Groundwater Prospectus Map for Suryanagar Subwatershed

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Abstract- **In developing accurate hydro geomorphological analysis, monitoring, ability to generate information in spatial and temporal domain and delineation of land features are crucial for successful analysis and prediction of groundwater resources. However, the use of RS and GIS in handling large amount of spatial data provides to gain accurate information for delineating the geological and geomorphological characteristics and allied significance, which are considered as a controlling factor for the occurrence and movement of groundwater used IRS LISS II data on 1: 50000 scale along with topographic maps in various parts of India to develop integrated groundwater potential zones.**

The present work is an attempt to integrate RS and GIS based analysis and methodology in groundwater potential zone identification in the Suryanagar sub watershed, Urban Bangalore, study area. 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. Five categories of groundwater potential zones namely poor, moderate to poor, moderate, good and very good were identified and delineated. The spatial variation of the potential indicates that groundwater occurrence is controlled by geology, land use / land cover, slope and landforms.

Index terms- Sub-watersheds-Hydrological studies-Groundwater-water, Groundwater prospectus map

INTRODUCTION

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. 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.

Study area

The study area is located between Latitude 12º47′32″N and Longitude 77º41′59″ E as shown in figure 3.3 The study area covers an area of 172.42 km2 and attains maximum elevation 950m and minimum elevation of 880m. Suryanagara township is situated on the anekal main road, chandrapura near by cities benahalii, attibele, Bangalore. Suryanagara located at distance of 25 km from Bangalore. physiography of the area is characterized by undulating topography with pediplains, pediment and valley fills. The mean annual total rainfall is about 920 mm with about 60 rainy days a year over the last ten years.. The summer temperature ranges from 17° C to 36° C, while the winter temperature ranges from 12° C to 25° C. Thus, Bangalore enjoys a salubrious climate all round the year. The area of the watershed is obtained from delineating the toposheets covering 57 H/9 and 57 H/10 of 1:50000 scale by using ARC GIS software. The area of the watershed is found to be 172.42km2 The Location map of the study area is shown in Fig: .1

MORPHOMETRIC ANALYSIS

For morphometric analysis the drainage map from SOI on 1:50000 has used. The morphometric analysis was divided into 3 types as linear aspects, areal aspects and relief aspects. Linear aspects include the measurements of the linear features of drainage system such as stream order, stream length, etc. The allocation of the stream orders is based on a hierarchic ranking of streams. Stream length measurements and statistical analysis of a stream length of overland flow is among the most commonly used attributes in linear aspects.

