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Spatial Analysis of Groundwater Quality Using GIS System in JnanabharathiWard.No 129, Bangalore, Karnataka state, India

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Abstract: ***Ground water is an essential renewable resource which we rely on since centuries without estimating its fate in terms of quality and quantity. The ground water is considered as pollution free and cleaner than surface water due to its hideous nature underneath the surface. Industries, residential, municipal, agricultural and commercial activities adversely affect the quality of ground water. The spatial variations in ground water quality in central part of Jnanabharathi Ward No 129, Bangalore city which is located in Karnataka state, India, have been studied using geographic information systems. For this study, water samples were collected from 19 of the bore well samples which represent the entire Jnanabharathi area. These samples were systematically analyzed for physico-chemical parameters such as pH, Total Hardness, Electrical Conductivity and Chemical Oxygen Demand (COD). It is observed that ground water quality of the study area is deteriorating beyond the limits and hence can affect human health adversely if not properly mitigated. In the era of information technology, modern technologies such as remote sensing (RS) and geographic information systems (GIS), coupled with GPS surveys are very helpful for the evaluation of groundwater. The results obtained in present study with spatial database established in GIS will be used to monitor effectively and periodically assess the quality and vital parameters of ground water and also to draw the attention of civic authorities for suitable action.***

1. Introduction

In India, ground water is considered to be the major source for most of the population especially for drinking purposes. Though groundwater is believed to be clean and free from pollution as compared to the surface water, it is being contaminated by natural or numerous types of human activities such as commercial, industrial, agricultural etc.

GIS (Geographic Information Systems) is one of the most effective tools for mapping of groundwater quality and plays a vital role in monitoring the environmental changes. GIS is being used to map the classification of groundwater quality, based on correlating the values of TDS (Total Dissolved Solids) with some aquifer characteristics. GIS is also used as a database system in preparing maps of water quality based on the concentration values of different chemical constituents. In such surveys, GIS is utilized to trace the groundwater quality zones suitable for different usages such as irrigation and domestic. Babiker [1] proposed a GIS-based groundwater quality index method which synthesizes different available water quality data by indexing them numerically relative to the WHO standards. Thus, the use of GIS technology has greatly simplified the assessment of natural resources and environmental concerns, including groundwater.

In groundwater studies, GIS is commonly used for site suitability analysis, managing site inventory data, estimation of groundwater vulnerability to contamination, groundwater flow modeling, modeling solute transport and leaching, and integrating groundwater quality assessment models with spatial data to create spatial decision support systems. Engel [2] carried out a GIS based study to determine the effect of urbanization on groundwater quality in relation to land-use changes. Using GIS, Nas and Berktay [3] have mapped urban groundwater quality in Koyna, Turkey. Ground water quality map is important for any city to estimate the water safeness for drinking and irrigation purposes. It is also

helpful as a precautionary indication of potential environmental health problems.

2. Materials and Methods

2.1. Study Area

Jnanabharathi Ward Number 129 Bangalore bearing the **GeographicalCoordinates:** 12.95814°N 77.51876°E.

This area is thickly populated and has a lot of commercial activity along the main road. These areas have smaller roads and a rough terrain. It has first and second stages. The 1st stage is very old, the 2nd stage is a relatively new area. It is very well planned and most of the areas have wide roads and the road connectivity is splendid. The water samples are collected from ward no.129, Bangalore, Karnataka.

Due to its elevation, Bangalore enjoys a pleasant and equable climate throughout the year. The highest temperature recorded was 38.9°C (102.0°F) on 22 May 1935 and the lowest was 7.8°C in 1884.

Bangalore receives about 970 mm of rain annually, the wettest months being August September, October and in that order. The summer heat is moderated by fairly frequent thunderstorms and occasional squalls causing power outrages and local flooding. The heaviest rainfall recorded in a 24-hour period was 159.7 mm recorded on 1 October 1997. October 2005 was recorded as one of the wettest months in Bangalore with heavy rains causing severe flooding in some areas, andclosure of a number of organizations for over a couple of days.

2.2 Sample Collection

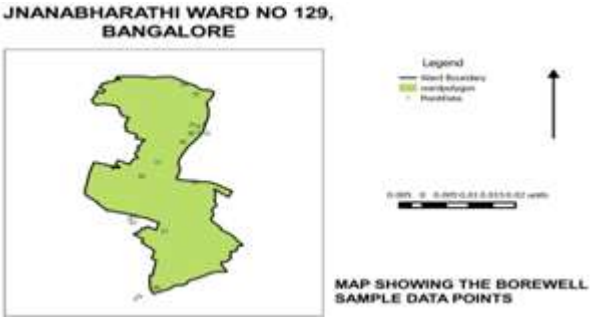
A total of 19 water samples were collected in the month of March of the year 2015 in pre-summer season in Jnanabharathiward.no 129, Bangalore, Karnataka, India.

