INTERNATIONAL JOURNAL OF CIVIL ENGINEERING AND TECHNOLOGY (IJCIET)

ISSN 0976 – 6308 (Print)
ISSN 0976 – 6316(Online)
Volume 5, Issue 9, September (2014), pp. 162-168
© IAEME: www.iaeme.com/Ijciet.asp
Journal Impact Factor (2014): 7.9290 (Calculated by GISI)
www.jifactor.com

IJCIET

©IAEME

WATER QUALITY INDEX MAPPING OF KENGERI INDUSTRIAL AREA OF BANGALORE CITY USING GEOSPATIAL ANALYSIS

B. Santhaveerana Goud[1], Basavaraj Paruti[2]

[1](Professor and Former Chairman, Department of Civil Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore, Karnataka, India)
[2](Research Scholar, Department of Civil Engineering, Bangalore University, Bangalore, Karnataka, India)

ABSTRACT

Assessment of groundwater quality is essential in the field of environmental quality management. The present study aims at the assessment of groundwater quality of Kengeri industrial area, comprises of 133.95 Sq Km, in Bangalore city with the help of water quality index (WQI).The groundwater samples collected from thirty locations were analyzed as per the standard methods. p^H, total hardness, iron, chloride, fluoride, total dissolved solids, calcium, magnesium, sulphate and nitrate were considered for the study. The WQI of thirty samples were ranged between 0.92 and 361.41. Nearly 24 % of the samples exceeded the value of WQI 100. The high value of WQI may be attributed due to higher concentrations of iron, nitrate, total dissolved solids, total hardness and fluorides beyond desirable limits in the groundwater samples. During post monsoon season, groundwater of about 42.78 Sq Km area was unfit for drinking. The analysis reveals that the groundwater of south-west Kengeri industrial area needs some treatment before using it for domestic applications and it also necessitates for protection from the risk of further contamination.

Keywords: Geographical Information System, Groundwater Quality, Spatial distribution, Water Quality Index, Water Quality Parameters.

I. INTRODUCTION

Water is an important natural resource. It is a basic human need and a valuable national asset. Discharge of industrial effluents without proper treatment into open pits or through unlined channels to move towards low lying depressions on land, results in the contamination of groundwater (Purandara and Varadarajan 2003). The industrial effluents if not treated and properly controlled, can pollute and cause serious damage to the groundwater resources, which results in poor quality of groundwater (Mishra, P.C.et.al, 2005). In this study an attempt has made to evaluate the groundwater quality of the Kengeri industrial area of Bangalore city by using WQI.

The Department of Mines and Geology carried out investigations to evaluate the groundwater quality in Bangalore Metropolis. It is reported that 51% of the samples were found to be non-potable due to the presence of excessive concentrations of one or more water quality parameters such as Nitrates, Hardness, Iron, Chloride, Total Dissolved Solids etc. Nitrate was however found to be a major pollutant accounting for 45% of non-potability (Shivashankar and Vijaya Bhaskar, 1998).

The Central Groundwater Board carried out studies on industrial pollution in Bangalore city covering major industrial belts of an area of 80 Sq km and reported that the groundwater was slightly alkaline in nature and dominated by calcium and magnesium as Cations, and chloride and nitrate as anions. The groundwater occurring in these belts showed excessive concentrations of nitrates, resulting in non-potability ranging from 12.5 to 50% (CGWB 1999).

Water quality index is one of the easy ways to communicate information on the quality of water to the concerned citizens and the policy makers. It thus, becomes an important parameter for the assessment and management of groundwater. A water quality index (WQI) may be defined as a rating reflecting the composite influence of a number of water quality parameters on the overall quality of water. The main objective of WQI is to express complex water quality data in simple manner that is understandable and useable by the public.

II. STUDY AREA

Bangalore is the capital of Karnataka State and is situated in the central part of peninsular India on the Deccan Plateau, with a world-wide reputation as 'Silicon Valley' of India. It is home to somewhere between 8 to 9 million people. The study area is located between latitudes 12^0 51'N to 12^0 59'N and longitudes $77^0$24'E to 77^0 33' E.. It is situated at an average altitude of 920 m above mean sea level. The study area, Kengeri Industrial area, comprises of 133.95 Sq km, lies in the Southern part of Bangalore city, is covered in part of the Survey of India Toposheet No 57 H/5 & 57 H/9. It houses more than 500 industries dominated by chemical, pharmaceutical, distilleries, plating and allied industries. Map of the study area is as shown in fig-1.

