Int. J. Chem. Sci.: 6(3), 2008, 1518-1525

QUANTITATIVE ASSESSMENT OF UNDERGROUND AQUATIC ENVIRONMENTAL POLLUTION AT MORADABAD

NAVNEET KUMAR[*] and D. K. SINHA[a]

Department of Chemistry, K.G.K. (P.G.) College, MORADABAD - 244001(U. P.) INDIA
E-mail: dkskgk@rediffmail.com

ABSTRACT

Quantitative assessment of underground drinking water pollution of water of India Mark II (IM2) hand pumps at Moradabad for seven different sites, which are also deprived of other source of drinking water, has been carried out on the basis of calculated values of water quality indices (WQI). Water quality index for all the sites has been calculated with the help of estimated values of thirteen different physio-chemical parameters and drinking water standards prescribed by W.H.O. Underground drinking water was found to be severely polluted invariably at all the sites of study. People dependent on the water of source of study are prone to health hazards of polluted drinking water and water quality management is needed in the catchment area of study. Estimated higher values of different water quality parameters also verify the extent of drinking water pollution. Hence, assessment of water quality on the basis of calculated values of WQI is once again proved to be an effective tool.

Key words: Underground aquatic environment, Water pollution, Physico-chemical parameter, Water quality index, Unit weight, Quality rating.

INTRODUCTION

Adequate supply of fresh and clean drinking water is basic need for all human beings on the earth. It is the duty of scientists to test the available water in any locality in and around any residential area. As a part of society, it is a must. The resulting degradation of quality of water in water body creates a condition so that water can not be used for intended beneficial uses including bathing and recreation[1-3]. The present study is aimed to assess the underground drinking water quality of IM2 hand pumps in the localities of Moradabad city, which are deprived of other source of drinking water. Water quality index (WQI) is regarded one of the most effective way to communicate water quality. The data

[*] Author for correspondence; E-mail:navkchem@gmail.com

obtained through quantitative analysis of water and W.H.O. drinking water quality standards are used for calculating water quality indices[4-6].

Moradabad is a B class city of Uttar Pradesh having urban population more than 41 lacs. Moradabad is situated at the bank of Ram Ganga river and its altitude from the sea level is about 670 feet. It is extended from Himalaya in north to Chambal river in south. Moradabad is at 28° 20', 29° 15' N and 78° 4', 79° E. District Bijnor and Nainital are in the north, Rampur is in the east, Ganga river is in the west and district Buduan is in the north of district Moradabad. Moradabad has seen rapid industrialization during last few decades. The major industries are – Brassware, Steelware, Paper mills, Sugar mills, Crushers and Dye factories etc. Most of these industries are playing their usual role in multiplying underground water pollution.

The importance of present study is to draw attention towards study area for taking required necessary measures to minimize the hazardous effects likely to occur due to severely polluted drinking water.

EXPERIMENTAL

In order to study thirteen important physico-chemical characteristics of underground drinking water, seven different drinking water sites of IM2 hand pumps were selected. All the samples were collected and analysed quantitatively following standard methodology of sampling and estimation[7,8]. Details of sampling sites are summarized in Table 1.

The estimated parameters are: pH value, turbidity, alkalinity, conductivity, hardness, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total solids, total dissolved solids, calcium, magnesium and chloride concentration of water. Drinking water quality standard prescribed by W.H.O.[9] were used for the calculation of water quality indices.

WQI of underground water collected at seven different sites were calculated using the methods proposed by Horton and modified by Tiwari and Mishra[10, 11]. For calculating WQI, following four equations were used:

Table 1. A brief description of sampling sites

	Number and Name of site	Location of site	Depth of boaring (Approx. mtrs.)	Type of source	Apparent water quality	Use of water
I	I, IM2 Hand pump at Preet Vihar	6 Km south-west to Moradabad collectrate	35	Only source of water	Odourless, turns yellowish on standing	Drinking , domestic purposes
II	II, IM2 Hand pump at Balmiki basti	2 km east to site No. I	33	Only source of water	Colourless, odourless	Drinking, bathing etc.
III	III, IM2 Hand pump at Bank colony	1.5 km east to site No. I	36	Only source of water	Colourless, odourless	Drinking, domestic purposes
IV	IV, IM2 Hand pump at Prathmik Vidyalay, Khushalpur	1.5 km north-east to site No. III	35	Only source of water	Colourless, odourless	Drinking, domestic purposes
V	V, IM2 Hand pump at Community Centre, Budhi Vihar	1.5 km north to Mandi Samiti	34	Only source of water	Colourless, fishy smell	Drinking, domestic purposes
VI	VI, IM2 Hand pump at Balmiki Basti, Majhola	1.0 km north to site No. V	33	Only source of water	Colourless, odourless	Drinking, bathing
VII	VII, IM2 Hand pump at Prathmik Kanya Vidyalay, Majhola	1.0 km north-east to site No. V	34	Only source of water	Colourless, odourless	Drinking only

