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RESEARCH ARTICLE

Groundwater Contamination and Pollution Prone Zones of Northern Part of Yale Mallappa Shetty Kere (YMSK) Watershed, Bangalore North using Remote Sensing and GIS

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Abstract

Hydro-Geochemical study of part of Yale Mallappa Shetty Kere (YMSK) watershed comprising two adjacent third order basins has been carried out. There are Twenty one water bodies including two major tanks viz., Singanayakanahalli kere and Gantiganahalli in the study area. Basin morphometry, geology, soil, slope, land use / land cover, transmissivity, depth to first fracture, depth to second fracture, depth to third fracture, resultant layers of Electrical Resistivity Survey which includes Resistivity of Soil, weathered zone, Bedrock, thickness of soil and weathered zone studied in detail using experimental data, Remote Sensing and GIS. Land use/ land cover both regional and around the contaminated bore wells have been studied. Nine borewell water samples collected and analysed for their physico-chemical parameters to understand the groundwater quality. Heavy metals like lead, zinc, copper, Iron, cadmium also analysed. Iron and Nitrate crosses the permissible limit in two bore wells. The details of land use / land cover around the bore wells have been used to identify the sources of contamination. The presence of big factories as well as small scale industries, agricultural practices, waste dumpsites, residential patches, vehicular traffic, vehicle garages, gasoline stations, quarries, air base, firing ranges, air traffic, asphalt manufacturing units, solar lamp manufacturing unit in and around the study area is playing a devil role in contaminating the water. Pollution Prone Zones have been delineated and validated. A comparative analysis of contaminated region and pollution prone zones has been made and it is matching with marginal exception.

Introduction

Hydro-Geochemical analysis of the Northern part of Yale Mallappa Shetty Kere (YMSK) for the pre-monsoon season has been carried out. It is one of the clusters of lead contamination in the YMSK watershed with Nine borewells. Study of geology, soil, geomorphology both qualitative and quantitative, weathered zone, land use / land cover, has been carried out. Land use and Land cover on small scale map has been prepared to find out the sources (water chemistry) of lead contamination.

The study area lies in the North part of Bangalore at the Latitude13°8', 13°12' and Longitude 77°33', 77°37' (Fig 1). Its total area is 24 km^2. It is a part of Bangalore North taluk and comprises of Singanayakanahalli and Gantiganahalli kere catchment. The altitude varies from 900-932m in the study area covering in topographical map of 57 G/12 NE-NW of 1:25000 scale.

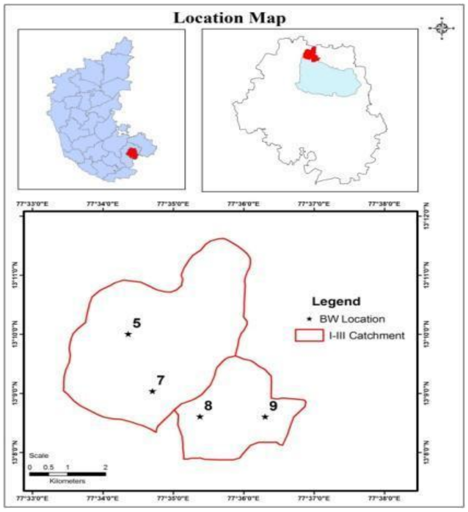

Fig.1. Location map

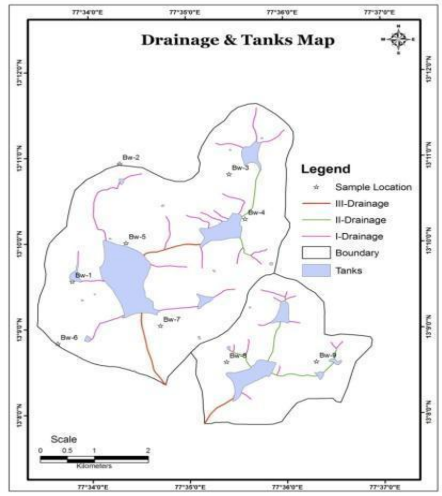

Fig.2. Drainage and water bodies

Material and Methods

One of the lead contaminated clusters of YMSK which comprises two adjacent third order basins studied using RS and GIS. Thematic maps like geology, soil, land form, land use / land cover obtained by remote sensing data; Weathered zone thickness, Soil thickness, depth to first fracture and fracture density have been prepared using Electrical resistivity survey (VES with Schlumberger configuration) and Transmissivity data from secondary sources. Land use / land cover map on small scale has been prepared using remote sensing as well as a thorough fieldwork. Basin morphometry and slopes studied in detail using GIS. Drainage and water bodies in the two adjacent third order basins also studied. Chemical analysis of bore well water has been carried out. All the cat-ions, an-ions and heavy metals are analysed and their spatial variation has been noted. Pollution prone zones have been delineated with the help of thematic layers and compared with the contaminated regions. Sources for contamination and impact of contamination on bio-diversity also studied. MapINFO and ArcGIS packages are used for the analysis.