CLIMATE

Bangalore city climate is pleasant and healthy, and devoid of extremes, neither very humid nor very dry. The temperature of the city varies between 28°C and 37°C during the hottest months (April/May) and from 15°C to 25°C during winter months (December/January). Annual average rainfall over the city is about 850 mm.

III. MATERIALS AND METHODS

The groundwater samples from borewells and open wells in the study area from thirty locations were collected during pre-monsoon & post monsoon seasons in the year 2010 in two litre PVC containers as per the standard procedure and were analyzed for physico-chemical parameters as per standard methods for examination of water and wastewater (APHA, 2002). pH and Electrical Conductivity were determined at the time of sample collection. The results obtained were assessed in accordance with 'Indian Standard Drinking Water Specification IS 10500: 1991 of Bureau of Indian Standards 2003. Water quality index was estimated by selecting ten drinking water quality parameters (Table-1). Data for WQI and identified contaminants were linked to the sampling locations using ArcGIS software. The present study used the Inverse Distance Weighted (IDW) method for spatial interpolation of WQI and chemical contaminants. Inverse Distance Weighted

(IDW) is an interpolation technique in which interpolated estimates are made based on values at nearby locations weighted only by distance from the interpolation location.

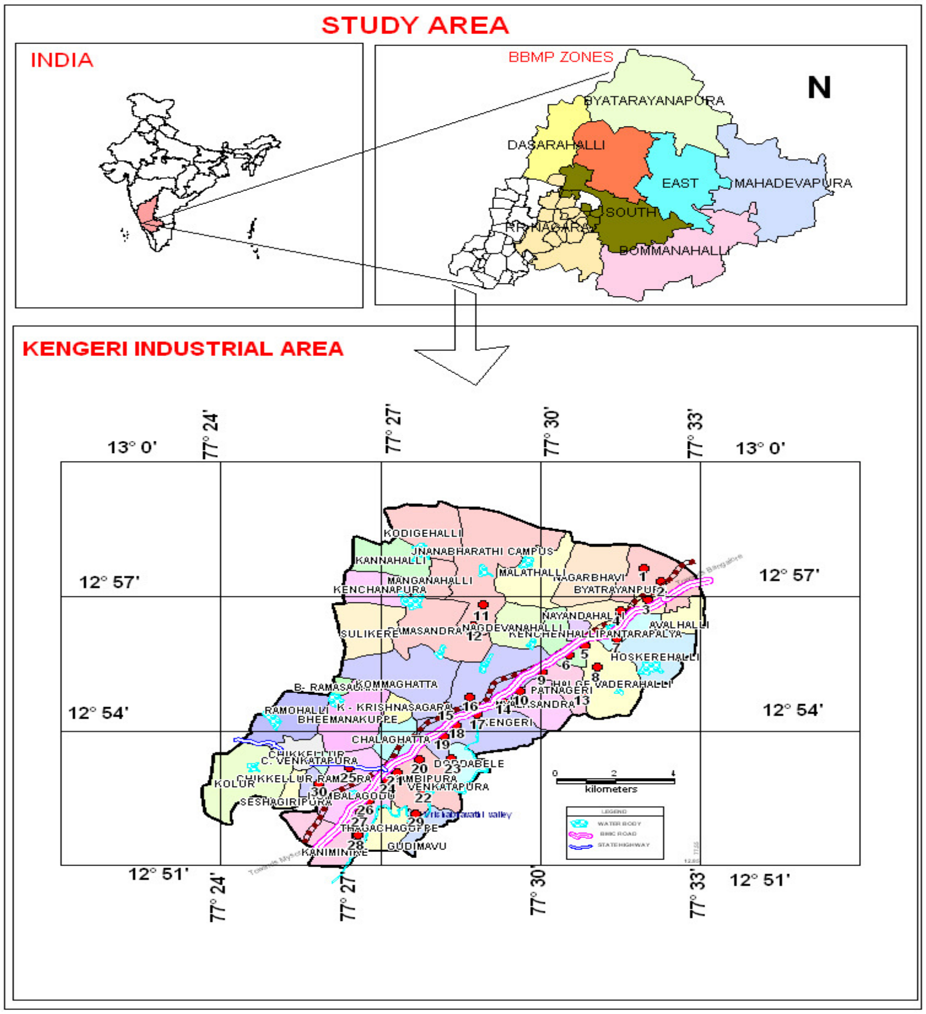

Figure 1: Location map of the study area

IV. DETERMINATION OF WATER QUALITY INDEX (WQI)

In the design of a WQI, the importance of various water quality parameters depends on the intended use of water. This paper attempts to evaluate the water quality indices from the viewpoint of suitability of water for human consumption. The method of evaluating the WQI has been briefly discussed in the following paragraphs.

