International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
National Conference on
Sustainable Practices & Advances in Civil Engineering (SPACE 2019)
Volume 5, Special Issue 06, June-2019.

GROUND WATER QUALITY INDEX FOR EVALUATION OF GROUNDWATER QUALITY IN WARANGAL, TELANGANA, INDIA

Manvitha S[1],Lalith Kumar S[2],Pavan V[3],Vamshi Krishna D[4]
[1]*Assistant Professor, Civil Engineering Department, Kakatiya Institute of Technology & Science, Warangal*
[2,3,4]*B.Tech Student, Civil Engineering Department, Kakatiya Institute of Technology & Science, Warangal*

Abstract— Groundwater is a major source of drinking for rural and urban areas, in addition to surface water. Human and industrial activities are deteriorating the groundwater quantity and quality, which is a serious issue these days. Analysis of groundwater quality thus attained significance in order to preserve and perfect the eco-system. Determining the groundwater quality index (GWQI) is an analytical technique which can be adopted to get a clear picture of extent of groundwater pollution. The present work is aimed at assessing the groundwater quality for the city of Warangal, Telangana by determining the GWQI. For this purpose, samples of groundwater were collected from 11 different locations spreading across the city, in the month of December, 2018. To calculate the GWQI, the following 12 groundwater quality parameters have been considered: pH, Alkalinity (AL), Total Solids (TS), Hardness, Chlorides (Cl), Dissolved Oxygen (DO), Fluoride (F), Sodium (Na), Calcium (Ca), Magnesium (Mg), Potassium (K) and Electrical Conductivity (EC) for both pre monsoon and post monsoon period. Most of the parameters were not found to be in the desirable range for the purpose of drinking. The GWQI of samples from 11 locations was found to be ranging from 136.7 to 412.5 during post monsoon period, indicating poor, very poor and unsuitability of groundwater for drinking purpose. For pre monsoon period, GWQI values were found to be ranging from 85.98 to 295.02 representing that only 3 locations are of good ground water quality and remaining locations are with poor quality. Also the samples collected during Pre-monsoon were analyzed for Heavy Metal Pollution Index (HPI) and the values were found to be ranging from 0.07 to 94.48 indicating the traces of heavy metals and its significant effect on ground water quality.This analysis revealed that, the groundwater in locations from industrial areas is highly contaminated and found to be unsuitable for drinking. Remaining 75% of samples from the area are also found to be poor in quality where certain amount of treatment before consumption is must.

Keywords— groundwater quality, groundwater quantity, analytical technique, groundwater quality index, quality parameters, heavy metal pollution index

I. INTRODUCTION

Ground water quality is very important and is of great environmental concern. In India, 50 percent of urban water requirement and 85 percent of rural domestic water requirements is met by ground water. It is used for domestic and industrial water supply and irrigation all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Urbanization especially in developing countries like India, has affected the availability and quality of groundwater due to it's over exploitation and improper waste disposal. According to WHO organization, about 80% of all the diseases in human beings are eased by water. Once the groundwater is contaminated, its quality cannot be restored even by stopping the pollutants from the source. It therefore becomes crucial to regularly monitor the quality of groundwater and to device ways and means to protect it. Another reason is that, even though it is underground, and we can't see it, groundwater pollution does occur. The importance of groundwater for the existence of human society cannot be over emphasized. Quality is the primary assessment which has to be done before utilizing the groundwater for any purpose. Ground water spreads across entire area and various parameters are must to be analysed for concluding on the quality of ground water. So, huge data has to be analysed to come up with the picture of ground water pollution. To handle such huge and complex data and convert it into common base which can be understood by people, analytical methods are to be adopted. Ground Water Quality Index (GWQI) is one such technique which can be adopted to get an idea of extent of ground water pollution and present it in common terms which can be unsderstood by various pollution control boards and quality management departments in order to come up with strategies to handle and manage the water sources in any area.

II. STUDY METHODOLOGY

A Study Area

The study area considered is Warangal district which is located in south India in the state of Telangana. It is the second largest city in Telangana district, spreading across the coordinates 18°N and 79.58°E. It covers an area of 471 sq.km with a population of 819,406 (as per 2011 census).