Result and Discussion

Drainage and water bodies: A drainage map of a basin provides a reliable index of the permeability of the rocks and also gives an indication of the yield of the basin (Wisler and Brater, 1959). There are 23 water bodies (Fig 2) having the total water spread area of 2.03 km^2 in the study area with a drainage network of 34.79 km. There are 38 numbers of streams comprising thirty two I-order; five II-order and two III-order drainages with a cumulative length 21.3km, 6.9 km and 6.4 km with a cumulative area of the I-order stream is 16 sqkm, 9.4 and 24.4 sqkm respectively.

Mean Stream length (Lsm) is a characteristic property related to drainage network components and its associated basin surfaces (Strahler, 1964). The Lsm of the I-order ranges between 0.25 and 1.0 and its mean is 0.631; II-Order ranges between of 1.36 and 1.41 and its mean is 1.38; III-Order ranges between of 1.62 and of 4.80 and its mean is 3.21 km.

The study area is with a low mean bifurcation ratio (Rbm) varies from 3.66 to 5.50. The lower bifurcation ratio values are characteristics of the watersheds which have suffered less structural disturbances (Strahler, 1964) and the drainage pattern has not been distorted because of the structural disturbances. The low values of Rb indicate that the basin has suffered less structural disturbances and the basin is one elongated nature (Nag, 1998). Usually these values are common in the areas where geologic structures do not exercise a dominant influence on the drainage pattern. (Chow, 1964) stated that an Rb range ‘3 to 5’ for watersheds of a geologic structure does not exercise a dominant influence on the drainage pattern. There is much scope for infiltration of water.

The area of the circle covers a minimum area of 9.83 and maximum of 25.55 km^2 and mean is 17.69 in all III-order basins. Drainage frequency (Fs) higher in one area than the other means the growth of new channels or lengthening of the existing streams (Singh, 2006). The minimum Fs is 1.18, maximum is 2.56 and mean is 1.87 in III-order basin. The low Fs indicates that the lesser growth of channels. The Drainage Density varies between 1.39 and 1.44; Circularity Ratio. Rc varies between 0.59 and 0.98. The elongation ratio values of the basins vary from 0.45 to 1.12. Values near to 1.0 are typical of regions of very low relief, whereas values in the range 0.6 to 0.8 are generally associated with strong relief and steep ground slope. (Chow, 1964) The variation of the elongated shapes of the basins is due to the guiding effect of thrusting and faulting in the basin. High Re values indicate that the areas are having high infiltration capacity and low runoff (Sreedevi, 2009). Low Dd generally results in the areas of highly resistant or permeable sub-soil material, dense vegetation and low relief. Low density leads to course drainage texture (Rudraiah *et al.*, 2008). The rocks are prone to crack, joints and fissures. In the study area drainage is coarse in nature which promotes to more infiltration this implies that the pollutant from anthropogenic agents have favored for infiltration to the groundwater.

Length of overland flow: The length of overland flow also points to the efficiency of the drainage in the basin and it varies between 1.38 and 1.43. Schumm (1956) introduced the factor, constant of channel maintenance, as the inverse of the drainage density. It is also the area required to maintain one linear kilometer of stream channel. Generally, a higher constant of channel maintenance of a basin indicates higher permeability of the rocks of that basin, and vice versa. It varies between 0.69 and 0.71. The factor basically relates inversely to the average slope of the channel and quite synonymous with the length of sheet flow to the large degree (Rudraiah *et al.*, 2008). In the study area the Lg has high values indicating low relief. The low relief tends to infiltration of the water.

Geology and Lineaments of the study area: The Geological formation is of Gneissic complex having the Granitic exposures. The lineaments are identified using satellite data. Major lineaments are found in the north to South direction (Fig.3). The major Lineaments are found in the western part of the study area, running from North to south (Fig.8). There are 19 Lineaments (13.59 km), The drainages controlled by the major lineaments with high lineament density act as a good recharging zone and it is marked under very good ground water potential zone (Reddy *et al.*, 2000). Lineaments are the major sources for the ground water infiltration. Lineaments and their intersections play a significant role in the occurrence and movement of groundwater resources in crystalline rocks (Rao, 2006). The combination of fractures (lineaments) with topographically low ground can also serve as the best aquifer horizons (Rao, 1992). Lineaments provide the path ways.

Soil: The types of soil found in the study area are clayey skeletal, Fine and Fine Loamy (Fig 4). The areal extent of the distribution of soil types calculated. Areal extent of clayey skeletal is 7.83Sq.km; Fine soil is 9.59 sq.km; Fine loamy is 3.16. Totally the soil covers about 20.59 km^2.

Weathered Zone Thickness: The weathered zone thickness (Fig 5) is more in the western part ranging from 150-200ft; 100-150ft spreads from North to South and 70-100ft depth in North-western and Eastern part.