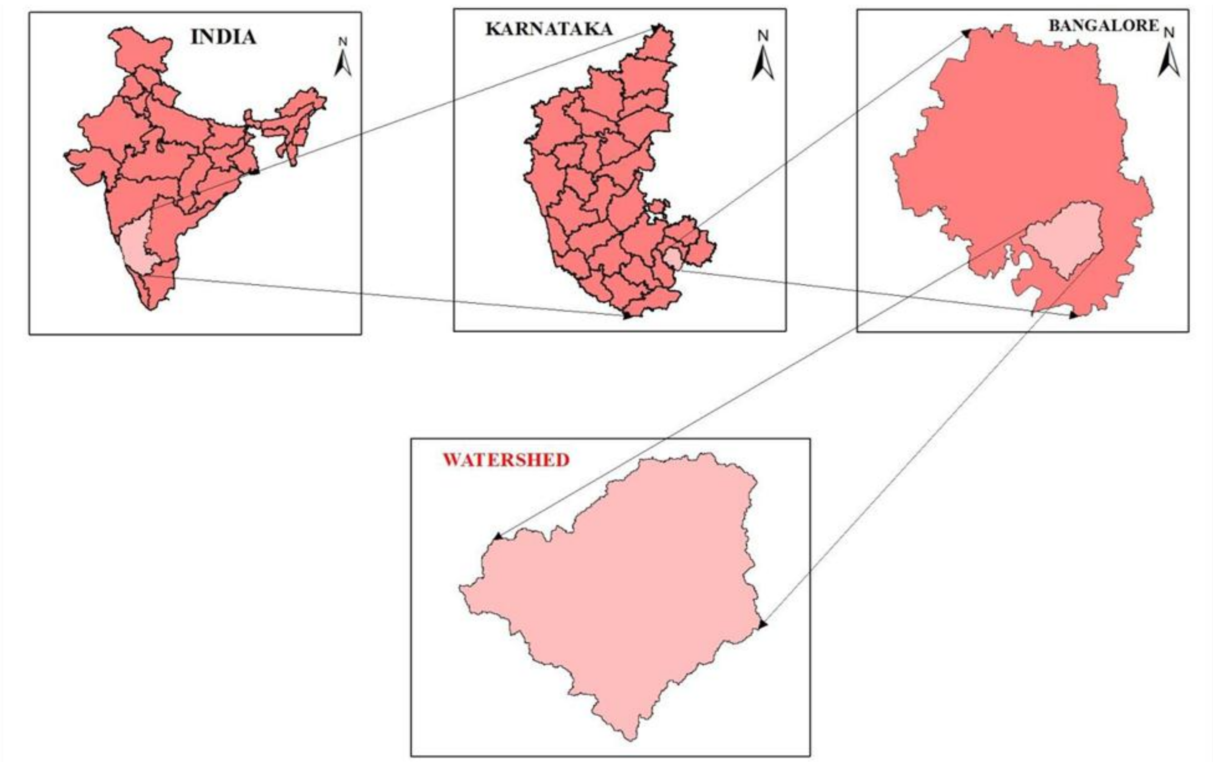

Fig:1 The Location map of the study area

One of the first attribute to be quantified in morphometric analysis is the designation of the stream orders. The concept of channel ordering was first described by Strahler (1957) to decrease the subjectivity of the analysis. In the present study, the highest stream order obtained is 5th order and hence it is designed was 5th order and hence it was designed as 5th order watershed. In Order to know the total number of streams in each order, the segment of each order was numbered. The number of stream segments of any given order will be lesser than the next lower order but more numerous than the next higher order. The concept of stream order is used to calculate other indicators of drainage character of a watershed. Fig 2 shows the stream order assigned to Suryanagar watershed for the morphometric analysis. Plotting the number of streams and stream order (Fig 3) reveals a good relationship between them. Table 1&2 shows all the morphometric analysis of the study area.

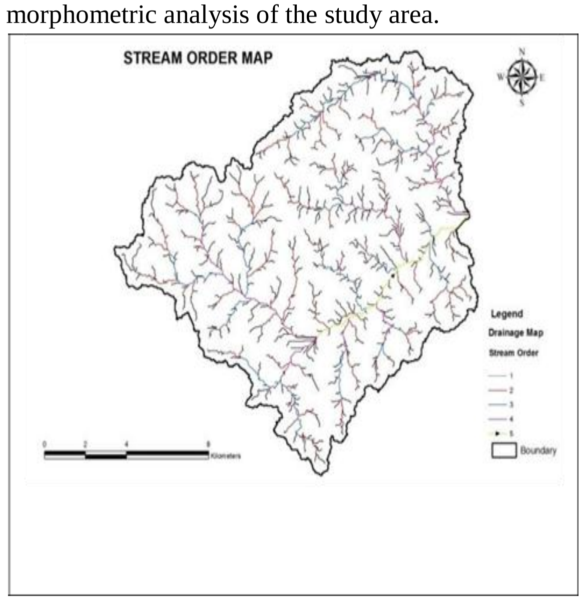

Fig2: Stream Order Map of Watershed

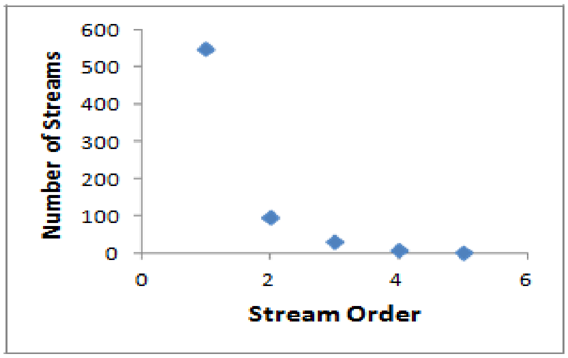

Fig.3 Regression on stream order vs. Number of streams

Table 1: Different Morphometric Characteristics of Watershed

Stream order	No. Of streams	Total length of streams (km)	Cumulative length (km)	Mean stream length (km)	Bifurcation ratio (km)	Length ratio	Drainage Density (Dd) (Km/Sq.km)
1	547	208.92	208.92	0.38			2.27
2	96	91.38	300.30	0.95	5.70	2.49	
3	30	51.41	351.71	1.71	3.2	1.80	
4	8	28.32	380.03	3.54	3.75	2.07	
5	1	10.53	390.56	10.53	8	2.97	

Drainage density reflects land use and affects the infiltration and the basin response time between the precipitation and discharge. For the present study the drainage densities evaluated for the watershed was 2.27 km/Sq.km. which indicates that the area is coarse in nature.

