Int. J. Chem. Sci.: 10(4), 2012, 2297-2305
ISSN 0972-768X
www.sadgurupublications.com

EVALUATION AND OPTIMIZATION OF WATER QUALITY INDEX FOR GROUND WATER SOURCE OF NORTH WEST JAIPUR AND AGGLOMERATES

SONIKA SHARMA and R. C. CHHIPA*

Department of Chemistry and Centre for Air & Water Modalling, Suresh Gyan Vihar University, JAIPUR – 302025 (Raj.) INDIA

ABSTRACT

Water quality tool has been optimized by application of Water Quality Index (WQI) method. WQI measures the quality of underground water in North West Jaipur city and agglomerates during April to May 2010. Ground water collected from pointed places as Bore well and Tube well sources. Various parameters are used to calculate WQI including pH, Total Dissolved Solids, Turbidity, Total Hardness, Chloride, Nitrate, Electrical Conductance, Sodium and Potassium .Ground water quality of North West Jaipur as WQI confines WQI index of 103.98 exhibits "Poor Water Quality" observed and developed in pointed areas obtained as quality modals in which three defined aspects (1) Arithmetic mean, (2) Standard Deviation, (3) Coefficient variation, are included and optimized. WQI provides comprehensive information for water quality assessment of Jaipur. Water quality in North West region of Jaipur specially of Brahmpuri, Jhotwara, Bindiaka and Railway station pointed areas were found poor quality of underground water. It has been concluded and optimized that high value of Total Hardness, TDS, Nitrate and Electrical Conductance defines the poor quality of water lead to higher side of WQI.Results shows Jhotwara and Railway Station area have very high value of hardness (upto 631 mg/L) as compared with mean value of hardness in North-West. Accordingly, hard water is not suitable because of the precipitating materials as scale and sludges have adverse effects on human being.

Key words: Water quality index, Ground water, North West Jaipur, Optimization, Quality parameter

INTRODUCTION

Adequate and safe supply of drinking water is a basic need for all human being and health consequences called at least 2 to 5 Litre of water required everyday[1]. Presently main source of drinking water in North West of Jaipur is ground water which is dynamic, quality depends on the entrants of percolated water, precipitation quality, surface area and on sub-surface geochemical processes.

*Author for correspondence; E-mail: chprcc@rediffmail.com

Jaipur is the capital of Rajasthan, in the North West part of India and geographically extends from latitude 26.92 degrees in the north to longitude 75.82 degrees in the East and covers an area of 200.4 sq kms and lies at an altitude of 431 m above sea level.

Earlier Jaipur city has ample water supply covering more than 86.5% population. However, there has been a tremendous increase in the demand for fresh water because of rapid growth of population and accelerated pace of industrialization [2]since last two decades.

Water Quality Index (WQI) is a mathematical tool for quality and can be used to transform large quantities of water quality data into a unique measuring scale[3]. Water quality can be classified into excellent, good, poor, very poor, and unfit depending on the WQI value. Various research workers have carried out an extensive work on water quality index for various purposes, still concise optimization need to evaluate[2-6].

This research work will generate WQI among North West Jaipur and its agglomerates. The study would provide reliable Water Quality Index which can be used for the assessment of precise health risks and forming up of effective management to design necessary water treatment required for water.

EXPERIMENTAL

Study area

Present study of research was on the North West area of Jaipur and its agglomerates in which ten pointed locations are used and overall 30 ideal samples were collected through random selection and are weighed serial into composite sample as shown in Fig. 1.

Preparation of water sample

All sampling bottles were cleaned and rinsed thoroughly with 8M nitric acid and followed by repeated washing with deionised water and were rinsed thrice before sample collection. Sample bottles were brought to laboratory and analyzed by international standard method [7,8].

Analysis

Water samples were analyzed for different physico- chemical parameters as (pH, Total hardness (mg/L), Chloride (mg/L), TDS, (mg/L) Electrical Conductance (µS/cm), Nitrate (mg/L), Sodium (mg/L), Potassium (mg/L), Turbidity (NTU) as per the method described in “Standard Methods for the Examination of Water and Waste Water”[7,8].