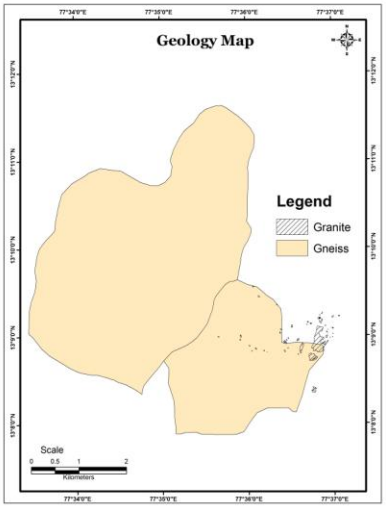

Fig.3. Geology map

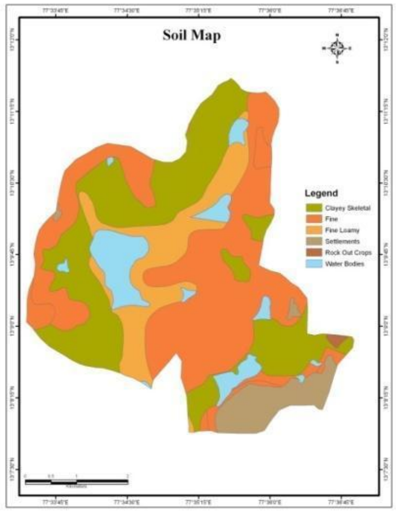

Fig.4. Soil map:

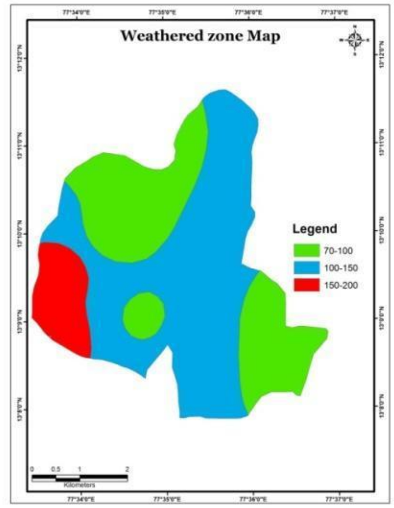

Fig.5. Weathered Zone map

Land Use / Land Cover: The Agricultural land and landuse/ landcover map is done in detail (Fig 6). The main features observed in the study area is the Brick manufacturing units, Dumpsite, Fodder industry, Garages, Poultry, Quarry, Stone crushers, Chewing-gum factory, Asphalt units, Solar cell factory, Steel-ware house and agricultural lands. There are Settlements, Educational centers and open lands also. The spatial distribution has been obtained.

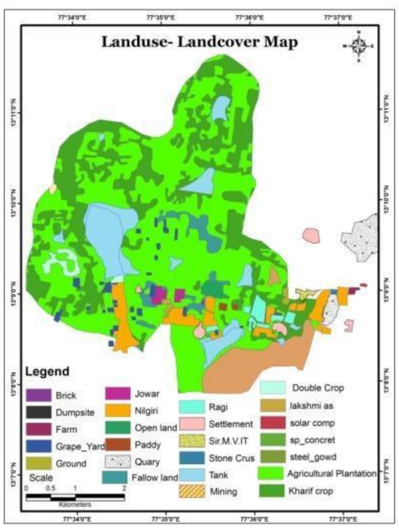

Fig.6. Landuse-Landcover map

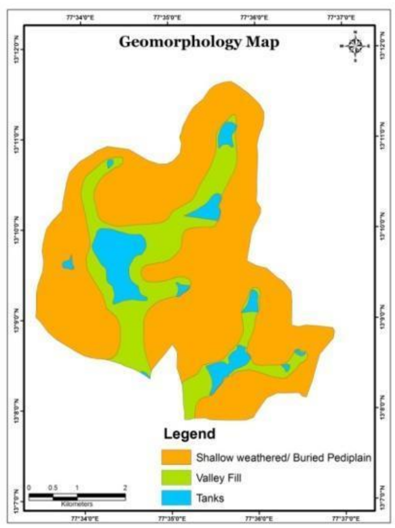

Fig.7. Geomorphology map

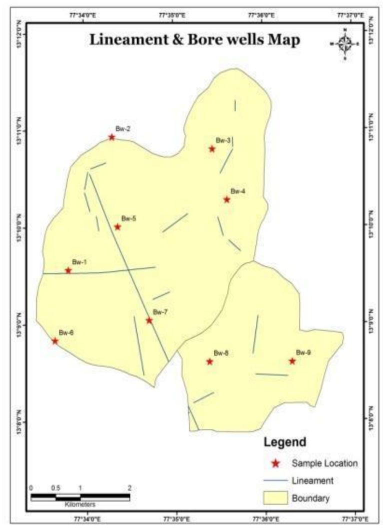

Fig.8. Lineament and Borewell map

Geomorphology: The Land forms present in the study area are Shallow weathered and Valley fill (Fig 7). Here the shallow weathered / buried pediplain area covers most vastly in 17.53 sq.km; Valley Fill in 4.75 sq.km. Shallow weathered / buried pediplain are gently undulating plains, large areal extent, plains formed by the coalescence of several pediments. According to general expectation, these areas are having good ground water potential (Rao, 1998). Valley Fills are the depression zones where intense landuse practices are seen. Valley fills are shallow to moderate along the peripheral zones with underlying weathered zones that are structural in origin. They coincide well with drainage and lineament trends. Valley fills are mainly occupied by detritus material consisting unconsolidated boulders/sediments, cobbles, sand silt, gravels and deposits of varying lithology were noticed.