The length of overland flow suggests that the surface runoff will reach the stream faster. The stream frequency is obtained for the study is 3.96 No/Sq.km, so it's classified under the class of low drainage density, leading to higher bifurcation ratio into the soil. The circularity ratio of the watershed is 0.3, which indicates mature nature of the topography. The elongation ratio is evaluated as 0.5, which indicates that the watershed is elongated. The stream frequency is obtained for the study is 3.96 No/Sq.km, so it's classified under the class of low drainage density, leading to higher bifurcation ratio into the soil.

Table 3 shows the watershed wise morphometric characteristics and parameters respectively of Suryanagar watershed.

TABLE 2 Watershed wise morphometric characteristics and parameters of Suryanagar watershed

Sl No	Watershed Parameters	Units	WATERSHED NUMBER									
			1	2	3	4	5	6	7	8	9	10
1	Watershed area	km^2	13.64	40.51	18.48	33.36	12.37	12.7	16.76	10.31	2.35	12.04
2	Perimeter of the watershed	km	25.63	51.08	31.44	40.26	23.15	27.32	34.03	20.92	10.46	28.17
3	Maximum length of the watershed	km	5.64	6.1	7.77	5.42	5.71	4.16	4.47	4.84	1.44	5.4
4	Maximum width of the watershed	km	3.43	11.17	4.03	6.76	3.4	5.67	6.1	3.1	2.76	2.94
5	Watershed highest stream order	No.	5	4	4	5	3	4	4	4	4	3
6	Cumulative stream segments	No.	51	183	78	143	38	47	66	39	9	36
7	Cumulative stream length	km	30.67	71.32	45.5	75.45	26.18	27.02	38.92	22.01	5.6	24.28
8	Length of overland flow	km	0.22	0.21	0.2	0.22	0.24	0.24	0.22	0.34	0.21	0.25
9	Drainage density	km/km^2	2.55	2.34	2.46	2.26	2.12	2.13	2.32	2.13	2.38	2.02
10	Constant of channel maintenance	km^2/km	0.44	0.43	0.41	0.44	0.47	0.47	0.43	0.47	0.42	0.5
11	Stream frequency	No/km^2	3.74	4.52	4.22	4.29	3.07	3.7	3.94	2.03	3.83	2.99
12	Bifurcation ratio		3.05	3.82	4.42	3.62	2.58	3.11	5.47	4.42	2.67	5.88
13	Length ratio		70.44	4.88	2.32	3.76	3.25	2.52	3.29	2.42	35.65	3.13
14	Form factor		0.43	1.09	0.31	1.14	0.38	0.73	0.84	12	1.13	0.41
15	Shape factor		2.33	0.92	3.27	0.88	2.64	1.36	1.19	2.27	0.88	2.42
16	Circularity ratio		0.26	0.2	0.24	0.26	0.29	0.21	0.18	0.3	0.27	0.19
17	Elongation ratio		0.42	0.66	0.35	0.68	0.39	0.54	0.58	0.42	0.68	0.41
18	Compactness coefficient		13.1	22.57	15.24	20.48	12.47	12.64	14.52	11.38	5.44	12.3
19	Total watershed relief	km	0.02	0.04	0.04	0.02	0.036	0.003	0.002	0.02	0.007	0.05
20	Relief ratio		0.003	0.01	0.01	0.004	0.006	0.0007	0.005	0.004	0.005	0.009
21	Relative relief		0.001	0.001	0.001	0.0005	0.001	0.0001	0.00006	0.001	0.0007	0.002
22	Ruggedness number		0.0004	0.001	0.001	0.0005	0.0008	0.0001	0.00005	0.0004	0.0002	0.001