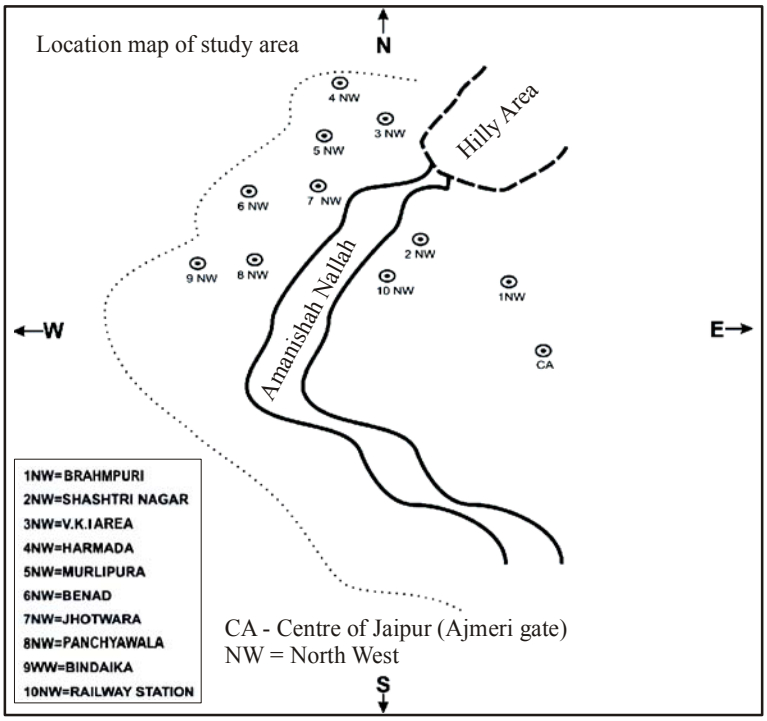

Fig. 1: Map showing pointed sampling of North West Jaipur and agglomerate

Table 1: Physico-chemical analysis of North West area of Jaipur and agglomerates

S. No.	Para-meter	Sampling point										
		1NW	**2NW**	**3NW**	**4NW**	**5NW**	**6NW**	**7NW**	**8NW**	**9NW**	**10NW**	**IS[9]**
1	pH	6.8	8.2	7.3	8.1	7.5	7.1	7.6	7.4	7.6	8.2	6.5-8.5
2	EC	2198	576	513	1102	561	363	1344	601	1000	1759	600
3	TUR	5	8	7	8	7	7	6	5	4	6	5
4	TH	329	252	158	225	171	162	514	36	356	631	300
5	TDS	1090	482	349	760	362	274	958	403	642	1282	500
6	Na	83	52	42	86	39	50	63	99	53	84	200*
7	K	1.48	4.48	5.15	3.21	1.64	220	6.78	1.72	3.81	8.81	-
8	Cl	158	61	44	105	61	26	149	61	105	219	250
9	NO_3	58	60	20	22	30	14	190	14	66	194	45

* value given by WHO standard, All parameter are in mg/L except pH, EC ,TUR., EC in (µS/cm), Turbidity. in NTU.

Water quality index modalling

In the present research work water parameter were considered for modalling and optimization of WQI. It is established that more harmful of pollutants corresponds degree of quality of water and the higher is its standard permissible value recommended for drinking water[2,4].

Step 1: we compute relative weight of each parameter from the following Equation

$$W_i = \frac{W_i}{\sum_{i=1}^{n} w_i} \quad \ldots(1)$$

W_i is calculated according to its relative importance in the over all quality of water for drinking purposes

Step 2: Quality Rating Scale (q_i) for each parameter was calculated by dividing concentration in each water sample by its respective Indian standard value.

$$q_i = (C_i/S_i) \times 100 \quad \ldots(2)$$

Where C_i = Conc. of each parameter

S_i = Respective Indian standard value

Step 3: The Sub index (SIi) of water sample were determined for each parameter, by which WQI determined as per following Equation

$$SI_i = W_i.q_i$$
$$WQI = \sum SI_i \quad \ldots(3)$$

Generally, WQI were discussed for a specific and intended use of water. In this study the WQI for drinking purposes is considered and permissible WQI for the drinking water is taken as 100.

$$\text{Overall WQI} = \frac{\sum q_i W_i}{\sum W_i} \quad \ldots(4)$$

RESULTS AND DISCUSSION

TDS present in water describes the inorganic salts and small amount of organic matter present as solute in water. TDS of studied area vary between 240 ppm at V.K.I Area and 1282 ppm in Railway Station due to dense residential area[4]. The mean value of TDS in North West Jaipur is 594 ppm is above IS and not drinkable and results in stomach upset and effect person suffering from kidney and heart disease[10].

pH of water has profound effect on human body and health. Results of pH obtained are between 6.8 and 8.2 in pointed areas. Average pH observed was 7.58 as value was shown to be the most stable parameter but combining other quality parameters. It degrades quality of water.

Hardness results from the presence of divalent metallic cation which calcium and magnesium are the most abundant in ground water[11]. In studied area Total Hardness varies between 36.03 (at Panchyawala) to 630.63 (at Railway Station) with mean value of 283.4 mg/L expressed hard water in the whole area expect specified IS Much the concern for Hardness is for the problems in human physiological system and domestic and industrical purpose[12].