B Collection of samples

Groundwater samples were collected from 11 identified locations across the study area, during post monsoon and pre monsoon season. In and around each sampling location, 3 samples were collected for 2 days continuously to obtain a representative sample. Sampling was done by bore pumps and hand pumps.

C Assessment of Groundwater Quality Parameters

All the groundwater samples were analysed for 12 quality parameters like pH, Alkalinity (AL), Total Solids (TS), Hardness, Chlorides (Cl), Dissolved Oxygen (DO), Fluoride (F), Sodium (Na), Calcium (Ca), Magnesium (Mg), Potassium (K) and Electrical Conductivity (EC) using standard procedures recommended by IS 10500.

D Ground Water Quality Index (GWQI)

For computing GWQI, each quality parameter has been assigned a weight (wi) according to its relative importance in the overall quality of groundwater to serve the drinking purpose Table (II). The maximum weight of 5 has been assigned to the parameter hardness and fluorides, due to their significant impact on water quality. Sodium and Potassium were given the minimum weight of 2 as they may not be harmful by themself. Then relative weight (Wi) was computed from the following equation:

$$Wi = wi / \sum^{n} wi$$

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters.

A quality rating (qi) for each parameter is assigned by dividing its concentration found in each sample by its respective standard, according to the guidelines laid down in the BIS.

$$qi = (Ci / Si) \times 100$$

Where qi is the quality rating, Ci is the concentration of quality parameter in each water sample in mg/L, and Si is the Indian drinking water standard of each parameter in mg/L. For determining the GWQI, the sub index (SI) is first determined for each parameter, which is then used to compute the GWQI as per the following equation:

$$SI_i = Wi * qi$$

$$GWQI = \sum^{n} SI_i$$

SI_i is the sub index of i^{th} parameter; qi is the rating based on concentration of i^{th} parameter and n is the number of parameters. The computed GWQI ranges were classified into five categories, excellent, good, poor, very poor and unsuitable for drinking (Table I).

TABLE I
GROUND WATER QUALITY RANGES

GWQI	Extent of Pollution
Less than 50	Excellent
50-100	Good
100-200	Poor
200-300	Very poor
300 and above	Unsuitable for drinking

E Heavy metal Pollution Index (HPI)

The HPI shows overall quality of ground water with respect to content of heavy metals. The critical HPI value is 100. The weighted arithmetic average of the concentrations was used to calculate HPI values using the Eq. 1 given below.

$$HPI = \frac{\sum_{i=1}^{n} WiQi}{\sum_{i=1}^{n} Wi} (1)$$

Where Wi is the unit weightage defined as reciprocal value of Si, where Si is the maximum permissible limit for drinking water given by BIS (2012), and n is the number of parameters considered. Qi isthe sub-index of the ith parameter, and calculated by Eq. 2

$$Qi = \sum_{i=1}^{n} \frac{Mi}{Si} \times 100 (2)$$

Where Mi is the monitored value of heavy metal, Si is the standard value of the ith parameter, in ppm (µg/L).

Iron, Zinc, Lead and Total Chromium are the heavy metals analysed for ground water samples collected from different locations in the study area.

III. RESULTS

A. Analysis of Groundwater Quality Parameters

All the samples were analysed for 12 quality parameters. Average of concentrations of each quality parameter was done and overall parameters at the sampling locations are presented in the Table II.

TABLE III
GROUND WATER QUALITY PARAMETERS FOR ALL SAMPLING LOCATIONS

LOCATIONS	GROUND WATER QUALITY PARAMETERS in mg/l											
	pH	**AL**	**TS**	**HARDNESS**	**Cl**	**DO**	**EC**	**F**	**Ca**	**Mg**	**Na**	**K**
Weightage (wi)	3	3	4	5	3	2	4	5	4	4	2	2
RANGAMPET	7.78	100	1600	115	92.5	8.05	1013	1.27	44	1.215	81.5	3.25
SHIVANAGAR	8.07	125	1000	245	110	8.05	1088	0.33	42	34.02	104	4.5
BATTUPALLY	7.78	175	1000	240	344.5	6.04	1832	1.77	124	43.74	247.25	1.5
M.G.M	7.72	120	3000	116	39.8	8.05	1120	1.03	42	1.43	78	2
KAREEMBAD	7.86	250	5000	605	422.5	3.02	3120	1.11	58	111.78	277.75	92
NAIMNAGAR	7.87	150	4500	340	213	3.02	1692	1.47	34	61.975	178	0.5
MADIKONDA SAMPLE-1	7.49	250	3500	390	372.3	6.04	1493	0.476	120	14.35	104	3.25
MADIKONDA SAMPLE-2	7.43	200	4000	255	245	6.04	1471	0.525	122	12.55	96.25	3.75
DESHAIPET	7.28	100	1500	245	135	6.04	1133	0.49	74	14.58	78	6.5
KITS COLLEGE	7.3	225	3000	285	81.65	6.04	876	2.425	28	52.745	42.5	0.5
CAMP	7.69	175	4000	290	113.6	9.06	1105	0.98	34	49.815	73.75	2