In the first place, the more harmful a given pollutant of water, the smaller in magnitude is its standard for drinking water. So the unit weight W_i for the ith parameter P_i is assumed to be inversely proportional to its recommended standard S_i (i=1, 2,…..,n) and n= no. of parameters considered. Thus,

$W_i = K / S_i$, --------------------------------------(1)

The quality rating q_i for the ith parameter P is given, for all other parameters except pH, by the relation

$q_i = 100 (V_i / S_i)$ ----------------------------------(2)

Where V_i is the observed value of the ith parameter and S is its recommended standard for drinking water. For pH, the quality rating q_{pH} can be calculated from the relation

$q_{pH} = 100[(V_{pH} \sim 7.0)/1.5]$ -------------------------(3)

Finally, the water quality index (WQI) can be calculated by taking the weighted arithmetic mean of the quality rating q_i, thus,

$WQI = [\Sigma (q_i W_i) / \Sigma W_i]$ ------------------------(4)

Based on the WQI values (Table-2), the ground water quality can be rated as excellent, good, poor, very poor, and unfit for human consumption (Table - 3).

V. RESULTS AND DISCUSSIONS

The Water quality indices for all the 30 sampling stations have been calculated using the groundwater quality data as per the standard procedure using the equations 1 to 4. The complete results have been presented in Table - 2. It was observed that, the overall quality of the groundwater of the area was reflected with the values of WQI ranged between 0.92 and 361.41. Nearly 24 % of the samples exceeded the value of WQI 100, the upper limit of WQI for drinking water. The high value of WQI may be attributed due to higher concentrations of iron, nitrate, total dissolved solids, hardness and fluorides beyond desirable limits in the groundwater samples. During post monsoon season, groundwater of about 42.78 Sq Km area was unfit for drinking. The analysis reveals that the groundwater of the Kengeri industrial area needs some treatment before using it for domestic applications and it also necessitates for protection from the risk of further contamination. By using GIS software the thematic maps have been generated based on the results obtained for the entire study area separately for pre monsoon and post monsoon seasons, thus making GIS as a decision support system. The spatial distribution of WQI is depicted in the fig-2.

Table 1: Selected Water Quality Parameters, their Standards and Unit Weights

Sl No	Parameter (P_i)	Standard (S_i)	Unit weight (W_i)
1	pH	6.5-8.5	0.142
2	Total Hardness	300	0.003
3	Iron	0.3	3.330
4	Chloride	250	0.004
5	Fluoride	1	1.000
6	TDS	500	0.002
7	Calcium	75	0.013
8	Magnesium	30	0.033
9	Sulphate	200	0.006
10	Nitrate	45	0.022

$\Sigma W_i =$ 4.555

Table 2: Water Quality Index (WQI) for the groundwater of Kengeri industrial area