2.3 Parameters under monitoring:

The groundwater samples were analyzed by using chemical and physical parameters such as pH, TH(Total Hardness), Electrical Conductivity and COD using standard protocols and the quality of the data was ensured through careful standardization.

3. Results and Discussion

Area WARD NO 129
MAP SHOWING THE BOREWELL SAMPLE DATA POINTS

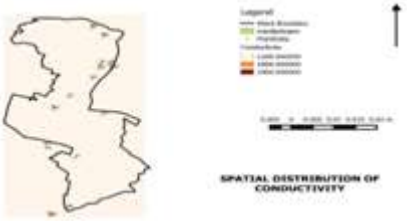


3.1. Electrical Conductance of Water Samples

The mineral constituents are dissolved in water by using conductivity cell with a conductivity bridge instrument showed the electrical conductance of water samples.The total concentration of dissolved minerals in water is a general indication of the overall suitability of water for many types of uses. The electrical conductance of water samples were classified in to three ranges (0-1200mhos/cm, 1200 -1800 mhos/cm and 1800-2400 mhos/cm).

From the spatial variation map it was observed that the very high range of electrical conductance values (>1800 mhos/cm) was distributed in the samples - 4, 5, 6, 10, 14,15,16,18. The high range of electrical conductance values (1200- 1800 mhos/cm) was found in the samples – 1, 2, 3, 7, 8, 9,11, 12, 13, 17, 19. Medium range of electrical conductance values (501-1000 mhos/cm) and permissible limit of conductance values (<500 mhos/cm) was not found anywhere in that particular area. Groundwater with less than 500 mhos/cm of electrical conductance is generally satisfactory for domestic use and for many industrial purposes. If the Water with more than 1000mhos/cm of dissolved salts usually gives disagreeable taste or makes the water unsuitable in other respects, the values are given in table.1.

Map Showing The Spatial Distribution Of Electrical Conductivity In Ward.No 129



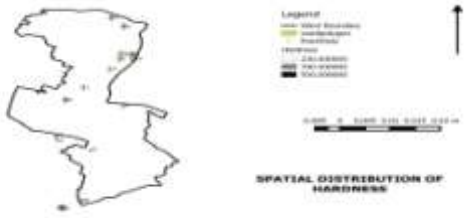
3.3. Hardness

Hardness in water is especially caused because of the presence of carbonates and bicarbonates of Calcium and Magnesium including sulphates and chlorides and nitrates. Based on the ranges of above contents total hardness is classified into
i) <300 mg/litre
ii) 300-600 mg/litre
iii) >600 mg/litre

From the chemical analysis of bore well samples were indicated in the map it was observed that the low range of total hardness < 300mg/l (permissible limit) present only in sample 11 groundwater and medium range of 300-600mg/l

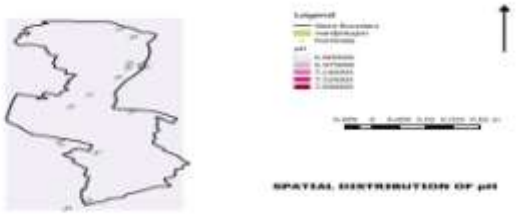
(acceptable limit) was observed in all the remaining samples. Thehigh range of total hardness (>600 mg/l) was nowhere observed all these values are shown in table.1.

MAP SHOWING THE SPATIAL DISTRIBUTION OF TOTAL HARDNESS (TH) IN WARD.NO 129



pH:
pH is defined as negative logarithm of [H^+] concentration of a liquid. It ranges from 1 to 14. pH of pure water is 7. If it is <7, then it is acidic. Else, it is basic. Lesser the pH value, greater the acidity of a liquid.According to the WHO permissible limit of drinking water is 6.5 to 7.5. From the chemical analysis of water the same is showed in the map it was observed thatthe pH of water in Jnanabharathiis in permissible limit of 6.8 to 7.5 (Table.1.) indicating the suitability of water for consumption.

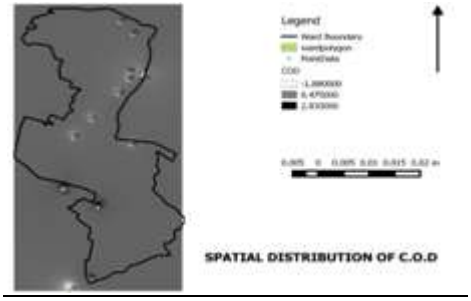
MAP SHOWING THE SPATIAL DISTRIBUTION OF pH VALUES IN WARD.NO 129



Chemical Oxygen Demand (COD)
It is amount of oxygen required for the complete chemical oxidation of both organic and inorganic matter present in the sample of water by a strong chemical oxidizing agent such as acidified potassium dichromate. Greater the COD, greater contamination of water.