B. Ground Water Quality Index Values

Ground water Quality index was computed for each sampling location and the extent of pollution at each location was identified based on the pre determined GWQI ranges. GWQI was determined for both pre monsoon and post monsoon period separately.

TABLE IIIII
CONSOLIDATED GWQI OF EACH LOCATION (PRE MONSOON)

SL.NO	LOCATION	GWQI	EXTENT OF POLLUTION
1	RANGAMPET	87.44	Good
2	SHIVANAGAR	85.98	Good
3	BATTUPALLY	131.74	Poor
4	M.G.M.	110.9	Poor
5	KAREEMBAD	295.02	Very Poor
6	NAIM NAGAR	187.38	Poor
7	MADIKONDA 1- SAMPLE	162.11	Poor
8	MADIKONDA 2- SAMPLE	158.2	Poor
9	DESHAIPET	94.34	Good
10	KITS COLLEGE (BOYS HOSTEL)	153.51	Poor
11	CAMP	159.54	Poor

Table III shows the extent of pollution at each sampling location across the city of Warangal during pre monsoon period. GWQI values were found to be ranging from 85.98 to 295.02 representing that only 3 locations are of good ground water quality and remaining locations are with poor quality.

Table IV shows the extent of pollution at each sampling location across the city of Warangal during post monsoon period. GWQI values were found to be ranging from 137.69 to 412.5 representing that all the locations are with poor ground water quality. Ground water in locations nearby industrial areas and solid waste dump site like Naim Nagar and Madikonda are found to be unsuitable for drinking purpose with high GWQI values.

Variation of GWQI values over different sampling locations across the study area during pre monsoon is represented in Fig. 1. and during post monsoon period is presented in Fig. 2.

TABLE IVV
CONSOLIDATED GWQI OF EACH LOCATION (POST MONSOON)

SL.NO	LOCATION	GWQI	EXTENT OF POLLUTION
1	RANGAMPET	147.00	Poor
2	SHIVANAGAR	281.95	Very Poor
3	BATTUPALLY	137.69	Poor
4	M.G.M.	192.61	Poor
5	KARIMABAD	269.43	Very Poor
6	NAIM NAGAR	412.50	Unsuitable for drinking
7	MADIKONDA 1- SAMPLE	327.44	Unsuitable for drinking
8	MADIKONDA 2- SAMPLE	354.36	Unsuitable for drinking
9	DESHAIPET	140.72	Poor
10	KITS COLLEGE (BOYS HOSTEL)	210.68	Very Poor
11	CAMP	295.06	Very Poor