Sl No	Sampling Location	WQI Pre-Monsoon	WQI Post-Monsoon	Type of well
1	Mr. Krishnamurthy's Residence, No. 362, 2nd Cross, Kavika Layout.	68.31	81.65	OW
2	Near Ganapathy Enterprises and Provision Stores, No 136, Kavika Layout.	38.59	43.50	BW
3	Balmuri Vinayaka Seva Trust, 5th Cross, Nayandahalli.	323.76	361.41	BW
4	Chhabhaiya Saw Mill, Nayandahalli.	83.63	89.55	BW
5	Ashwathkatte, Mysore Road, Byatarayanapura.	45.29	69.52	BW
6	D Cross, Mysore Road, Byatarayanapura.	21.85	23.90	BW
7	Sri Beereshwar Enterprises, Pantharapalya, Mysore Road.	58.35	96.66	BW
8	Vrishabhavathi Sewage Treatment Plant Compound, Mysore Road.	26.63	29.21	BW
9	The Club, 20/2, 7th Mile, Mysore Road.	72.60	85.43	BW
10	Bangalore Malleable Castings, Mysore Road.	42.22	77.05	BW
11	Garden Department, Jnanabharathi Campus.	31.70	33.45	BW
12	Bangalore University, Jnanabharathi Ladies Hostel.	44.21	50.93	BW
13	In front of Raja Rajeshwari Temple, Raja Rajeshwari Nagar.	11.81	13.10	HP
14	Wonder Blues Dyeing Industry, 7th Mile, Mysore Road.	30.96	43.88	BW
15	Sri Lakshmi Devi Prasanna, No 2163, Kengeri Upanagar.	269.11	282.68	HP
16	Sri Madakeswami Ashram, Kengeri.	40.45	39.76	BW
17	Near RVCE, Kengeri.	0.92	0.90	HP
18	Athena's St Philomena's School, Kengeri Hobli.	53.52	66.27	OW
19	Next to Petrol Bunk, Kengeri.	40.47	71.92	BW
20	In front of Track Wheels Garage, Anchepalya, Mysore Road, Bangalore - 74.	34.35	50.62	BW
21	In front of Raja Rajeshwari Dental College and Hospital, Ramohalli, Mysore Road	7.53	8.52	BW
22	Kambipura, near Vrishabhavathi flow, downstream.	183.90	244.20	OW
23	Irrigation well of Madappa, Doddabele.	105.72	125.27	BW
24	YMCA, Kumbalgod.	40.75	43.15	BW
25	Wirtgen India Pvt.Ltd. No, 22-B, Kumbalgod Industrial Area.	31.66	26.96	BW
26	Pepsi factory, No. 23 1st phase, Kumbalgod Industrial Area.	14.40	18.77	BW
27	Near Don Bosco Institute of Technology, Kumbalgod.	35.15	41.29	BW
28	Amrith Distilleries, Kumbalgod.	296.16	351.78	BW
29	Mr. Bodappa's Farm, No. 190, 2nd Cross, Kumbalgod.	302.16	336.58	OW
30	Associated Drug Company, Jagdale Industries, 47/1, Kumbalgod.	126.14	164.97	BW

Table 3: Classification of selected area in to different categories on the basis of Water Quality Index

Water Quality Index(WQI)	Groundwater quality	Area influenced by each category in Sq-km	
		Pre-monsoon	Post-monsoon
0-25	Excellent	1.64	0.92
25-50	Good	25.81	11.42
50-75	Poor	53.01	44.97
75-100	Very Poor	26.26	33.86
>100	Unfit for drinking	27.23	42.78

