

MONITORING OF UNDERGROUND DRINKING WATER QUALITY AT MORADABAD, INDIA

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ABSTRACT

To study the underground drinking water quality at Moradabad, water quality indices for underground drinking water at five different sites at Moradabad have been calculated with the help of water quality standards prescribed by W.H.O. and values of water quality physico-chemical parameters estimated for all the sites following standard methods and procedures of sampling and estimation as well. The underground water invariably at all the sites of study was found to be severely contaminated and unfit for human consumption .Some strict and effective measures are urgently needed for underground water quality management in the catchment area of study. Present study is indicative of men's disregard towards nature.

Keywords: Underground water quality, water quality index, unit weight, quality rating

INTRODUCTION

Water is absolutely essential for healthy living. It plays an indispensable role in the life of every species that survive in this world and is required by all living organisms for their existence. Today, human activities are constantly adding industrial, domestic and agricultural wastes to ground water reservoirs at an alarming rate. Ground water contamination is generally irreversible i.e. once it is contaminated ; it is difficult to restore the original quality of aquifer (Mahapatra 2005, Khan 2005)

Water quality index (WQI) is regarded as one of the most effective way to communicate water quality. The data obtained through quantitative analysis and W.H.O water quality standards are used for calculating water quality indices (Sinha 1994, Pradhan 2001, Sinha 2006, Rajmohan 2003, W.H.O. 1971). The objective of calculating WQI and comparing it with the standard assumption is to assess underground drinking water quality at Moradabad.

Moradabad is a 'B' class city of western Uttar Pradesh having urban population more than 38 lakhs. 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. It is at 28°20', 29°15' N and 78°4', 79°E. District Bijnor and Nainital are in the north, Rampur in the east, Ganga river in the west and district Budaun is in the north of district Moradabad. Moradabad has seen rapid industrialization and population growth during the last few decades. The major industries are brassware, steelware, paper mills, sugar mills, crushers, dye factories and a number of associated ancillaries. Most of these industries and different kinds of human activities are playing their roles in multiplying the level of underground drinking water pollution.

MATERIAL AND METHODOLOGY

Five different sites at Moradabad were selected in order to study the physico-chemical characteristics of underground drinking water of India Mark II (IM2) hand pumps. The samples were collected during 2007 following the standard methods of sampling. The standard methods and procedures were used for quantitative estimation of water quality parameters (APHA 1995, Merck 1974). All the chemicals of anal R grade were used for this purpose. The standards prescribed by W.H.O. were used for calculation of water quality indices. Estimated water quality physico-chemical parameters are – pH value, conductivity, turbidity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total hardness, calcium, magnesium, chloride, total solids, total dissolved solids, iron, alkalinity, fluoride, sulphate and free CO₂. Details of sampling sites are given in Table 1. WQI of underground drinking water collected at five different sites has been calculated using the methods proposed by Horton and modified by Tiwari and Mishra (Horton 1965, Tiwari 1985, Tiwari 1986). According to the role of various parameters on the basis of importance and incidence on the overall quality of drinking water, the rating scales were fixed in terms of ideal values of different physico-chemical parameters. Even if, they are present, they might not be the ruling factor. Hence, they were assigned zero values. For calculating WQI, following four equations were used :

- Quality rating, $Q_n = 100 [(V_n - V_i) / (V_s - V_i)]$
 here, $V_n =$ actual amount of nth parameter
 $V_i =$ the ideal value of this parameter
 $V_i = 0$, except for pH and D.O.
 $V_i = 7.0$ for pH; $V_i = 14.6$ mg/lit for D.O.
 $V_s =$ recommended W.H.O. standard of
 Corresponding parameter

2. Unit weight (W_n) for various parameters is inversely proportional to the recommended standard (S_n) for the corresponding parameter.

$$W_n = K / S_n$$

here,

S_n = world-widely accepted drinking water quality standard prescribed by W.H.O.

K = constant

$$\sum_{n=1}^{n=18} W_n = 1, \text{ considered here}$$

3. Sub indices, $(SI)_n = (Q_n)^{W_n}$

4. The overall WQI is calculated by taking geometric mean of these sub indices.

$$WQI = \text{antilog}_{10} \left[\sum_{n=1}^{n=18} W_n \log_{10} Q_n \right]$$

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. On the basis of a number of water pollution studies, the following assumptions were made with reference to assess the extent of pollution or quality of drinking water. The assumptions were : $WQI < 50$: fit for human consumption; $WQI < 80$: moderately polluted ; $WQI > 80$: excessively polluted ; $WQI > 100$: severely polluted.

RESULTS AND DISCUSSION

The physico-chemical parameters with their W.H.O. Standards and unit weights (W_n) assigned with the help of equation no. 2 are listed in Table 2. Site-wise and parameter-wise estimated values (V_n) and calculated quality rating (Q_n) are presented in Table 3. Site-wise calculated values of WQI are given in Table 4.

Critical analysis of the data of the WQI presented in Table 4. and its comparison with standard assumptions revealed following facts regarding the level of drinking water pollution at Moradabad during the course of study.