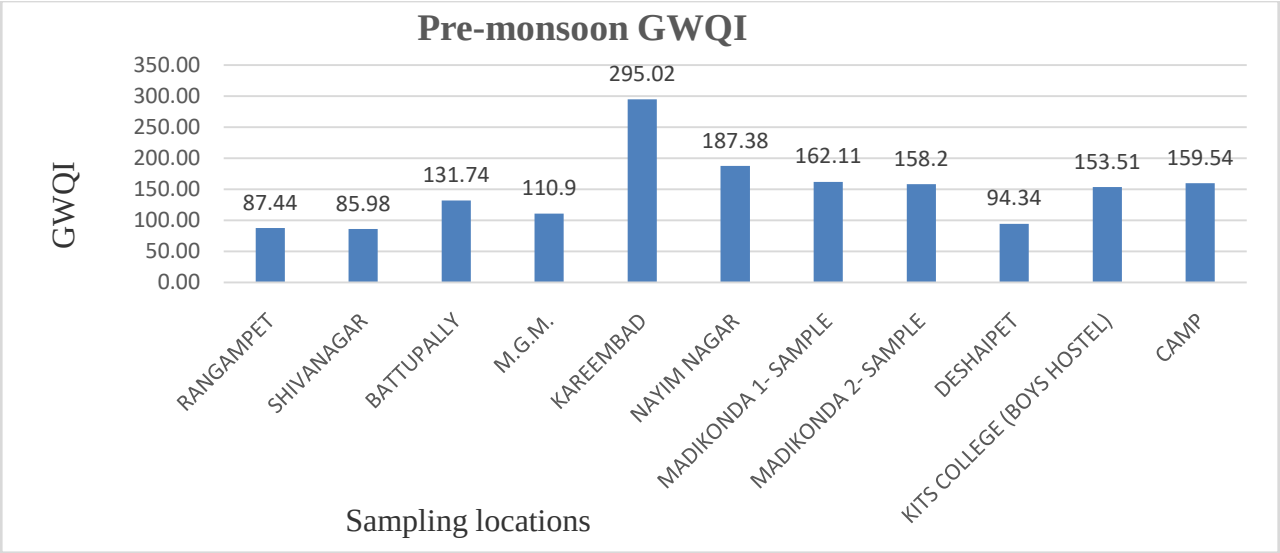

Fig. 1 Variation of GWQI over various locations during Pre-Monsoon period

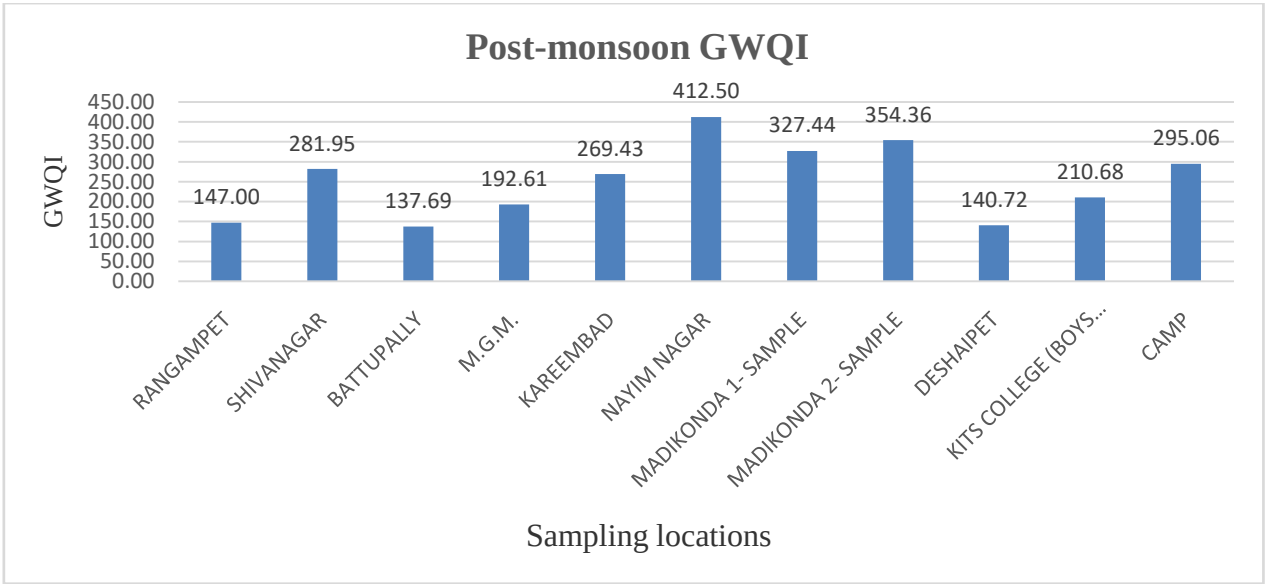

Fig. 2 Variation of GWQI over various locations during Post-Monsoon period

C. Analysis of Heavy Metals Pollution Index Values

All the samples were analysed for 4 heavy metal parameters, i.e., Iron, Zinc, Lead and Chromium. Traces of Chromium were not detected in any of the locations in the study area. Average of concentrations of each heavy metal was done and overall heavy metal concentrations are presented in the Table V.

