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A STUDY OF GROUNDWATER QUALITY OF DEORIA CITY, UTTAR PRADESH INDIA

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ABSTRACT

This study is aimed at providing information about physico-chemical properties of groundwater of Deoria city for understanding of groundwater quality. Samples were collected from ten wells located at different locations of the study area. Analysis was carried out for pH, TDS, total hardness, alkalinity, chloride, iron, nitrate, fluorides, sulphates, turbidity etc the results showed that the all parameters except alkalinity were within permissible limits. Total alkalinity values were found beyond permissible limit prescribed by BIS standards for drinking water. It is therefore, suggested that a regular chemical analysis must be done to ensure that the quality of drinking water in this area is not contaminated.

KEYWORDS: Waterquality, Physico-chemical parameters, ground water, rain water harvesting**.**

INTRODUCTION

Water is an essential natural resource for sustaining life and environment that we have already thought to be available in abundance and free gift of nature.[1] The fresh water in form of groundwater, rivers and lakes is our primary source of drinking water. The amount of groundwater represents about 0.6% of total global water resources and out of this, only 0.3%

is extractable economically.[2] Due to urbanization, industrialization and population increase, the demand for water increased tremendously, which creates a critical stress on groundwater, most especially in the dry season when water from other source are not readily available. The ground water levels continue to decline due to over exploitation of the resources induces degradation of underground water quality. Ground water contains various minerals, often salts in solution. Determination of physico-chemical characteristics of ground water is essential for assessing the suitability of water for various purposes like drinking, domestic, industrial and irrigation.

Groundwater quality of various regions has been studied by a number of researchers. Few of them have been listed as Suhail Ayub et al. (2010) have been studies groundwater contamination in Aligarh city. Vikash Vishwakarma et al. (2012) have been studies groundwater quality in Ujjain city. Gupta et al. (2004) studied the chemical analysis of groundwater quality of Sanganer area, Jaipur to observe the suitability of groundwater for safe drinking and irrigation. Khwaja M. A. et al. (2012) evaluate shallow aquifer groundwater quality of Atrauli town, U.P. India. Guruprasad (2003) carried out a study to find out the suitability of groundwater for drinking purpose in Tadepalli Mandal of Guntur district Sharma Moti Lal (2003), Analyze groundwater quality of Bilaspur area in Himachal Pradesh. Kumar N. (2010) studied groundwater quality in shallow and deep aquifers of Dhampur, district Bijnor, Uttar Pradesh, India. Elangovan et al. (2004) studied the groundwater quality in Salem Namakkal districts and reported that the water is suitable for drinking purposes. Chaudhari et al. (2004) studied the quality of groundwater near an industrial area at Jalgaon (Maharastra). Sheila Srivastava et al. (2011) studied the quality of groundwater at Raebareli district India.[3-12]

The study was conducted to assess the physico-chemical quality of ground water of Deoria city, Uttar Pradesh, India.

Study Area

The study concentrates on Deoria, is a city in the state of Uttar Pradesh, India. It is located at 26.50167^{o} North latitude and 83.77936^{0} East. On the name of Sant Deoraha Baba the city is named as Deoria. Deoria is situated at 50 km to south-east of Gorakhpur on Gorakhpur-Siwan broadgauge railway line towards Siwan and about 310 km from state capital Lucknow. As per 2011 India censes, Deoria had a population of 1, 29, 570. Climate of the town is hot

and dry. May & June are hot and December & January months of the year are cold. Different types of soil found in Deoria such as Domat, Bhat, Matiyar and Balui Domat.

MATERIAL AND METHODS

Ten sites of Deoria town were selected in order to study the physico-chemical characteristics of groundwater samples. The depth of all these sources studies ranged 30 to 45 meter. These samples were collected as per the standard methods prescribed for sampling. The grab sampling method was chosen for collection of the samples, which reflects composition of water at the source at the sampling time and place. The samples were collected in plastic bottles which were pre-cleaned with concentrated hydrochloric acid followed by rinsing in tap and finally in distilled water.[13] The water samples were subjected to analysis within 24 hours of collection for the physico-chemical parameters. Water quality parameters viz. pH, total dissolved solids, alkalinity, iron, nitrate, fluorides, chlorides, turbidity, sulfates, and total hardness were analyzed in the laboratory using standard methods 16th edition (APHA, 1995).[14]

RESULTS AND DISCUSSION

The results obtained were evaluated in accordance with the standards prescribed under Indian standard drinking water specification IS: 10500:1991 of Bureau of Indian Standards.[15] The physical and chemical analysis of groundwater samples were tabulated in table 1 & 2. Table 3 shows the classification of groundwater on the basis of total hardness. Table 4 indicates correlation among water quality parameters.