From the chemical analysis data observed in the map, it is found that COD of water from the bore well samples-1,2,4,5,6,7,8,9,10,12,16 are equal to zero, this is clearly represents these water samples are free from organic impurities, from the samples 3,13,14,18 in all bore well samples, COD values are within the permissible limit 11,15,17,19 are greater than one as indicated in table.1.

MAP SHOWING THE SPATIAL DISTRIBUTION OF C.O.D IN WARD.NO 129



For all samples:
Odour – Odourless
Taste – Tasteless
Color – Colorless

Conclusion

This study has described the significance of GIS in analyzing the quality of ground water at various locations in Jnanabharathiward.no 129. This spatial distribution map of Conductivity, Total Hardness, pH and Chemical Oxygen Demand shows that these parameters were not within the permissible limit throughout the study area uniformly.

The spatial distribution map of hardness concentration illustrates that
- About 57.89% of the total 19 groundwater samples were within Permissible Limit (i.e. <300mg/liter).
- About 42.10% of the total 19 groundwater samples were within Acceptable Limit (i.e. 300-600mg/liter).
- None of the groundwater samples were in the range above 600mg/liter.

The spatial distribution map of Chemical Oxygen Demand concentration illustrates that
- About 57.89% of the total 19 groundwater samples showed zero COD.
- About 21.05% of the total 19 groundwater samples were in Permissible Limit.
- Rest 21.05% showed COD above Permissible Limit.

The spatial distribution map of pH concentration illustrates that
- All the tested 19 groundwater samples pH were in the Permissible Limit (i.e. 6.8 - 7.5).

The spatial distribution map of Electrical Conductivity concentration illustrates that
- None of the samples showed EC within Permissible Limits (i.e. 0-1200mhos/cm).
- About 42.1% of the samples showed high EC (i.e. 1200-1800mhos/cm).
- About 57.9% of the samples showed very high EC (i.e. >1800mhos/cm).

Only 69 percent of the study area was distributed with groundwater within the permissible limit of fluoride concentration. The spatial distribution map of Chloride concentration illustrates that only 44 percent of the groundwater samples contain Chlorides within the limit. Thus spatial distribution maps of various quality parameters are used to demarcate the location distribution of water quality in a comprehensive manner and help in suggesting groundwater suitable for domestic purposes.

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Table 1: Shows the measurement of bore well water quality parameters by using chemical and physical methods

Sl.No	Map point number	Y(Longitude) (Degrees)	X(Latitude) (Degrees)	Elevation (Meters)	1st Source (Feet)	2nd Source (Feet)	3rd Source (Feet)	Casing Depth (Feet)	Total Depth (Feet)	Yield (Inches)	Hardness (mg/l)	C.O.D (mg/dm3)	pH	Conductivity (mhos-cms)
1	**15**	12.9756	77.5094	896	320	-	-	40	570	3	328	0	7.3	1320
2	**4**	12.9757	77.5092	879	718	-	-	60	800	2	428	0	7.2	1720
3	**5**	12.9764	77.5092	897	520	-	-	60	680	2	404	0.68272	7.2	1680
4	**6**	12.9759	77.5089	894	440	550	-	70	650	3	539.28	0	7.2	2240
5	**7**	12.9758	77.5088	841	600	-	-	20	600	3	453.6	0	7	2120
6	**30**	12.9748	77.5061	886	150	455	-	60	455	4	372.36	0	7.2	2000
7	**9**	12.9758	77.5088	845	220	450	520	80	630	3	389.48	0	7.4	1440
8	**10**	12.9715	77.5042	841	450	680	-	45	800	2	398.04	0	7	1720
9	**11**	12.9656	77.499	849	700	900	-	60	950	2	419.44	0	7.3	1640
10	**32**	12.9615	77.4954	849	120	200	-	40	420	2	505.04	0	6.9	2240
11	**27**	12.9455	77.5003	848	250	300	-	20	465	3	234.72082	2.8202	6.9	1240
12	**26**	12.9598	77.5069	847	250	320	-	100	390	4	361.10896	0	7.5	1700
13	**31**	12.9765	77.5065	880	90	140	-	30	350	2	379.16441	0.94006	7	1500
14	**33**	12.9853	77.5071	917	80	-	-	40	400	1	496.52482	0.94006	7.1	2220
15	**28**	12.9291	77.4986	826	420	760	-	50	760	5	541.66344	1.88013	7	2280
16	**29**	12.9264	77.4948	819	600	850	-	80	1200	3	523.60799	0	6.8	2160
17	**22**	12.9497	77.4936	830	180	240	-	80	460	6	397.21986	1.88013	7.5	1740
18	**24**	12.9881	77.5046	896	250	300	-	30	412	2	496.52482	0.94006	6.9	2400
19	**23**	12.95	77.4937	833	220	-	-	80	470	2	352.08124	2.8202	6.8	1660