TABLE V
CONCENTRATIONS OF HEAVY METALS AT DIFFERENT LOCATIONS

LOCATIONS	HEAVY METAL CONCENTRATION in mg/l		
	IRON	ZINC	LEAD
RANGAMPET	0.809	1.379	0
SHIVANAGAR	0	0.01	0
BATTUPALLY	0	0.909	0
M.G.M	0.672	1.254	0
KAREEMBAD	0	0.109	2.708
NAIMNAGAR	0	0.022	0.032
MADIKONDA SAMPLE-1	0	0.043	0.024
MADIKONDA SAMPLE-2	0	0.047	0.032
DESHAIPET	0.232	0.031	0
KITS COLLEGE	0	0.05	0
CAMP	0	0.028	0.032

D. Heavy Metals Pollution Index Values

Heavy metal index values were found to be ranging from 0.07 at Shivanagar to a maximum value of 94.48 at Madikonda which was near by a solid waste dump site of the study area. It can related to the leaching effect of solid waste on the ground water quality. HPI values obtained at different locations of the study area are presented in the Table VI.

TABLE VI
HEAVY METAL POLLUTION INDEX VALUES AT DIFFERENT LOCATIONS

SL.NO	LOCATION	HPI
1	RANGAMPET	58.4
2	SHIVANAGAR	0.07
3	BATTUPALLY	7.12
4	M.G.M.	49.36
5	KAREEMBAD	80.06
6	NAYIM NAGAR	94.29
7	MADIKONDA 1- SAMPLE	70.92
8	MADIKONDA 2- SAMPLE	94.48
9	DESHAIPET	13.89
10	KITS COLLEGE (BOYS HOSTEL)	0.39
11	CAMP	94.33

IV. CONCLUSIONS

The study provides significant information of groundwater quality in various parts of Warangal region. This was carried out by collecting ground water samples during both Pre-monsoon and Post-monsoon seasons for the year 2018-19. During post monsoon period, Ground Water Quality Index values were found to be ranging from 137.69 to 412.5 representing that all the locations are with poor ground water quality. Ground water in locations nearby industrial areas and solid waste dump site like Naim Nagar and Madikonda are found to be unsuitable for drinking purpose with high GWQI values. During pre monsoon period, GWQI values were found to be ranging from 85.98 to 295.02 representing that only 3 locations are of good ground water quality and remaining locations are with poor quality. Almost all the samples were found to be of poor quality and crossing the upper limit for drinking water purposes. The high value of Ground Water Quality Index values at locations were found to be mainly from the higher values of Total solids, Hardness and Chlorides in the groundwater. GWQI were found to be higher for post monsoon period in comparison with pre monsoon period. This variation and increased ground water pollution during post monsoon period can be attributed to the effect of runoff and over flow of sewers. Also the samples collected during Pre-monsoon were analyzed for Heavy Metal Pollution Index (HPI) and the values were found to be ranging from 0.07 to 94.48 indicating the traces of heavy metals and its significant effect on ground water quality. It was also thus observed that ground water quality in Warangal city, is also effected by presence of heavy metals. More than 75% of samples from the area are also found to be poor in quality. The analysis also revealed that the groundwater of area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.

REFERENCES

[1] C.R.Ramakrishnaiah, C.Sadashivaiah and G.Ranga Rao (2009),"Assessment of water quality index for groundwater in tumkur taluk, Karnataka, *Engineering journal*.

[2] Sarala C and P.Ravibabu (2012),"Assessment of groundwater quality parameters in and around jawahar nagar, Hyderabad", *International journal of scientific and research publications*, volume 2,issue 0.

[3] R.Srinivas, Prashant bhaskar and Arjit pratap singh (2015),"Groundwater quality assessment in some selected areas of Rajasthan", *Aquatic procedia*.

[4] H.Annapoorna and M.R.Janardhana (2015),"Assessment of groundwater quality for drinking purpose in rural areas surrounding a defunct copper mine", *Aquatic procedia*.

Basavarajappa.H.T, Manjunatha M.C (2015),"Groundwater quality analysis in precambrian Rocks of Chitradurga District, Karnataka, India", *Aquatic procedia*.