1. Quality rating, $Qn = 100\ [(V_n - V_i) / (V_s - V_i)]$ …(1)

Here, V_n = Actual amount present of nth parameter

V_i = Ideal value of this parameter,

V_i = 0, for all parameters except for pH and dissolved oxygen

V_i = 7.0 mg/Lt for pH; V_i = 14.6 mg/Lt for dissolved oxygen and

V_s = Standard of this parameter

2. Unit weight, Wn for various parameters is inversely proportional to the recommended standard, Sn for the corresponding parameters.

$$Wn_1 = K/Sn_1 \quad \ldots(2)$$

$\sum_{n=1}^{n=13} Wn = 1,$ Considered here

3. Sub indices, $(SI)n = (Qn)^{Wn}$ …(3)

4. $WQI = \pi_{n=1}^{n=13}(SI)_n = \pi_{n=1}^{n=13}(Qn)^{Wn}$ or

$$WQI = \text{antilog}_{10}\left[\sum_{n=1}^{n=13} Wn \log_{10} Qn\right] \quad \ldots(4)$$

To include the collective role of various physico-chemical parameters on the overall quality of drinking water, quality status is assigned on the basis of calculated values of water quality indices. The assumptions for extent of pollution or water quality status are: WQI < 50 : fit for human consumption; WQI < 80 : moderately polluted; WQI > 80 : excessively polluted and WQI > 100 : severely polluted.

RESULTS AND DISCUSSION

The estimated physico-chemical parameters with their W.H.O. standards and assigned unit weight (Wn) with the help of equation (2) are presented in Table 2. Parameter-wise and site-wise estimated values (Vn) and calculated quality rating (Qn) are listed in Table 3. Site-wise calculated values of water quality index (WQI) are given in Table 4.

Table 2. Parameter wise W.H.O. standards and their assigned unit weights

Parameter	W.H.O. Standard	Assigned unit weight (Wn)
pH	8.0	0.029781
Turbidity (NTU)	5.0	0.047649
Conductivity (μS/cm)	0.300	0.794153
Alkalinity (mg/L)	100.0	0.002382
Total hardness (mg/L)	100.0	0.002382
Calcium (mg/L)	100.0	0.002382
Magnesium (mg/L)	30.0	0.007941
Chloride (mg/L)	200.0	0.001191
Total solids (mg/L)	500.0	0.000476
Total dissolved solids (mg/L)	500.0	0.000476
Dissolved oxygen (mg/L)	5.0	0.047649
Biological oxygen demand (mg/L)	6.0	0.039708
Chemical oxygen demand (mg/L)	10.0	0.023825

Critical analysis of the data of WQI and its comparison with the standard assumptions reveals following facts regarding the extent of underground aquatic environmental pollution at Moradabad in the study area, which is also deprived of other source of drinking water.

The observed range of water quality index was 147-233. Water with WQI values more than 100 are assumed to be severely polluted. Therefore, underground drinking water is severely polluted invariably at all sites of study area, unfit for human consumption and other domestic purposes. The extent of pollution is maximum at site No VI. Comparison of estimated values of physico-chemical parameters with W.H.O. standards also reveals that drinking water is severely polluted at all the sites with reference to almost all the parameters studied. This also verified the findings based on calculated values of water quality indices.