Physical characteristics

The water samples collected from sampling station S_1 to S_{10} found odorless and colorless. Taste of the water samples found sweet. Turbidity causes degradation in transparency it is caused by presence of clay, organic, inorganic and other.

Table 1: Physical characteristics of ground water.

S. No.	Sampling locations	Parameters					
		pH 6.5-8.5	Elect. Cond. In µ mahos	Taste	Odour	Colour	Turbidity in (5.0 NTU)
S_1	Cremation place near Ali nagar.	7.5	446.2	sweet	odourless	colourless	2.72
S_2	Deoria Khas, primary school.	7.5	392.3	sweet	odourless	colourless	1.76
S_3	Town Hall, Gorakhpur Road.	7.5	453.8	sweet	odourless	colourless	2.34
S_4	Suraj Talkies.	7.5	484.6	sweet	odourless	colourless	1.95
S_5	Ram Nath Deoria, Grab Yard.	7.4	430.8	sweet	odourless	colourless	1.69
S_6	Ram Gulam Tola, Primary School no 1.	7.5	469.2	sweet	odourless	colourless	1.65
S_7	Ram Gulam Tola, Primary School no 2.	7.5	376.9	sweet	odourless	colourless	2.72
S_8	C.C. Road Hanuman Mandir.	7.5	500.0	sweet	odourless	colourless	1.92
S_9	Garul Park, Marwari Balika Inter college.	7.5	476.9	sweet	odourless	colourless	2.93
S_{10}	Lakri Hatta near R/O Rajesh Awasthi.	7.5	483.1	sweet	odourless	colourless	2.08

Table 2: Chemical characteristics of ground water.

Sampling Stations	Parameters							
	Total Dissolved Solids	**Total Hardness as $Caco_3$**	**Alkalinity as $Caco_3$**	**Chloride**	**Iron**	**Nitrate**	**Fluorides**	**Sulphates**
Specification as per BIS 10500:1991	500 mg/l	300 mg/l	200 mg/l	250 mg/l	0.30 mg/l	45 mg/l	1.0 mg/l	200 mg/l
S_1	290	195	282	11	0.15	20	0.7	9.6
S_2	255	180	268	19	0.05	10	0.65	19.2
S_3	295	210	236	09	0.18	00	0.80	4.8
S_4	315	195	242	21	0.15	15	0.75	23.2
S_5	280	165	224	13	0.25	10	0.60	9.6
S_6	305	195	252	11	0.15	20	0.70	13.2
S_7	245	180	214	09	0.05	15	0.65	9.6
S_8	325	195	248	17	0.20	10	0.95	4.8
S_9	310	165	271	19	0.05	20	0.65	23.2
S_{10}	314	195	282	23	0.25	15	0.85	19.2

Substances present in water in suspension. The turbidity for all the samples found below the BIS Standards limits 5.0 NTU. The highest value of turbidity found 2.93 NTU at sampling station S_9. Electrical conductivity is the measure of capacity of a substance or solution to conduct electric current. It is an excellent indicator of TDS which is a measure of salinity that affects the taste of potable water (WHO, 1984).[16] Electrical conductivity values in all the samples under study varied from 376.9 to 500 micro-mho.

pH of the ground water samples varied between the acceptable limits 6.5 and 8.5 prescribed by BIS. The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. A direct relationship between human health and pH of drinking water is impossible to ascertain, because the pH is closely associated with other aspects of water quality (WHO, 1984).[16] It was also unable to establish any significant correlation between the incidence of diseases and pH.[17]

Chemical characteristics

Hardness is caused by multivalent metallic cations. The hardness in water is derived largely from contact with the soil and rock formations. Calcium and Magnesium is the greatest portion of the hardness occurring in natural waters. The total hardness of the water samples ranged from 165 to 210 mg/l which were within permissible limit. The world health organization says that "there does not appear to be any convincing evidence that water hardness causes adverse health effects in humans." Hardness of water causes disadvantages in

domestic uses by producing poor lathering with soap, deterioration of cloths, scale forming and skin irritation.