Transmissivity: The rate at which the ground water flows also controls the rate at which a contaminant moves away from the point at which it enters the aquifer. Transmissibility values found in study area are 2-5 and 5-10m^2/day (Fig 9).

Depth to water level: In the study area the Depth to water level ranges from 5-20m (Fig 10). Depth of 5-10m is present in southern part and 10-20m is spread in rest of the area.

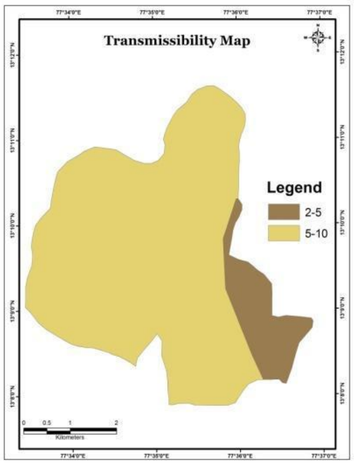

Fig.9 Transmissivity map

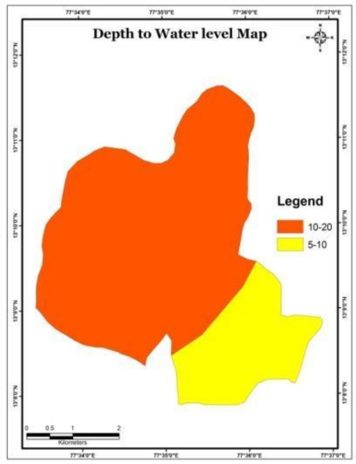

Fig.10. Depth to water level map

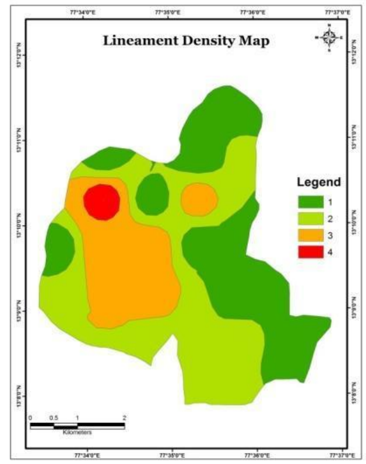

Fig.11. Lineament Density map

Lineament Density: A lineament density map (Fig 11). The color gradation from Green to Red in the Lineament map shows that the density/ km^2. Single lineament structure in North and South-eastern part; TWO lineaments/km^2 is spread in the North to south and western part; THREE lineaments/km^2 and it is spread in the central-western part. FOUR lineaments per/km^2 and it is spread in the western part, indicates high scope for infiltration for groundwater movement and are hydro-geologically very important (Sankar *et al.,* 1996).

Depth to Fractures: The Depth to First Fracture map shows the spatial variation of Depth of First fracture encountered in the study area (Fig 12). The Depth to First Fracture is min in the South-eastern part of the study area having a depth of 75ft. Depth ranges from 75 to 200ft. The deepest fracture is found in southwest part ranging up to 200 ft. The spatial variation of Depth to Second fracture encountered in the study area (Fig 13). The Depth to Second Fracture is min in the Southern part at a depth of 80ft. Depth ranges from 80 to 160ft. The deepest fracture is found in Northern part ranging 160 ft. The spatial variation of Depth to Third fracture encountered in the study area (Fig 14). The Depth to Third Fracture is min in the South-Western part of the study area having at a depth of 150ft. Depth ranges from 150 to 210ft. The deepest fracture is found in North-west part at 210 ft depth. Depth to Fourth Fracture is encountered in North South direction part of the study area having at a depth of 220ft. Depth ranges from 220 to 280ft. The deepest fracture is found in central part ranging 280 ft (Fig 15).

Fracture density: The spatial variation of fracture density in the study area (Fig 16). The Green color in the map shows the presence of only One fracture spread in SW-NW and Eastern part. The Yellow color shows the presence of Two fracture density spread from NS direction, The Red color shows the presence of Three fracture density spread from NS direction. The fracture density is more prone for infiltration and act as conduit to the pollutants to reach groundwater body.

Apparent Resistivity: The spatial variation map of Apparent Resistivity at the depth of 70m, 100m, 140m and 220m is generated (Fig 17), (Fig 18), (Fig 19) and (Fig 20). The Low resistivity value at the depth of 70m, 100m, 140m depicted in blue colour is present in the center of study area as shown in the figure, but at the depth of 220m the low resistivity is at the South-eastern part of the study area. The medium apparent resistivity values at the depth of 70m, 100m, 220m depicted in Green colour has spread in the east-south-west part of the study area but at the depth 140m the medium values is present in North-western and South-eastern part; viz the high apparent resistivity at the depth of 70m, 100m, 140m is depicted in Red colour in the North-western and South-eastern part, however high apparent resistivity value at 220m is present in the Northern part.

