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Physico-chemical analysis of groundwater in Gandhi Nagar area, District Bhopal, Madhya Pradesh

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ABSTRACT

An assessment of the groundwater quality was carried out in Gandhi Nagar area of District Bhopal, Madhya Pradesh. The study was aimed at examining the various samples of ground water and the quality of the groundwater as it relates to public health. Ten groundwater samples were taken from boreholes and open wells and were analyzed for pH, electrical conductivity (EC), chloride, total alkalinity, total acidity, total dissolved solids (TDS) and total hardness. The results were compared with WHO, ICMR and IS:10500 standards. The usefulness of these parameters in predicting ground water quality characteristics were discussed. Thus an attempt has been made to find the quality of ground water in Gandhi Nagar area suitable for drinking purposes or not.

Keywords: Ground water, water pollution, alkalinity, acidity, chloride.

INTRODUCTION

Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and sub-surface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors may cause periodic changes in groundwater quality[1]. Water pollution not only affects water quality but also threatens human health, economic development and social prosperity [2]. Ground water is a source of drinking water, and even today more than half the world's population depends on ground water for survival. The assessment of water quality is very important for knowing the suitability for various purposes[3]. Assessment of groundwater for drinking and irrigation has become a necessary and important task for present and future groundwater quality management. Nowadays, a lot of studies have focused on groundwater quality monitoring and evaluation for domestic and agricultural activities around the world[4]. Water is a prime need for human survival and industrial development. For many rural and small communities, groundwater is the only source of drinking water. The geology of a particular area has a great influence on quality of water and its environment[5]. Many a time ground water carries higher mineral contents than

surface water, because there is slow circulation and longer period of contact with sediment materials in case of groundwater. Changes of groundwater quality with the passage of time have hydrologic significances. The quality also varies due to a change in chemical composition of the underlying sediments and aquifer. The present study attempts to evaluate the quality of ground water in Gandhi Nagar area of District Bhopal, capital of Madhya Pradesh.

MATERIALS AND METHODS

In the present investigation ground water samples were collected from 10 locations in Gandhi Nagar area in the month of October 2010. Samples were collected in polythene bottles, pre-cleaned by washing with non-ionic detergents, rinsed with water, 1 : 1 hydrochloric acid and finally with deionised water[6]. Before sampling, the bottles were rinsed three times with sample water. Tube wells were operated at least five minutes before collection of the water samples. The water quality parameter estimation and calibration of equipments were done using standard methods and techniques [7,8] . Samples were brought to the laboratory for analysis of physico-chemical parameters. Some parameters like pH, temperature, and electrical conductivity (EC) was measured in-situ using sensor of Systronics water analyzer. Alkalinity, acidity and total hardness was estimated titrimetrically. Chloride content was estimated by argentometric method [9].

RESULTS AND DISCUSSION

The results obtained from analysis of different ground water samples are shown in Table-1. The statistical evaluation are given in Table-2. The values of correlation coefficients are listed in Table-3.

Table-1 Physico-chemical parameters at different sampling stations

Parameters	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10
Temp °C	29.1	29.2	28.9	29.0	29.2	29.1	29.3	28.8	28.9	29.0
pH	6.9	6.4	6.7	6.3	6.5	7.2	6.8	7.3	7.1	7.3
EC µs/cm	50	92	102	111	123	120	86	74	104	48
Alkalinity	44	57	263	264	271	259	60	75	241	85
Acidity	04	09	87	104	67	115	17	25	39	11
Total hardness	36	106	528	430	484	403	118	248	376	126
TDS	540	940	1050	1170	1280	1250	890	790	1090	490
Chloride	103.7	107.9	85.2	68.2	98.7	69.4	101.3	105.5	99.1	111.1

Table-2 Descriptive statistics of Physico-chemical parameters

Parameters	Min	Max	Mean	SD
pH	6.3	7.3	6.85	0.37
EC	48	123	91	26.67
Alkalinity	44	271	161.9	103.81
Acidity	4	115	47.8	42.04
Total hardness	36	528	285.5	179.65
TDS	490	1280	949	276.06
Chloride	68.2	111.1	95.01	15.46

