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DETERMINATION OF WATER QUALITY INDEX AND SUITABILITY OF GROUND WATER IN A COLLEGE IN BALRAMPUR, U.P.

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ABSTRACT

This paper presents a study on the influence of environmental parameters on ground water quality in MLK (PG) College, Balrampur (U.P.). Ground water samples were collected from different points in the college campus and their quality was compared on the basis of water quality index, which determines the water quality for drinking purpose. WQI was determined on the basis of various physical and chemical parameters like pH, EC, turbidity, TDS, acidity, alkalinity, total hardness, calcium, magnesium, chloride, nitrate, sulphate, iron and dissolved oxygen. These parameters were determined for the calculation of water quality index (WQI). A comparison of the quality of ground water of five different locations of the college has been made.

INTRODUCTION

The pollution of water bodies is increasing steadily due to rapid population growth, urbanization, increasing living standards and diverse human activities. Time is perhaps not too far when pure and clean water may be unavailable for maintaining the normal human life. There are several ways to assess the quality of water as deemed fit for drinking, irrigation and industrial use. A number of parameters affect the usability of water for a particular purpose. Ground water is one of the main sources of water requirement of people in India as well as other parts of the world. Pollution of water has been reported to cause 80% of human diseases and 30% of infant mortality. It is, therefore, important to monitor the quality of ground water pollution of various parts of our country (Singh & Parwana 1992).

Keeping this in view, the present study aims to calculate the water quality index (WQI) in order to assess the suitability water for human use in M.L.K. (P.G.) College, Balrampur.

MATERIALS AND METHODS

District Balrampur is located in the Tarai region of Uttar Pradesh bordering Nepal with a latitude of 27°20' and longitude 82°49'. The ground water quality of the whole region appears to be not very good since most of the population is suffering from various waterborne diseases. Ground water is available for domestic use even at a depth of 9 to 12 meters. This low depth ground water has many pollutants perhaps due to comparatively insufficient filtration medium as earth. The present study has been made on the hand pump groundwaters of the M.L.K. (P.G.) College, Balrampur at five sites situated at Departments of Chemistry, Botany, Geography and Physics, and Principal's Office.

Standard equipment and AR or GR chemicals were used in chemical analysis following standard methods (APHA 1992).

Water Quality Index System

A water quality index, common with many other indices systems, relates a group of water quality

parameters to a common scale and combines them into a single number in accordance with a chosen method of computation. The desired use of WQI is to assess water quality trends for management purpose even though it is not meant for an absolute measure of the degree of pollution or the actual water quality.

The water quality index was calculated considering nine important physico-chemical parameters using ICMR and ISI standards by following formula:

$$WQI = \sum_{i=1}^{n} q_i W_i / \sum_{i=1}^{n} W_i$$

Where, W_i is a unit weight factor, given by the formula, $W_i = K/S_i$

S_i is the standard value of i^{th} parameter and K is proportionality constant.

The unit weights W_i for all the 9 chosen parameters with standard values are given in Table 1.

The quality rating q_i is determined as follows:

$$q_i = 100 (Vi - V_{10}) / (S_i - V_{10})$$

Where,

q_i = Quality rating for the n^{th} water quality parameter.
V_i = Estimated value of the n^{th} parameters at a given sampling station.
S_i = Standard permissible value of n^{th} parameter.
V_{10} = Ideal value of the n^{th} parameter in pure water.

All the ideal values (V_{10}) are taken as zero for the drinking water except for pH = 7.0 and DO = 14.6 mg/L.

RESULTS AND DISCUSSION

The values of various physico-chemical parameters for calculation of WQI are presented in Table 2, quality rating in Table 3, sub index values in Table 4, WQI values in Table 5, and status of water quality based on WQI in Table 6.

pH Values: The pH values of the ground water of the college are in acidic range varying from 6.93 to 6.50. The present observation finds support by the work of Chatterjee & Raziuddin (2002). It is

Table 1: Drinking water standards recommending agencies and unit weights (all values except pH are in mg/L).