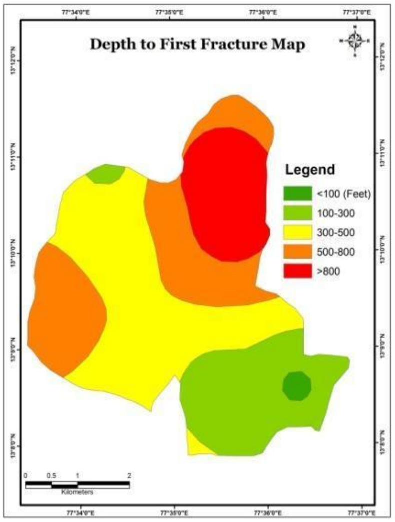

Fig.12. Depth to Fracture map

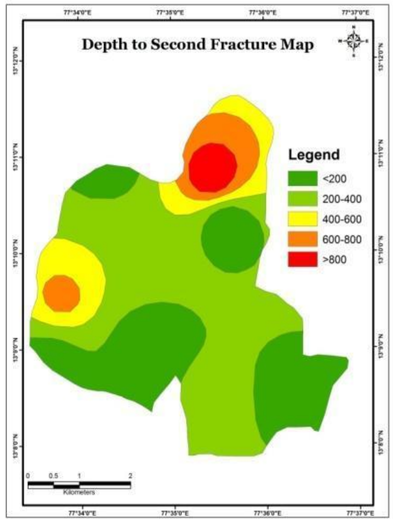

Fig.13. Depth to Second Fracture map

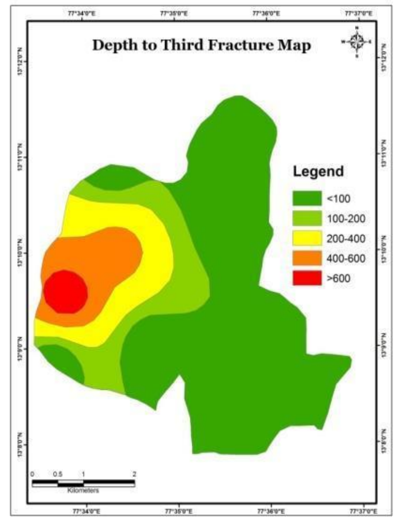

Fig. 14. Depth to Third Fracture map

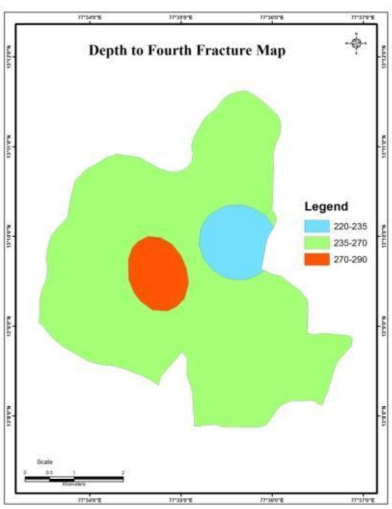

Fig.15. Depth to Fourth Fracture map

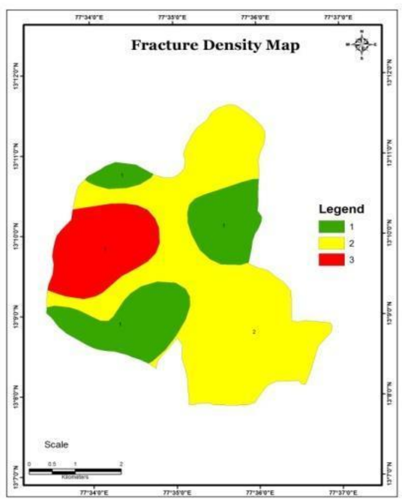

Fig.16. Fracture density map

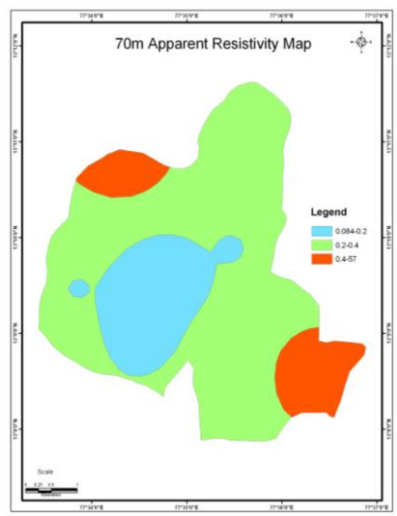

Fig.17. 70m App Res map

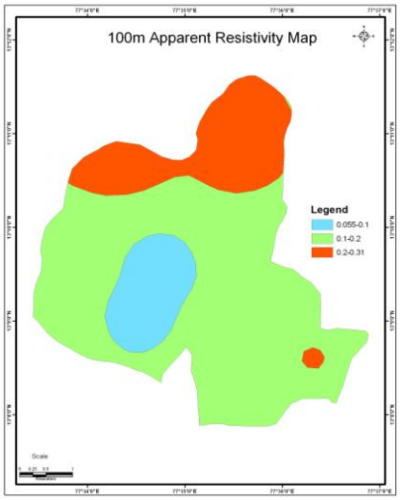

Fig.18. 100m App Res map

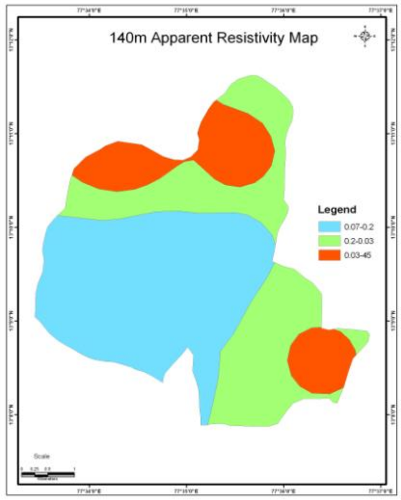

Fig.19. 140m App Res map

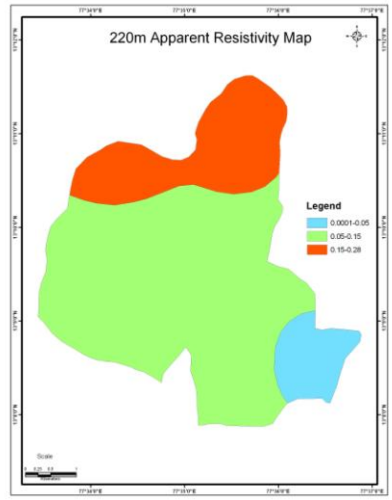

Fig.20. 220m App Res map

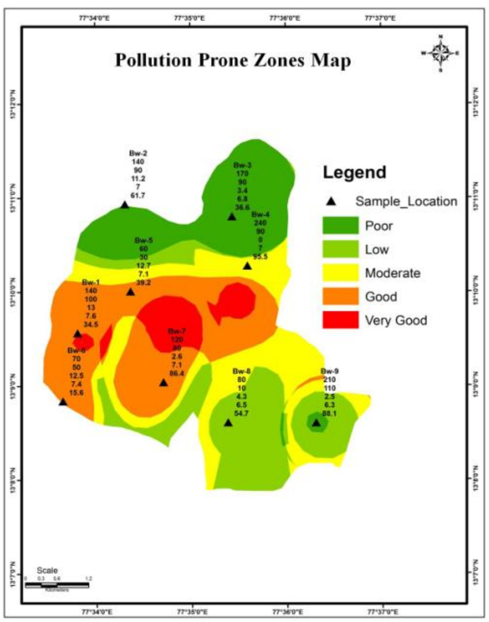