In the present investigation most of the water samples are colourless and odourless. However some water samples are slightly coloured due to muddiness. The temperature of water samples is varied from 28.8 °C to 29.3 °C the variation of the water temperature having more effect directly or indirectly on all life processes[10].

pH is a term used to indicate the alkalinity or acidity of a substance. In the present study area the pH value ranged from 6.3 to 7.3. A pH range from 7.0 to 8.5 is desirable concentration as per guided by ICMR. It is known that pH of water does not cause any severe health hazard. Water of study area is slightly acidic in nature.

Electrical conductivity estimates the amount of total dissolved salts or the total amount of dissolved ions in the water. In the present study the electrical conductivity ranges from 48 to 123 $\mu\text{S}/\text{cm}$ and it is found to be within permissible range [11].

The main sources of natural alkalinity are rocks, which contain carbonate, bicarbonate, hydroxide compounds and phosphates. The value of alkalinity in study area is ranged from 44 to 271ppm with the mean value of 161.9 ± 101.81 . Alkalinity in itself is not harmful to human being, but in large quality, alkalinity imparts bitter taste to water and may cause eye irritation in human [12].

The acidity may result due to presence of carbon dioxide in the atmosphere, an indication of high population and industrialization. The studied ground water samples show the acidity in the range 4 to 115 ppm [13].

The mean value of total hardness of studied groundwater samples is 285.5ppm with the standard deviation of ± 179.65 ppm which indicates that most water samples are hard except the sample from GW1 with total hardness 36ppm. This water sample is soft in terms of hardness.

TDS is an important parameter which imparts a peculiar taste to water and reduce its potability. Desirable limit of TDS is 500 mg/l (ICMR). The mean value of TDS of studied groundwater samples is 949 ppm with the standard deviation of ± 276.06 . All the values obtained are much higher than the limit except in the sample from GW10 (490ppm).

Chloride is an important quality parameter that affects the aesthetic property of water including taste and renders it unsuitable for drinking purpose if present in high concentration. The chloride concentrations in study area ranged from 68.2 to 111.1 with mean values of 95.01 ± 15.46 ppm. The values the present study are on lower side considering WHO maximum limit of 250ppm.

In statistics correlation is a broad class of statistical relationship between two or more variables. The correlation coefficient for different parameters are given in Table-3.

Table-3 Correlation coefficient (r)

Parameter	pH	EC	T. Alk.	T. Acidity	T. hardness	TDS	Chloride
pH	1.00						
EC	-0.45	1.00					
T. Alkalinity	-0.24	0.82	1.00				
T. Acidity	-0.22	0.78	0.88	1.00			
T. hardness	-0.22	0.81	0.96	-0.86	1.00		
TDS	-0.44	0.99	0.83	0.79	0.89	1.00	
Chloride	0.26	-0.66	-0.74	-0.93	-0.67	-0.67	1.00

The correlation is considered good if $r > 0.6$ and marginal of $0.47 < r < 0.6$ [14]. The pH shows negative correlation with EC, total alkalinity, acidity, TDS and hardness but shows poor positive correlation with chloride. EC shows good positive correlation ($r > 0.6$) with EC, total alkalinity, acidity, TDS and hardness But shows negative correlation with chloride. All parameters except

pH show negative correlation with chloride. Total alkalinity is positively correlated with TDS and total hardness.

CONCLUSION

The objective of present work was to study the water quality of groundwater in Gandhi Nagar area of Bhopal so as to assess its suitability for domestic purpose. All parameters studied are within the permissible limit of WHO, ICMR and IS:10500 standards. Continuous monitoring of ground water is necessary for the health of human, animals and crops. Sample water GW1 and GW10 are safe for drinking purposes and rest of samples except GW3 may be used for drinking purposes after boiling or some treatment. Sample GW3 is not suitable for drinking but can be used for irrigation.

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