Sl. No.	Parameters	Standards (S_i)	Recommending agency	Unit Weight (W_i)
1.	pH	6.5-8.5	ICMR and ISI	0.218176
2.	Total Dissolved Solid (mg/L)	500	ICMR and ISI	0.003708
3.	Total Hardness (as $CaCO_3$) (mg/L)	300	ICMR and ISI	0.00618
4.	Calcium (mg/L)	75	ICMR and ISI	0.02472
5.	Magnesium (mg/L)	30	ICMR and ISI	0.0618
6.	Sulphate (mg/L)	150	ICMR and ISI	0.01236
7.	Chloride (mg/L)	250	ICMR and ISI	0.007416
8.	Nitrate (mg/L)	45	ICMR and ISI	0.0412
9.	Dissolved oxygen (mg/L)	5	ICMR	0.37089
10.	Electrical conductivity, µmhos/cm	300	ICMR	0.00618

Table 2: Water quality parameters of M.L.K.(P.G.) college, Balrampur.

Sl. No.	Parameters/Place of samples	Chemistry Dept.	Botany Dept.	Physics Dept.	Geography Dept.	Principals's Office
1	pH	6.50	6.75	6.93	6.67	26.60
2	TDS (mg/L)	275.00	250.00	280.00	330.00	331.00
3	Total hardness (as $CaCO_3$) (mg/L)	165.00	155.00	265.00	233.00	190.00
4	Total acidity (mg/L)	140.00	175.00	130.00	170.00	210.00
5	Turbidity (N.T.U.)	6.50	5.00	8.80	6.00	66.80
6	Dissolved O_2 (mg/L)	3.20	4.30	1.50	2.50	2.10
7	Calcium (mg/L)	60.00	70.00	70.00	63.00	80.00
8	Magnesium (mg/L)	18.00	16.00	25.00	23.00	32.00
9	Chloride (mg/L)	135.00	148.00	200.00	190.00	122.00
10	Sulphate (mg/L)	85.00	90.00	135.00	165.00	100.00
11	Nitrate (mg/L)	32.00	25.00	40.00	40.00	35.00
12	Iron (mg/L)	0.50	0.20	0.70	0.4	00.80

known that pH of water does not cause any severe health hazard, however, low pH induces the formation of trihalomethanes which are toxic. In the present study pH values are within the ICMR standards (6.5-8.5) and ISI standards (6.5-9.2).

Total dissolved solids: TDS values ranged from 250 to 331 mg/L. In the present study TDS values are within the ICMR standards (1500 to 3000 mg/L) and ISI standards (500 mg/L). Higher concentration of dissolved solids may produce distress in cattle and livestock and a salty to water.

Total hardness: Hardness values were recorded between 155 and 265 mg/L. High values of hardness in the sample of Physics Deptt. attributed to low water level. The scale of hardness from the consumers point of view may be taken as below:

0-50 mg/L	-	Soft
50-100 mg/L	-	Moderately soft
100-150 mg/L	-	Slightly hard
150-250 mg/L	-	Moderately hard
Over 250 mg/L	-	Hard

In this respect the ground water of college is moderately hard. Hardness below 250 mg/L is considered potable but this limit produces gastrointestinal irritation.

Table 3: Water quality rating (Q_i) of M.L.K.(P.G.) College, Balrampur.

S. No.	Parameters	Chemistry Dept.	Botany Dept.	Physics Dept.	Geography Dept.	Principals's Office
1	pH	-33.3333	-16.6666	-4.6666	-22.00000	-22.0000
2	TDS	55.0000	50.0000	56.0000	66.00000	66.2000
3	Total Hardness	55.0000	51.6666	88.6300	77.6666	110.3333
4	Dissolved O_2	118.9473	118.9473	136.8421	126.8492	130.4109
5	Calcium	80.0000	93.3200	93.3200	84.0000	106.6400
6	Magnesium	60.0000	83.3000	83.3000	76.6000	106.6666
7	Chloride	56.0000	90.0000	90.0000	110.0000	66.6660
8	Sulphate	54.0000	80.0000	80.0000	76.6000	48.8000
9	Nitrate	71.1111	88.8888	88.8888	88.8888	77.7777

Table 4: Calculated subindex (Q_iW_i) values of different parameters of M.L.K. (P.G.) College, Balrampur.