Fig.21. Pollution Prone Zones map

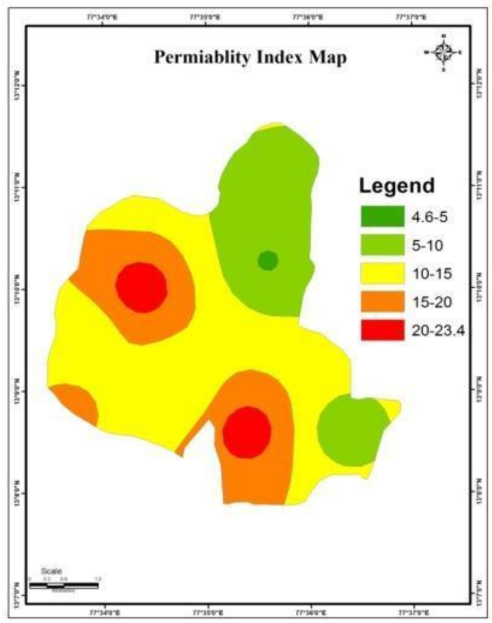

Fig.22. Permeability Index map

Pollution Prone Zones: Delineation of Pollution prone zones (Fig 21). has been done using thematic layers obtained by VES like Resistivity of soil, Weathered Zone and Bed rock; thickness of soil, weathered zone and bedrock; apparent resistivity at 70m, 100m, 140m, 220m; Fracture Density, Depth to Bedrock, Soil, Slope, Landforms, LU/LC, Depth to First Fracture and Depth to water. Ranking and weightages assigned to the categories of each layer (Table 1). Arc GIS Analysis tool/overlay/Intersect has been used to integrate the layers. The product of rank and weights summed up to get the total weights.