Table 3. Parameterwise and site-wise estimated actual values (Vn) and calculated quality ratings (Qn)

Parameters	Site I		Site II		Site III		Site IV		Site V		Site VI		Site VII	
	Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn
pH	7.85	85.00	7.55	55.00	7.75	75.00	7.65	65.00	7.75	75.00	7.80	80.00	7.65	65.00
Turbidity (NTU)	2.55	51.00	3.75	75.00	3.15	63.00	3.10	62.00	3.20	64.00	2.85	57.00	3.15	63.00
Alkalinity (mg/L)	215.00	215.00	185.00	185.00	165.00	165.00	155.00	155.00	165.00	165.00	220.00	220.00	155.00	155.00
Conductivity (µS/cm)	0.82	271.67	0.57	190.00	0.62	206.67	0.47	156.67	0.60	200.00	0.83	275.00	0.60	198.33
Total hardness (mg/L)	210.00	210.00	205.00	205.00	235.00	235.00	205.00	205.00	225.00	225.00	275.00	275.00	245.00	245.00
Dissolved oxygen (mg/L)	3.00	120.83	2.20	129.17	3.00	120.83	3.50	115.62	2.30	128.12	3.00	120.83	2.50	126.04
Biological oxygen demand (mg/L)	9.50	158.33	11.00	183.33	10.50	175.00	11.50	191.67	10.50	175.00	11.50	191.67	8.00	133.33
Chemical oxygen demand (mg/L)	30.00	300.00	15.00	150.00	23.00	230.00	28.00	280.00	26.00	260.00	35.00	350.00	30.00	300.00
Total solids (mg/L)	785.00	157.00	420.00	84.00	560.00	112.00	470.00	94.00	550.00	110.00	790.00	158.00	515.00	103.00
Total dissolved solids (mg/L)	565.00	113.00	300.00	60.00	325.00	65.00	365.00	73.00	415.00	83.00	615.00	123.00	410.00	82.00
Calcium (mg/L)	105.00	105.00	120.00	120.00	110.00	110.00	130.00	130.00	140.00	140.00	190.00	190.00	155.00	155.00
Magnesium (mg/L)	105.00	350.00	85.00	283.33	125.00	416.67	75.00	250.00	85.00	283.33	85.00	283.33	90.00	300.00
Chloride (mg/L)	35.00	17.50	30.00	15.00	40.00	20.00	40.00	20.00	35.00	17.50	35.00	17.50	45.00	22.50

Table 4.Site-wise calculated values of water quality index

	Number and name of site	Water quality index
I	IM2 Hand pump at Preet Vihar	185
II	IM2 Hand pump at Balmiki basti	170
III	IM2 Hand pump at Bank colony	184
IV	IM2 Hand pump at Prathmik Vidyalay, Khushalpur	147
V	IM2 Hand pump at Community Centre, Budhi Vihar	180
VI	IM2 Hand pump at Balmiki Basti, Majhola	233
VII	IM2 Hand pump at Prathmik Kanya Vidyalay, Majhola	177

On the basis of above discussion, it may be concluded that the underground aquatic environment at all the sites of study at Moradabad is severely polluted and it is maximum at site No. VI. People dependent on this water are prone to heath hazards of polluted drinking water and water quality management is urgently needed. Estimated higher values of different parameters and calculated values of WQI suggest similar results. The present study was urgently required to draw the attention towards this region for taking necessary steps to minimize the adverse impacts likely to occur because of polluted water.

REFERENCES

1. A. G. Matahi, Indian J. Env. Prot., **26(3)**, 260 (2006).
2. A. Anathussalam and D. Gnanaganesam, Poll. Res., **23(3)**, 473 (2004).
3. M. R. Sharma and A. B. Gupta, Poll. Res., **23(1)**, 33 (2004).
4. D. K. Sinha and A. K. Srivasatava, Indian J. Env. Prot., **14(5)**, 340 (1994).
5. S. K. Pradhan, D. Patnaik and S. P. Rout, Indian J. Env. Prot., **21(4)**, 355 (2001).

6. D. K. Sinha and R. Saxena , J. Environ. Science & Engg., **48(3)**, 157 (2006).

7. APHA, Standard Methods for Examination of Water and Waste Water, 19th Ed., AWWA, WPCE, Washington D. C. (1995).

8. E. Merck, The Testing of Water, Federal Republic of Germany (1974).

9. W. H. O., International Standards for Drinking Water, World Health Organization, Geneva (1971).

10. R. K. Horton, J. Water Poll. Cont. Fed., **37**, 300 (1965).

11. T. N. Tiwari and M. Mishra , Indian J. Env. Prot., **5(4)**, 276(1985).

Accepted : 01.03.2008