S. No.	Parameters	Chemistry Dept.	Botany Dept.	Physics Dept.	Geography Dept.	Principals's Office
1	pH	-7.2727	-3.6362	-1.0181	-4.7998	-4.7992
2	TDS	0.2039	0.1854	0.2076	0.2447	0.2454
3	Total Hardness	0.3390	0.3193	0.5480	0.4806	0.6820
4	Dissolved O_2	44.1163	39.8218	50.7533	46.8492	48.4109
5	Calcium	1.9776	2.3086	2.3086	2.0764	2.6361
6	Magnesium	3.7080	3.2959	5.1499	4.7376	6.5919
7	Sulphate	0.7003	0.7416	1.1124	1.3596	0.8239
8	Chloride	0.4004	0.4390	0.5932	0.5636	0.3619
9	Nitrate	2.9297	2.2888	3.6620	3.6622	3.2044

Total acidity: Total acidity values are within 75 to 210 mg/L. High values of total acidity in the sample of Principal's office might be due to the presence of septic tank. Acidity in itself is not harmful to human beings.

Turbidity: The values of turbidity are within 5.0 to 8.8. (N.T.U.). The high value of turbidity in the sample of Principal's office is due to presence of septic tank. The permissible turbidity prescribed as a standard for drinking water is between 5 to 10 mg/L (turbidity units).

Dissolved oxygen (DO): The values of DO vary from 1.5 to 4.3 mg/L. The low value of DO in Physics Deptt. and Principal's office can be attributed to addition of effluents containing oxidizable organic matter. The concentration of DO in the ground waters of college is below permissible limit of 5 mg/L during all the seasons.

Calcium: Calcium occurs in water mainly due to the presence of limestone, gypsum, dolomite and gypsiferrous minerals. The determination of calcium is usually required for potable water. The values varied in the range of 60 to 80 mg/L. High calcium contents in water are undesirable for washing, bathing and laundering. It tends to create scales on utensils. The permissible limit of calcium is 75 mg/L (ISI).

Table 5: Water quality index (WQI) of M.L.K. College, Balrampur.

Sl.No.	Place of sample	WQI
1	Chemistry Department	47.1027
2	Botany Department	45.7642
3	Physics Department	63.3171
4	Geography Department	55.1744
5	Principal's Office	58.1573

Table 6: Status of water quality based on WQI. (Chatterjee & Raziuddin 2002).

Sl.No.	WQI	Status
1	0-25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very Poor
5	100 and above	Unsuitable for drinking

Magnesium: The values varied within range of 16 to 32 mg/L in the waters of the college. The permissible limit of magnesium is 30 mg/L (ISI). Magnesium is an essential element for man. However, at higher levels, magnesium salts have a laxative effect.

Chloride: Concentrations of chloride were found to vary within 122 to 200 mg/L. Though chloride concentration is high in ground water, but it is below permissible limit.

Sulphate: The values of sulphate ranged within 85 to 165 mg/L. The maximum values observed can be attributed to addition of septic tank water. Sulphate may have laxative effect if magnesium is present at an equivalent concentration (Chatterjee & Raziuddin 2002). In the present study sulphate in ground waters is below permissible limit.

Nitrate: Nitrates are the end products of decomposition

of organic matter present in fully oxidised waters and harmful above 45 mg/L. In the present study nitrate in ground waters is below permissible limit.

Iron: WHO International standards of iron recommended a permissible limit of 0.3 mg/L and excessive limit of 0.1 mg/L in drinking water. The values ranged within 0.2 to 0.8 mg/L.

Application of WQI is a useful method in assessing the water quality of ground waters. In the present study, application of WQI gives a comparative evaluation of water quality at different sampling places. Perusal of WQI data from Table 5 indicates that the index value is maximum for Physics Deptt. and minimum for Chemistry Deptt. It can be concluded from the study that the water quality at various locations in the college is in the following decreasing order: Botany Deptt. > Chemistry Deptt. > Geography Deptt. > Principal's Office > Physics Deptt.

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