L A Y E R S		Category 1		Category 2		Category 3		Category 4		Category 5		Category 6		Category 7	
Sl.No	Name	Type	Wtg	Type	Wtg	Type	Wtg	Type	Wtg	Type	Wtg	Type	Wtg	Type	Wtg
1	Resistivity of Soil	.5-10	120	10-50	110	50-250	100	250-500	90	500-1000	80	>1000	70	Nil	-
2	Resistivity of Weath zone	<100	110	100-220	100	220-330	90	330-430	80	>430	70	Nil	-	Nil	-
3	Soil thickness	>2.3	105	1.8-2.3	95	1.3-1.8	85	.8-1.3	75	<.8	65	Nil	-	Nil	-
4	Weathered thickness	>28	100	21-28	90	14-21	80	7-14	70	<7	60	Nil	-	Nil	-
5	App resistivity 70m	<360	95	360-720	85	720-1080	75	1080-1400	65	>1400	55	Nil	-	Nil	-
6	App resistivity 100	<500	90	500-1000	80	1000-1500	70	1500-2000	60	>2000	50	Nil	-	Nil	-
7	App resistivity 140	<400	85	400-800	75	800-1200	65	1200-1600	55	>1600	45	Nil	-	Nil	-
8	App resistivity 220	<375	80	375-560	70	560-750	60	750-930	50	>930	40	Nil	-	Nil	-
9	Resistivity of Bed rock	119-617	75	617-1115	65	1115-1613	55	1613-2110	45	2110-2608	35	>2608	25	Nil	-
10	Depth to bed rock	>30	70	23-30	60	16-23	50	9-16	40	<9	30	Nil	-	Nil	-
11	Fracture Density	>4	65	2-3	55	3-4	45	Nil	-	Nil		Nil	-	Nil	-
12	Soil	Clayey skeleton	60	Fine	50	Fine Loamy	40	Nil	-	Nil		Nil	-	Nil	-
13	Slope	0-1%	55	1-3%	45	3-5%	35	5-10%	30	Nil		Nil	-	Nil	-
14	Landforms	Pediment/ valley floor	50	Shallow weathered	40	Valley fill	30	Water body mask	0	Settlement mask	0	Nil	-	Nil	-
15	LU/LC	Agricultural plantation	45	Dense grassland	35	Follow land	25	Forest plantation	20	Gullied	15	Industrial area	10	Kharif + rabi	5
16	Depth to first fracture	<75	40	75-120	30	120-160	20	160-200	15	>200	10	Nil	-	Nil	-
17	Depth to water	.38-.68	35	.26-.38	25	.17-.26	15	.1-.17	10	<.1	5	Nil	-	Nil	-

Permeability Index Map: Soil Permeability map generated using Permeability index (PI) values (Fig 22) is very much comparable with resistivity of soil and weathered zone maps. Similarly high ranges are showing close matching with Infiltration zone map except the North part with a mix of medium/Lower range values in the rest of the area. PI matches with Pollution prone zone except Bore well 3 and 7. A comparison of spatial distribution of soil with the Permeability index has revealed that there exists a close matching except a small variation in the central portion of the study area. Similar matching is seen except Northwest portion. The variation in the values of the permeability index and row-1 lies in the values in the same trend direction of North South direction. Accordingly the values exceeds desirable limit.

Water Quality: Nine bore well water samples of pre-monsoon season have been analysed for their physico-chemical properties including heavy metals (Table 2). Contamination above desirable (action) and permissible limits have been listed. Total hardness, Sodium, Bicarbonates, Nitrates, Iron, Lead and Cadmium exceeds the action levels and Calcium, Magnesium, Potassium, pH exceeds permissible limits (Table 3). Bore well (No.1) is in the moderate zone of pollution prone zones. Bore well No.5 and No.7 are in the good pollution prone zones. The presence of a lineament in the vicinity helps to infiltrate chemical parameters. There exists correlation of increased Calcium with Total Depth; Magnesium except in Borewell-9, No correlation with Potassium and pH decreases as the Percolation increases.

Table 2: Physico-chemical and Heavy metal Analysis of Singanayakanahalli and Gantiganahalli kere

BW.No	EC	TDS	pH	Temp	TH	Ca	Mg	Na	K	Cl	HCO_3	NO_3	SO_4	F	Cu	Fe	Zn	Cd	Pb
1	544	388	7.6	28	240	140	100	7.8	13	117.98	200	4.16	111.7	0.08	0.037	0.200	0.136	0.005	0.021
2	551	392	7	29	230	140	90	14	11.2	99.83	190	23.32	8.95	0.2	0.005	0.200	0.085	0.003	0.021
3	230	151	6.8	27	260	170	90	8.3	3.4	27.23	100	22.52	18.75	0.09	0.006	0.335	0.051	0.000	0.000
4	670	476	7	27	330	240	90	21.7	0	117.98	190	58.99	184.9	0.4	0.009	0.175	0.356	0.003	0.021
5	561	397	7.1	28	90	60	30	8.8	12.7	99.83	180	42.57	11.4	0.08	0.009	0.375	0.415	0.005	0.084
6	311	219	7.4	30	120	70	50	3.5	12.5	45.38	120	3.02	9.05	0.08	0.004	0.175	0.220	0.000	0.000
7	394	285	7.1	27	200	120	80	19.6	2.6	63.53	220	0.94	6.85	0.2	0.004	0.150	0.186	0.000	0.105
8	130	93	6.5	29	90	80	10	12.4	4.3	45.38	70	2.86	8.45	0.1	0.011	0.438	0.093	0.005	0.211
9	714	494	6.3	28	320	210	110	20	2.5	136.13	210	61.47	43	0.2	0.004	0.200	0.076	0.000	0.337

