places and vicinity of surface water bodies like MI tanks.

In the explored area it is observed that potential fractures are likely to occur even below 300 m depth. At Malur EW (308-309m; 7 lps), Malur OW (301-302m; 2.8 lps), Akkimangala EW (388-390m; 2.15 lps), Oregaum EW (374-375m; 3 lps), D. Karpanahalli (486.5 - 487.3 m; > 1 lps) deep potential fractures have been encountered. Deep drilling has revealed the existence of deep-seated potential fractures. The depth-wise fracture frequency analysis is given in the Table 3 and shown graphically in Fig.3.

Table 3 : Depth-wise fracture frequency

Depth (mbgl)	No of fractures	Fracture %
<100	37	39
100upto 200	30	32
200upto 300	20	21
300upto 400	5	6
400upto 500	2	2

Depth wise fracture frequency analysis indicates that, out of 94 fractures encountered down to a depth of five hundred meters (not in all cases), about 39% occur within 100 m, 32% between 100 and 200m, 22% between 200and 300m, 6% between 300and 400m and 2% between 400 and 500m. This shows that more than 70% of the fractures are concentrated within 200 m depth. Otherwise, it can be concluded that maximum fractures (39%) are concentrated with in 100m of depth and fractures are reducing with the depth. Majority of the fractures are encountered within 300m (92%) and below which they are very rare.

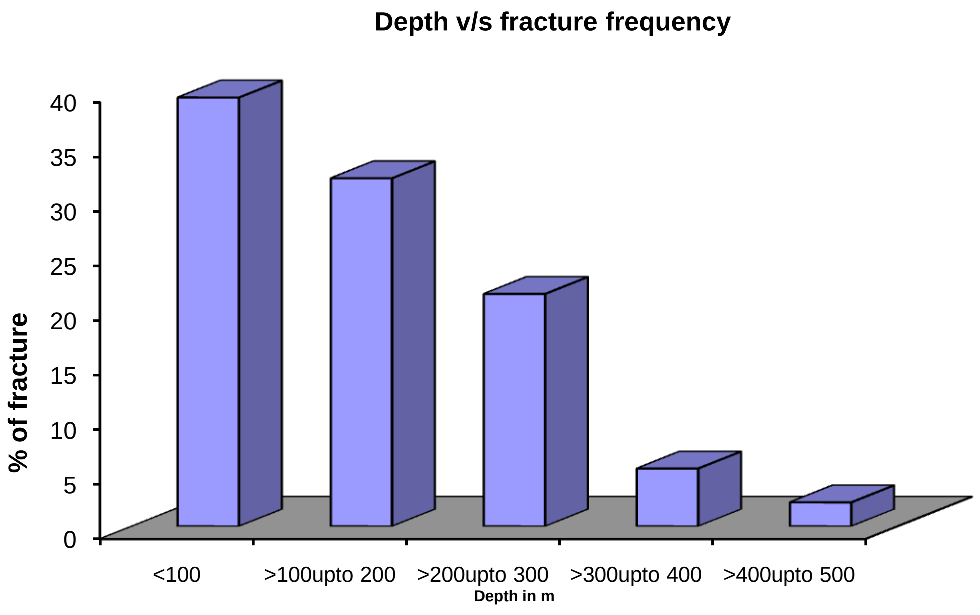

Fig.3: Showing plot of depth-wise occurrence of fractures

Fractures encountered are classified into five depth grades viz. < 100m, 100m to 200m, 200m to 300m, 300m to 400m and 400m to 500m.Then in each depth range, fractures are classified according the different yields (discharge) ie <1 lps, 1 to 5 lps and > 5 lps. This will give an idea of the optimum depth of a bore well for a good yield.