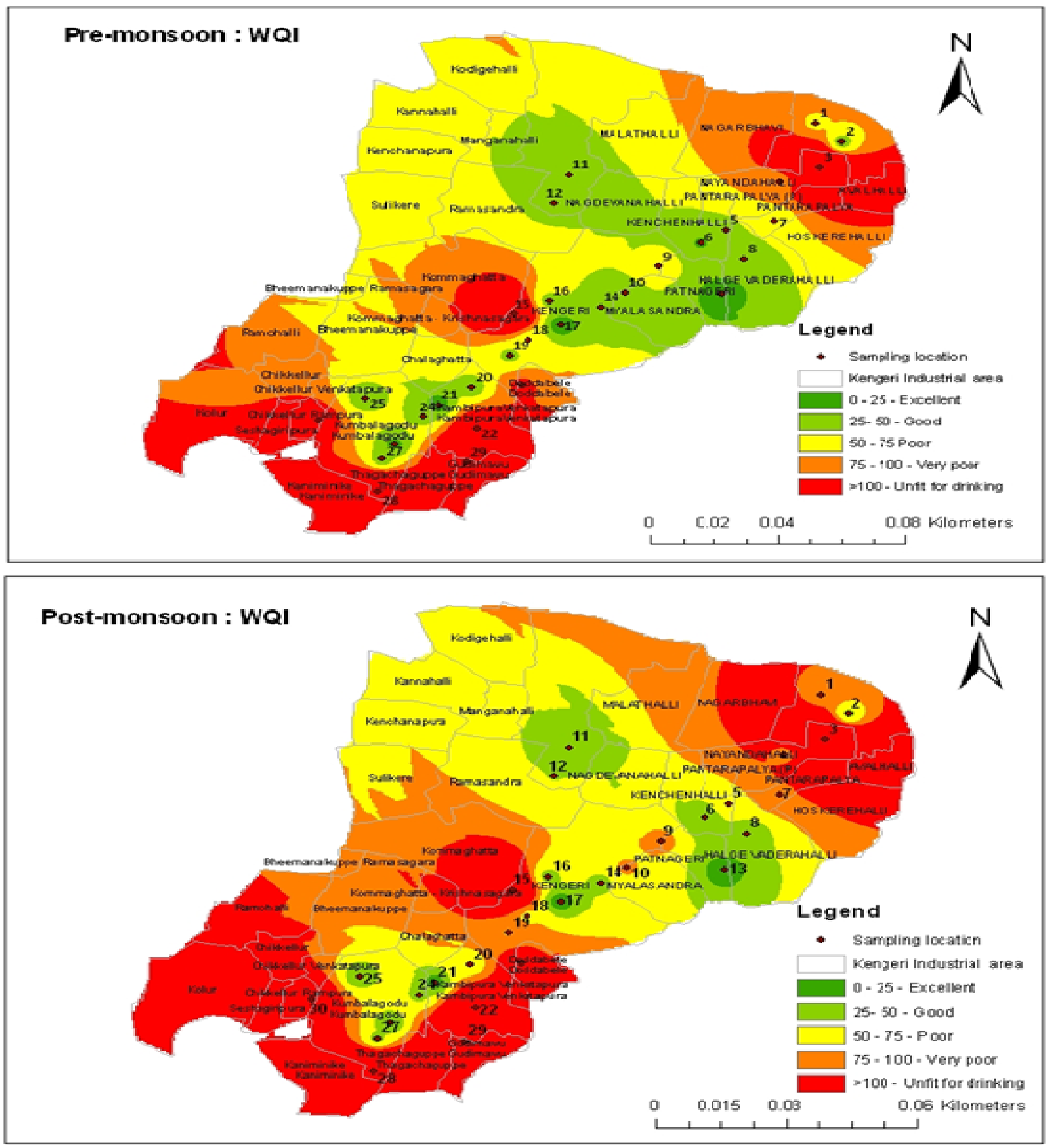

Figure 2: Spatial distribution of water quality index

VI. CONCLUSIONS

The present work of assessment of groundwater quality based on water quality index reveals that

1. Nearly 24% of the samples are contaminated and unfit for domestic use.

2. From the spatial analysis, it has been observed that the quality of groundwater in nearly 20% (27.23 sq-km) of the area in pre-monsoon & 32% (42.78 sq-km) of area in post-monsoon, found to be unfit for drinking and the WQI values are more than 100.

3. The high value of WQI may be attributed due to higher concentrations of iron, nitrate, total dissolved solids, total hardness and fluorides beyond desirable limits in the groundwater samples.

4. South-western part of the Kengeri industrial area was found to be highly contaminated. The highly contaminated area comprised of Doddabele, Kambipura, Thalaghattapura, Kolur, Chikkellur, Sheshagiripura, and Kaniminike.

5. Middle and North western part of the Kengeri industrial area was found to be less contaminated. That area comprised of Ramasandra, Sulikere, Kenchna Pura, Kannahalli.

6. The study helps us to understand the quality of the water as well as to develop suitable management practices to protect the ground water resources.

VII. REFERENCES

[1] Purandara, B. K., & Varadarajan, N. (2003). Impacts on Groundwater Quality by Urbanization. Journal of Indian Water Resources Society, 23, 107–115.

[2] Mishra, P. C., Behera, P. A., & Patel, R. K. (2005).Contamination of water due to major industries and open refuse dumping in the steel city of Orissa. Journal of Environmental Science and Engineering, 47, 141–151.

[3] Shivashankar, T. M., & Vijaya Bhaskar Reddy, R. (1998).Evaluation of Groundwater Quality in BangaloreMetropolis, Report, Department of Mines and Geology, Bangalore.

[4] Central Groundwater Board (1999). Hydrogeolgical report on Bangalore Metropolitan area, Karnataka, 12–14.

[5] BIS (2003). Bureau of Indian Standards IS: 10500 -1991, Manak Bhavan, New Delhi, India.

[6] APHA (2002). Standard methods for the examination of water and wastewater (*20th edition.*). Washington D.C.: American Public and Health Association.

[7] Mohammed Hashim Ameen and Dr. R. K. Pandey, "Delineation of Irrigation Infrastructural, Potential and Land Use/ Land Cover of Muzaffarnagar by Using Remote Sensing and GIS", International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 3, 2013, pp. 1 - 11, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[8] Santhosh Ram, "A Study on Variations in Water Productivity by using GIS Based Epic Model", International Journal of Civil Engineering & Technology (IJCIET), Volume 5, Issue 3, 2014, pp. 151 - 159, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.