Table 3: Grouping of data crossing threshold values

BW.No	1	2	3	4	5	6	7	8	9
EC	544	551	230	670	561	311	394	130	714
TDS	388	392	151	476	397	219	285	93	494
pH	7.6	7.0	6.8	7.0	7.1	7.4	7.1	6.5	6.3
Temp	28	29	27	27	28	30	27	29	28
TH	240	230	260	330	90	120	200	90	320
Ca	140	140	170	240	60	70	120	80	210
Mg	100	90	90	90	30	50	80	10	110
Na	7.8	14	8.3	21.7	8.8	3.5	19.6	12.4	20
K	13	11.2	3.4	0	12.7	12.5	2.6	4.3	2.5
Cl	117.98	99.83	27.23	117.98	99.83	45.38	63.5	45.4	136
HCO_3	200	190	100	190	180	120	220	70	210
NO_3	4.16	23.32	22.52	58.99	42.57	3.02	0.94	2.86	61.5
SO_4	111.7	8.95	18.8	184.9	11.4	9.05	6.85	8.45	43
F	0.08	0.2	0.09	0.4	0.08	0.08	0.2	0.1	0.2
Cu	0.037	0.005	0.006	0.009	0.009	0.004	0	0.01	0
Fe	0.200	0.200	0.335	0.175	0.375	0.175	0.15	0.44	0.2
Zn	0.136	0.085	0.051	0.356	0.415	0.220	0.19	0.09	0.08
Cd	0.005	0.003	BDL	0.003	0.005	BDL	BDL	0.01	BDL
Pb	0.021	0.021	BDL	0.021	0.084	BDL	0.11	0.21	0.34
(ft)	800	900	1050	1010	505	625	500	490	180
Distance (m)	175	375	607	474	751	537	1214	534	314

Note 1. Red Colour indicates the chemical elements crossing the Permissible limits;
2. Blue colour indicates the chemical elements crossing the Action limits.

The examination of grouped correlation matrix reveals that there exists high correlation (>0.9) of Cl with EC and TDS; TH with Ca and Mg); Ca with Mg; Mg with Fe (-ve); Na with F; EC with HCO_3 and NO_3; pH with Pb (-ve); moderate correlation (0.7-0.9) of Cl with HCO_3. Notable good correlation of NO_3 with SO_4 and F; SO_4 with Fe and Cu; Na with HCO_3, NO_3, Pb is also observed.

Contamination: As the four bore well (BW-5, BW-7, BW-8 and BW-9) water samples crosses desirable limit importance has been given to study the sources of contamination. The study of contamination with respect to the depth of the bore wells indicates that shallow wells are more contaminated; shallow fractured areas are also more contaminated. The proximity of surface water bodies of these bore wells also playing a vital role. The morphometric analysis of the drainage system like bifurcation ratio, stream frequency, drainage density, length of over land flow, elongation ratio, Circularity Ratio explains the facilitating factor of the contamination to pass through. Lineaments in the study area are also facilitating the infiltration of contaminants along with the feasible soil and weathered zones.

As the Fe content is also high in the study area, Iron hydroxilisation is facilitating the lead to reach the groundwater bodies. SO_4 not much precipitated during analysis because of cheliation with Pb. There exists –ve correlation of Pb with pH. It is also observed that there is a decrease in Pb with increase of Zn. It is observed Pb contamination is associated with 500ft depth of bore well. It is also noted that there is a bearing of distance to the nearest to the water bodies.

Conclusion

Pollution prone zones obtained by different thematic layers such as Resistivity of soil, Weathered Zone and Bed rock; thickness of soil, weathered zone and bedrock; apparent resistivity at 70m, 100m, 140m, 220m; Fracture Density, Depth to Bedrock, Soil, Slope, Landforms, Land use / land cover, Depth to First Fracture and Depth to water. The permeability index map had been compared with Pollution prone zones and Bore well (No.1) showed in the moderate zone and Bore well (No.5) and (No.7) are in the good pollution prone zones concludes that the above chemical parameters had infiltrated to groundwater. The bore-well locations as shown in the above figure are overlapped on pollution prone zone map depicts that the Physico chemical parameters like Total hardness, Sodium, Bicarbonates, Nitrates, Iron, Lead and Cadmium exceeds the action levels and Calcium, Magnesium, Potassium, pH exceeds permissible limits. The presence of land use / land cover such as Asphalt units, Solar cell factory, Brick manufacturing units, Dumpsite, Fodder industry, Garages, Poultry, Quarry, Stone crushers, Chewing-gum factory, Steel-ware house, agricultural land and Settlements are sources to cause the groundwater contamination found in the study area. The morphometric analysis like bifurcation ratio, stream frequency, drainage density, length of over land flow, elongation ratio, Circularity Ratio and the low mean bifurcation ratio also helps in percolation of the water. These parameters are common in the areas where geologic structures do not exercise a dominant influence on the drainage pattern and drainage is coarse in nature which promotes to more infiltration of the pollutant from anthropogenic agents have favored for infiltration to the groundwater. Lineaments in the study area are also facilitate the infiltration of contaminants along soil and weathered zones. Drainage and Valley fills present near the Bore-well (No. 1, 5 and 7) composed of unconsolidated detritus material like boulders/sediments, cobbles, sand silt, gravels and soils types of clayey skeletal, Fine and Fine Loamy helps in Ground water infiltration.

The present study reveals that the development of Pollution prone zone preparation, analysis of Ground water chemistry and study of land use & land cover in detail helps in taking care in management for Groundwater contamination.

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