Table 3: Classification of groundwater on the basis of total hardness.[18]

Total Hardness Range	Description	No of Samples
0 – 60	Soft	0
61 - 120	Moderately hard	0
121 -180	Hard	4
>180	Very hard	6

Total Dissolved Solids may be considered as salinity indicator for classification of groundwater. The BIS has established a water quality standard of 500 mg/l to provide for palatability of drinking water. TDS concentration values ranged from 245 to 325 mg/l. Water with high TDS is of inferior palatability and may induce an unfavorable physiological reaction in the transient consumers and gastrointestinal irritation.

Chlorides occur naturally in all types of waters. It reaches the ground water through the leaches from the percolated surface water over the land when cow dung heaps and such other organic waste abound in near vicinity. In the present study, chlorides content of ground water ranged from 9 to 23 mg/l, these values were within permissible limit 250 mg/l as per BIS standards. High concentration of chlorides can produce hypertension, effect metabolism of body and increases the electrical conductivity of water.[19]

The alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity in natural water is caused by bicarbonates, bicarbonates and hydroxides. Alkalinity in this study ranged from 214 to 282 mg/l. However the permissible limit for alkalinity is 200 mg/l as per BIS standards. Higher values of alkalinity may be due to dissolution of carbon dioxide present in soil which forms carbonic acid, leaching of rocks and weathered products.[20] Large amount of alkalinity imparts a bitter taste to water. Excess alkalinity in water is harmful for irrigation, which leads to soil damage and reduce crop yields.

Nitrate concentration in all samples varies from 00 to 20 mg/l. The desirable limit of nitrate for drinking water is 45 mg/l as per BIS standards for drinking water. Hence the nitrate concentration of all water samples studied was within the standard limits. Sulphate concentration in these samples ranged from 4.8 to 23.2 mg/l and it was within permissible limit. The desirable limit of sulphate for drinking water is 200 mg/l as per BIS standards.

The fluoride value ranged from 0.6 to 0.95 mg/l. Fluoride is an important criterion for groundwater quality with an acceptable limit of 1.0 mg/l as per BIS standards. Fluoride has beneficial effects on teeth at low concentrations in drinking-water, but excessive exposure to fluoride in drinking-water, or in combination with exposure to fluoride from other sources, can give rise to a number of adverse effects.

Iron concentrations varied from 0.05 to 0.25 mg/l. The maximum limit of iron in drinking water is 0.30 mg/l as per BIS standards. Iron will cause reddish-brown staining of laundry, porcelain, dishes, utensils and even glassware.

Statistical analysis

The data were subjected to calculation for Pearson correlation by using Microsoft Excel 2007. Correlation coefficients of various parameters analyzed were calculated. Pearson correlation analysis is an approach, which provides intuitive similarity relationship between any one sample and entire data set. Pearson's correlation coefficient is usually signified by 'r' (rho) and can take on the values from - 1.0 to 1.0. Where -1.0 is a perfect negative (inverse) correlation, 0.0 indicate no correlation and +1.0 reflects a perfect positive correlation. The variables having coefficient value (r) > 0.5 or < -0.5 are considered significant. Table 4 indicates the Pearson's correlation coefficient matrix between major chemical parameters of ground water of the study area.

The analytical data showed close significant positive association of TDS with EC and fluoride, pH with hardness and EC, hardness with fluoride, alkalinity with fluoride, chloride with sulphate and fluoride with EC.

Table 4: Pearson correlation between different water quality parameters.

	pH	Turbidity	TDS	Hardness	Alkalinity	Chloride	fluoride	Sulphate	EC
Ph	1.000	0.362	0.178	0.542	0.415	0.149	0.421	0.200	0.496
Turbidity		1.000	-0.124	-0.121	0.147	-0.004	-0.149	0.027	-0.124
TDS			1.000	0.354	0.367	0.440	0.660	0.137	0.990
Hardness				1.000	0.114	-0.154	0.685	-0.346	0.354
Alkalinity					1.000	0.518	0.190	0.442	0.367
Chloride						1.000	0.283	0.749	0.440
Flouride							1.000	-0.280	0.660
Sulphate								1.000	0.137
EC									1.000

CONCLUSION

The study of the physico-chemical parameters in the present investigation indicates that the groundwater quality is almost within the standard limits at all locations but suitable treatment is required to keep alkalinity values within desirable limit of BIS. It is recommended that, some investigations are necessary so as to confirm toxic metals are present within desirable limit or not and a regular chemical analysis must be done to insure that the water quality in Deoria city is not contaminated. Proper water safety measures shall be adopted to protect the drinking water sources.

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