High Turbid water causes difficulty in filteration and pathogenic organism may be clubbed in the particles and protected from disinfectant[13]. The IS has permissible limit of 5 NTU. Study which reveals Turbidity varied from 4 NTU of Bindaika to 8 NTU of Harmada EC is function of the dissolved (ionisable) solids concentration present in water. Table 1 reveals that the EC values of pre monsoon samples in North West varied from 513 to 2198 (micro Seimens /cm) and which were much higher than the prescribed standard limits (600 micro Siemens /cm) recommended by Indian Standard .for most of the sample.

Domestic sewage and industrial waste are significant sources of Chloride[15]. High result may indicate pollution of water by a sewage effluent. Chloride present in North West is from 61 to 219 mg\L. The average value of Chloride in North West is 61. All samples have lesser values than prescribed Indian Standard, Chloride has no adverse effect on health, but it impairs bad taste to drinking water.

The primary source of Sodium in natural water is from the release of the soluble products during the weathering of plagioclase feldspars[15]. In human, high concentration of sodium leads the cardiovascular disorders and in women, toxemia associated with pregnancy and may elevate blood pressure of susceptible persons[14]. North West sodium value varied from 39 to 99 mg/L.

Common sources of Potassium are the products formed by the weathering of orthoclase, microcline, biotite[15], Lucite and nepheline in igneous and metamorphic rocks. Potassium is not very much significant from health point of view, but large quantities may be laxative[14]. In North West potassium varied from 1.48 to 8.81.

Nitrate concentrations greater than 45 ppm is undesirable in water because of the toxic effects on young infants. (Methemoglobinemia, infant cyanosis or blue babies). In North West nitrate varied from 14 (at Panchyawala) to 194 (at Railway Station) due to leachates from waste disposal and railway junction activities[4]. Average value 66.8 ppm in North West. Jaipur clearly shows the nitrate concentration are more and water is more polluted.

Table 2: Computed WQI values for North West area of Jaipur city

S. No.	Parameter	Indian standard	Weight	Relative weight W_i	Quality Rating q_i	Subindex SI_i
1	pH	6.5-8.5	3	0.0938	101.06	9.48
2	EC	600	5	0.1515	166.95	25.29
3	Turbidity	5	3	0.0938	126	11.82
4	TH	300	5	0.1515	94.47	14.77
5	TDS	500	3	0.0938	132.06	12.44
6	Na	200	2	0.0625	32.55	2.03
7	K	-	2	0.0625	-	-
8	Cl	250	4	0.125	39.56	4.94
9	NO_3	45	5	0.1515	148.44	23.20

Table 3: Water quality classification based on WQIvalue[4]

WQI	Water quality	Water sample % in North West
≥ 50	Excellent	-
50 -100	Good water	60%
100-200	Poor water	30%
200-300	Very poor water	10%
Above 300	Water unsuitable for drinking	-
Average WQI = 103.98		

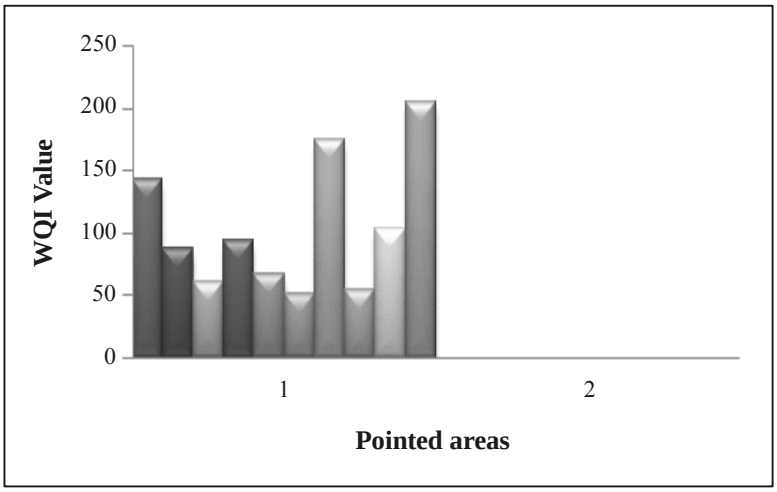

Fig. 2: WQIvalues for different pointed areas

Table 4: Calculation of WQI for individual water sample in North West of Jaipur city

S. No.	Labelling	Locality	Samples of North West (WQI)	Quality
1	1 NW	Brahmpuri	143.37	poor water
2	2 NW	Shastri Nagar	87.95	Good water
3	3 NW	V. K. I Area	60.86	Good water
4	4 NW	Harmada	95.40	Good water
5	5 NW	Murlipura	67.52	Good water
6	6 NW	Benad	52.78	Good water
7	7 NW	Jhotwara	175.94	poor water
8	8 NW	Panchyawala	54.73	Good water
9	9 NW	Bindaika	103.48	Poor water
10	10 NW	Railway Station	205.22	Very poor water

Water quality after WQI and optimization North West is 103.98. Therefore can be categorized into five types in Table 3. Water quality type, were determined on the basis of WQI. Calculation of WQI for individual samples is represented in Table 4. In North South area 60% 0f groundwater samples represent “good water, 30% indicate “poor water and 10% show ‘ very poor water.