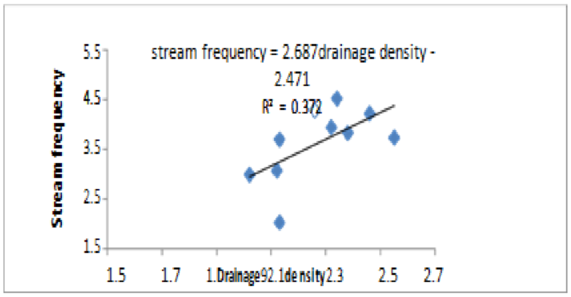

Fig. 6: Regression of Drainage density on Stream frequency

GROUNDWATER PROSPECT MAP

The groundwater prospect map is a systematic effort and has been prepared considering major controlling factors. The map depicts hydrogeomorphological aspects, which are essential as basis for planning and execution of groundwater mapping. In order to demarcate the groundwater potential zones using GIS for the study area the following thematic maps were used. Lithology, Slope, Soil, Land use, land covers Rainfall Hydro-geomorphology, and Groundwater level (Table 4). Were prepared as shown in Fig.7a, b, c,d e & f

Table 4: Characteristic Features of Thematic Layers

Thematic Layers	Characteristics
Geomorpholgy	Land forms , weathered zones etc.,
Lithology	Rock type, weathering character, thickness of weathering, joints, fracture etc.,
Land use and land cover	Forest area, barren land, vegetation land etc.,
Rainfall	Depth of rainfall
Slope	Slope percent
Soil	Permeability, porosity, texture
Groundwater level	Water level in dugwells