Table 4: Depth-wise frequency of fractures and their yield potentials

Depth Mbgl	No of fractures (%)	Yield Upto 1 lps (low yield)		>1 to 5 lps (medium yield)		>5 lps (upto 24 lps) (high yield)	
		No of fractures	% of total fractures	No of fractures	% of total fractures	No of fractures	% of total fractures
<100	37 (39)	32	86.5	4	10.8	1	2.7
100 to 200	30 (32)	12	40	10	33.3	8	26.7
200 to 300	20 (21)	6	30	13	65	1	5
300 to 400	5 (6)	2	40	2	40	1	20
400 to 500	2 (2)	2	100	Nil	Nil	Nil	Nil
Total	94	54 (57.45%)		29 (30.85%)		11 (11.70%)	

The graph showing the yield prospects of fractures in different ranges is given in fig.

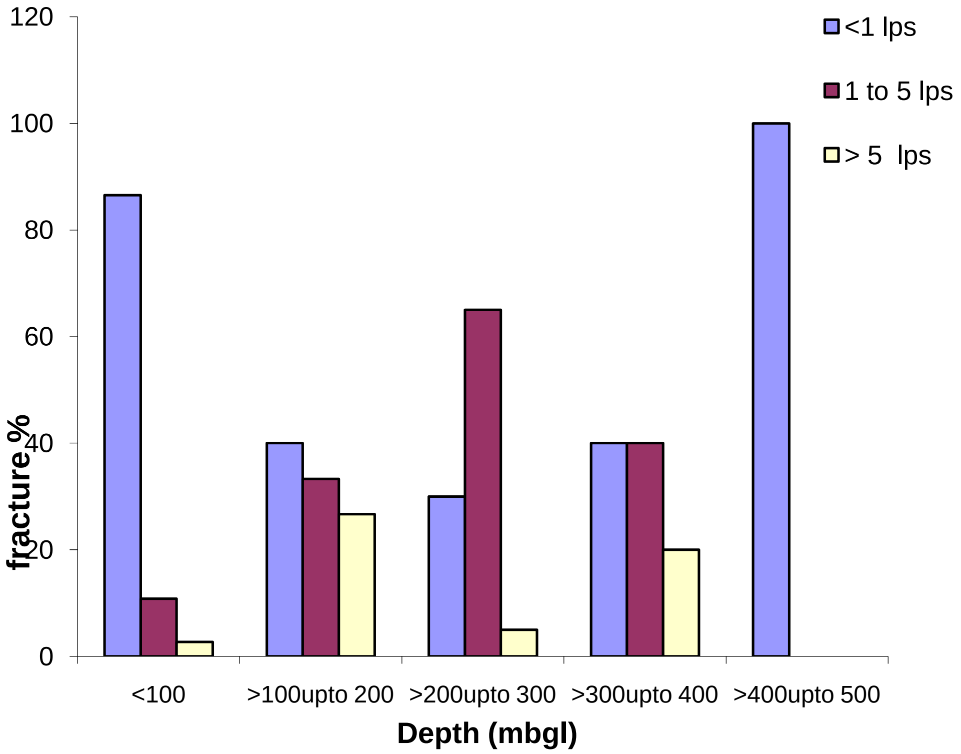

Figure 4 : Depth-Wise Fracture Frequency V/S Yield of Bore Wells

Conclusion:

The fracture depth against yield analysis reveals that majority of the fractures (92%) encountered are within 300m and generally, fractures with in 100m or below 300 m are low yielding(<1 lps). About 32% of the fractures are between the depth of 100m and 200m and in this range, nearly 27% are high yielding(> 5 lps) and 33% are medium (1-5 lps) . Thus, medium and high yield fractures constitute 60%. About 21% of the fractures are between the depth of 200m and 300m and in this range, only 5% fractures are high yielding (> 5 lps) and 65% are medium (1-5 lps) yielding. The 300m to 400m zone has only 5.3% of the total fractures and among these, 60% are in the medium to high yield category. The zone below 400m is of low fracture (2.2% of the total fractures) and low (< 1 lps) yield).

It is evident that, in the top 100 m depth zone, 86.5% of the encountered fractures are poor yielding with less than 1 lps discharge. This indicates that majority of the fractures in the top zones are depleted due to over-exploitation of groundwater. The 100 to 300 m zone is the optimum zone as far as the depth and the yield of bore wells are concerned. This depth zone has good number of groundwater potential fractures and the 300 to 400 m depth zone has less chances of encountering fractures of high yields.

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