Table 5: Correlation coefficient matrix of water ouality parameter for North West area of Jaipur city

	pH	E.C	TUR	TH	TDS	Na	K	Cl	No_3
pH	1								
EC	-0.046	1							
TUR	0.416	-0.412	1						
TH	0.372	0.705	-0.223	1					
TDS	0.380	0.834	-0.267	0.949	1				
Na	0.111	0.533	-0.300	0.131	0.420	1			
K	0.584	0.288	-0.060	0.793	0.691	0.009	1		
Cl	0.270	0.908	-0.360	0.884	0.975	0.506	0.592	1	
No_3	0.383	0.586	-0.213	0.940	0.892	0.168	0.834	0.818	1

Table 5 demonstrates the correlation coefficients parameter of North West of Jaipur. Few water quality parameters shows positive correlation with each other like EC with TH (r = 0.705), TDS (r = 0.834), Na (r = 0.533), Cl (r = 0.908), No_3 (r = 0.586); TDS with Cl (r = 0.975), $N0_3$ (r = 0.892), K (r = 0.691), Na (r = 0.420); Na with Cl (r = 0.506), K with Cl (r = 0.592), NO_3 (r = 0.834). Which indicating that NaCl, $NaNO_3$, KCl, KNO_3 may be present in water samples. TH bears positive correlation with TDS (r = 0.949), K (r = 0.793) Cl (r = 0.884), $N0_3$ (r = 0.940) it is suggested that Total Hardness of water samples is mainly due to presence of KCl and KNO_3; Turbidity show negative correlation with TH (r = -0.223), TDS (r = -0.267), Na (r = -0.300), Cl (r = -0.170).

CONCLUSION

Computed WQI value and optimization of water samples in North West area are 67.45 to 275.73 and high WQI in area has been found to be mainly because of higher values of EC, TH, TDS and NO_3, that means North West samples exhibit poor quality in great percentage. This may be due to over exploitation of ground water, direct discharge of effluents and agricultural : Correlation matrix of North West shows that TDS has positive correlation with Na (r = 0.887), K (r = 0.715), Cl (r = 0.923), NO_3 (r = 0.309) which indicating that NaCl, KCl, may be present in water samples. Table 5 shows that the Nitrate in North West was highly positive correlated with EC (r = 0.586), TH (r = 0.940), TDS (r = 0.892), K (r = 0.834), Cl (r = 0.818).

REFERENCES

1. WHO, Guidelines for Drinking Water Quality 2nd Edn., World Health Organization, Geneva (1996).
2. C. R. Ramakrishnaiah, C. Sadashivaiah and G. Ranganna, E- J. Chem., **6(2)**, 523-530 (2009).
3. M. Saeedi, O. Abessi, F. Sharifi and H. Meraji, Environ. Monit. Assess., **163**, 327-335 (2010).
4. J. Yisa and T. Jimoh, American J. Appl. Sci., **7(4)**, 453-458 (2010).
5. Reza Rizwan, and Gurdeep, Int. J. Appl. Environ. Sci., **5(4)**, 571-579 (2010).
6. B. B. Yakubo, S. M. Yidana, Nti Emmanuel, Akabzaa1 Thomas and Asiedu Daniel, "Environ. Earth Sci., **59(1-4)**, 867-879 (2009).
7. APHA, Standard Methods for Examination of Water and Waste Water, 20th Edn., Washington, DC (1998).
8. A. K. De, Environmental Chemistry, 5th Ed., New Age International Publishers, India (2003).
9. BIS, Bureau of Indian Standards, Drinking Water Standards IS : 10500 (1993).
10. L. I. Peiyue, Hu Qian and Hua Wujian, E – J. Chem., **7**, (SI) S209-S216 (2010).
11. D. K. Todd, Ground Water Hydrology, 2th Edn., John Wiley & Sons. Inc., New York (1980).
12. A. K. Yadav, Parveen Khan and S. K. Sharma, E – J. Chem., **7**, (SI) S428-S432 (2010).
13. S. M. Avvannavar and S. Shrihari, Environ. Monit. Assess., **143**, 279-290 (2008).
14. P. K. Goyal, Water Pollution Causes, Effects the Control 2th Edn., New Age Publishers, India (2006).
15. G. Udayalaxmi, D. Himabindu and G. Ramadass, Indian J. Sci. Technol., **3(5)**, 546-553 (2010).

Revised : 16.08.2012 *Accepted : 20.08.2012*