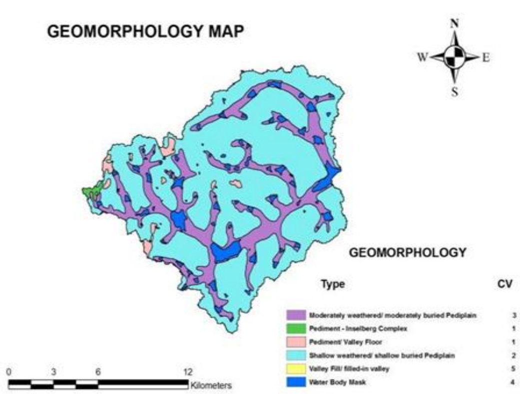

Fig 7a. Geomorphology map of the Study area

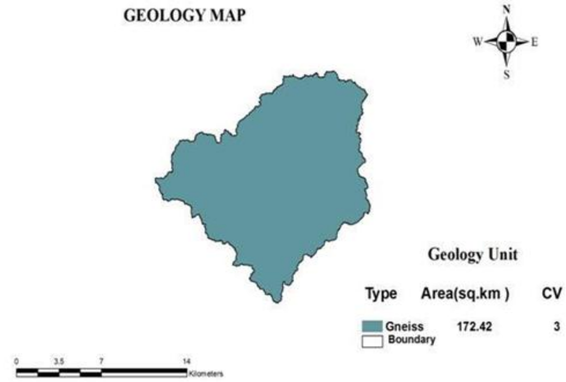

Fig 7b. Geological map of the Study area

Fig7d Rainfall Map of the Study Area

Fig 7e Slope Map of the Study Area

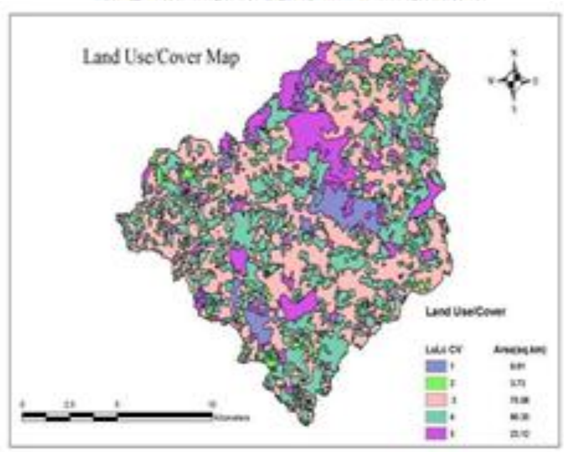

Fig 7c Lands Use/Land Cover Map of the Study Area

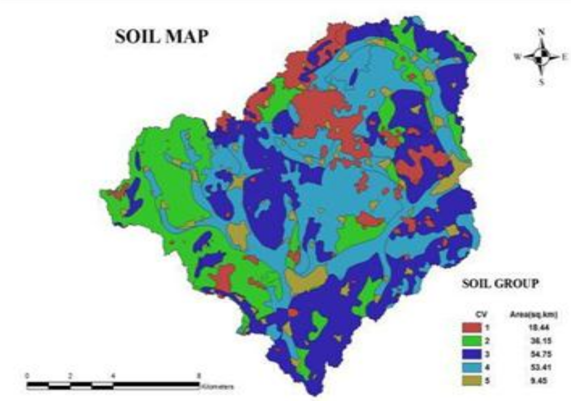

Fig 7f Soil Map of the Study Area

In the first step of integration, Geomorphology layer (L1) and Lithology layer (L2) maps were integrated by intersect option and a new integrated layer (R1) is generated 112 polygons of layer L1 (geomorphology layer) and 1 polygon of layer L2 (geology layer) has resulted in the generation of integrated layer (R1) with 112 polygons. The maximum and minimum WCV are 20 and 25 respectively. In the second step, the integrated layer R1 layer containing 112 polygons (the resultant of geomorphology and lithology) was intersected with the landuse and land cover layer (L3) which has 502 polygons and it resulted in the generation of integrated layer R2 with 843 polygons. The minimum and maximum WCV are 25 and 50 respectively. In the rainfall (L4) which has 6 polygons, which resulted in the generation of integrated layer R3 containing 961 polygons. The minimum and maximum WCV are 30 and 70 respectively. In the fourth step, Slope layer (L5) containing 20 polygons was intersected with the integrated layer R3 having 961 polygons, this resulted in the generation of integrated layer R4 containing 1338 polygons. The minimum and maximum WCV are 35 and 95 respectively. In the fifth step, Soil layer (L6) containing 221 polygons was intersected with the integrated layer R4 having 1338 polygons, which resulted in the generation of integrated layer R5 containing 2242 polygons. The minimum and maximum WCV are 40 and 120 respectively.

Theoretically, if WCV of the all the layers which are integrated, a maximum of 125 and minimum of 40 WCV must be obtained. But practically maximum of 120 and minimum of 40 WCV are obtained. This shows that the overlap of some of higher weights polygons with one another in the integrated layer. Ground Water prospectus map thus developed is shown in Fig8. Based on the total weights obtained by integration the study area has been delineated into Very good, Good, Moderate, Poor, and Very Poor groundwater potential zones and tabulated in table 5.

Table 5 Integrated Groundwater Potential Zones

Sl No	Groundwater category	Area Km^2	% of total area	Higher Weight age value	Lower weighta ge value	Ground water structures feasible
1	Very Good	10.38	6.02	125	105	Dug wells fitted with low power pumps and tube wells fitted with hand pumps
2	Good	90.68	52.59	105	85	Dug well, dug well cum bored well and tube well fitted with hand pump
3	Moderate	63.95	37.09	85	70	Dug well, dug-cum bored well, with tube well
4	Moderate to Poor	7.34	4.25	70	50	Dug well, dug-cum bored well
5	Poor	0.0634	0.037	50	40	Generally, groundwater structures will not be successful. Dug well dug-cum-bored well may be constructed. Roof top rainwater harvesting may be adopted.

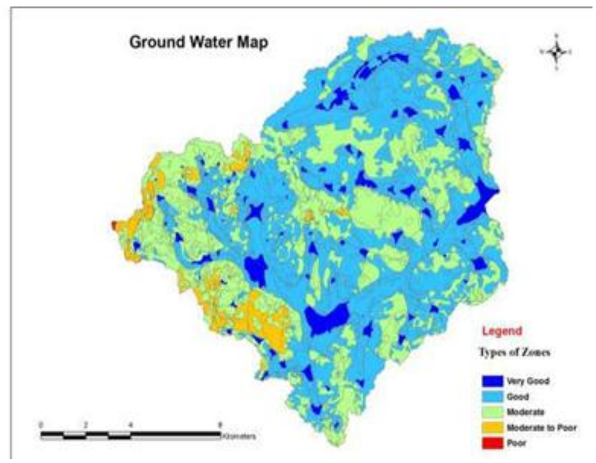

Fig 8 groundwater potential zones map of the study area

CONCLUSIONS

- The drainage densities Sub-watershed estimated for the watersheds varies from 2.02 to 2.55 km/Sq.km. which indicates that the area is coarse in nature.
- The elongation ratio is evaluated as 0.5, which indicates that the watershed is elongated.
- From Groundwater Potential map (fig no. 8), it is observed that Suryanagar watershed is having good Ground water prospect zone.
- Ground water potential maps thus developed will be useful for planning surface drainage networks and construction of ground water recharge

structures in very good ground water potential zones.

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