The observed range of water quality index is 137-257. The underground drinking water of IM2 hand pumps at Moradabad are severely contaminated with WQI values more than 100 invariably at all the sites of study and is unfit for consumption and other domestic purposes. The present study is an approach to assess drinking water quality statistically.

CONCLUSION

On the basis of above discussion, it may be concluded that the underground drinking water is severely polluted in the catchment area of study at Moradabad. The drinking water is polluted with reference to almost all the water quality physico-chemical parameters studied. The water is unfit for human consumption and other domestic usage. People dependent on this water are prone to health hazards of contaminated drinking water. Some strict and effective measures are urgently needed for underground water quality management in the catchment area of study. Water quality index is proved to be an effective tool for drinking water quality assessment.

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Table 1 : Details of sampling locations

Sl. No.	No. and Name of site	Location of site	Type of hand pump	Depth of boaring	Type of source	Apparent water quality
1.	I, Bus Station	1 km north to Tehsil	India Mark II	Approx. 33 meter	Only source	Water becomes turbid on standing
2.	II, Railway Station	200 m. west to site no. I	India Mark II	Approx. 30 meter	Only source	Neat and clear water
3.	III, Town Hall	200 m. west to site no. IV	India Mark II	Approx. 33 meter	Only source	Water colour turns yellowish on standing
4.	IV, Sadar Tehsil	Tehsil head quarter	India Mark II	Approx. 30 meter	Only source	Neat and clear water
5.	V, District Hospital	100 m. west to site no. V	India Mark II	Approx. 30 meter	Only source	Water becomes turbid on standing

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

Sl. No.	Parameter	W.H.O. Standard	Assigned Unit Weight (Wn)
1	pH value	7 - 8.5 (8.0)	0.016669
2	Conductivity ($\mu\text{S}/\text{cm}$)	0.300	0.444503
3	Turbidity (NTU)	5.0	0.026670
4	Dissolved Oxygen (ppm)	5.0	0.026670
5	Biological Oxygen Demand (ppm)	6.0	0.022225
6	Chemical Oxygen Demand (ppm)	10.0	0.013335
7	Total Hardness (ppm)	100	0.001334
8	Calcium (ppm)	100	0.001334
9	Magnesium(ppm)	30	0.004446
10	Chloride (ppm)	200	0.000667
11	Total Solids (ppm)	500	0.000267
12	Total Dissolved Solids (ppm)	500	0.000267
13	Iron (ppm)	0.5	0.266702
14	Alkalinity (ppm)	100	0.001334
15	Flouride (ppm)	1.0	0.133351
16	Sulphate (ppm)	500	0.000267
17	Zinc (ppm)	5.0	0.026670
18	Free CO_2 (ppm)	10.0	0.013335

Table 3 : Parameter- wise and site-wise estimated actual value (Vn) and calculated quality rating (Qn)

Sl No.	Parameter	Site No. I		Site No. II		Site No. III		Site No. IV		Site No. V	
		Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn	Vn	Qn
1	pH value	7.26	26	7.40	40	7.48	48	7.51	51	7.32	32
2	Conductivity ($\mu\text{S}/\text{cm}$)	1.14	380	1.0	333.33	1.16	386.67	1.10	366.67	1.14	380
3	Turbidity (NTU)	20	400	2	40	12	240	2	40	10	200
4	Dissolved Oxygen (ppm)	2.40	127.08	2.20	129.17	2.8	122.92	2.40	127.08	2.30	128.13
5	Biological Oxygen Demand (ppm)	10	166.67	12	200	16	266.67	14	233.38	14	233.38
6	Chemical Oxygen Demand (ppm)	60	600	80	800	58	580	58	580	60	600
7	Total Hardness (ppm)	320	320	304	304	300	300	340	340	328	328
8	Calcium (ppm)	89.6	89.6	75.20	75.20	51.20	51.20	54.40	54.40	84.8	84.8
9	Magnesium(ppm)	23.34	77.80	28.2	94	41.81	139.37	49.59	165.30	28.2	94
10	Chloride (ppm)	52	26	56	28	64	32	68	34	52	26
11	Total Solids (ppm)	400	80	350	70	450	90	380	76	420	84
12	Total Dissolved Solids (ppm)	380	76	320	64	435	87	330	66	380	76
13	Iron (ppm)	1.2	240	0.28	56	1.10	220	0.28	56	0.51	102
14	Alkalinity (ppm)	388	388	384	384	396	396	288	288	398	398
15	Flouride (ppm)	1.07	107	1.05	105	1.07	107	0.80	80	0.78	78
16	Sulphate (ppm)	80	16	80	16	80	16	80	16	80	16
17	Zinc (ppm)	0.40	8	0.20	4	0.10	2	0.10	2	0.40	8
18	Free CO_2 (ppm)	40	400	32	320	38	380	34	340	36	360

Table 4: Site-wise calculated values of Water Quality Index at Moradabad

Sl. No.	No. and Name of site	Water Quality Index
1	I, Bus Station	234
2	II, Railway Station	137
3	III, Town Hall	222
4	IV, Sadar Tehsil	257
5	V, District Hospital	176