

Assessment of underground water quality: A case study of Jhansi city, Uttar Pradesh, India

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Abstract: Seasonal variation on physicochemical parameters of groundwater in Jhansi city of Bundelkhand region, Uttar Pradesh was determined. Groundwater samples were taken from ten locations of city. The quality analysis has been made through the temperature (12°C-32°C), pH (6.5-8.4), EC (0.2-0.6 mmhos), TDS (110-280 mg/l), DO(4.3-6.9 mg/l), total alkalinity (118-230 mg/l), total hardness (230-610 mg/l), carbonate (85-165 mg/l), bicarbonate (116-210 mg/l) and chloride (23-85 mg/l). Parameters alkalinity, pH, DO, bicarbonate were found to be negatively correlated and EC, TDS, total hardness, carbonate, chloride were show a positive correlation with temperature.

Keywords: Underground water, Water Quality, Jhansi City

INTRODUCTION

Ground water is water located beneath the ground surface in soil pore space and in the fractures of lithologic formation (Anonymous, 2003). Ground water is used for domestic, agriculture and industrial purpose in most parts of the world (karunakaran et al., 2009). In India, most of the population is dependent on ground water as it is the only source of drinking water supply (Agrawal, 2010). The quality of ground water is the resultant of all the processes and reactions that act on the water from the moment it condensed in the atmosphere to the time it is discharged by a well or spring and varies from place to place and with the depth of the water table (Shyamala et al., 2008). Water fit for human consumption is called drinking water or "Portable water". Water that is not specifically made for drinking but is not harmful for humans when used for food preparation is called safe water (BIS, 1993).

The ground water is believed to comparatively cleaner and free from pollution than surface water (Agrawal, 2010). But nowadays the ground water potential and its quality level in major cities and urban centers is getting deteriorated due to the population explosion, urbanization, industrialization and the failure of monsoon and improper management of rain water (karunakaran et al., 2009). Contamination of drinking water may occur by percolation of toxics through the soil to

ground water (Sargaonkar and Deshpade, 2003). Study of chemical budget of major ions gain importance since it explains the origin of the ions in ground water and the level of contamination by natural as well as anthropogenic sources (Subba Rao, 2006).

Hence a continuous monitoring on ground water becomes mandatory in order to minimize the ground water pollution and have control on the pollution causing agents. Continuous monitoring on ground water may become easier with the development of rapid water quality measurement technique without making much compromise on the accuracy of measurement.

An attempt has been made under the present study to assess the physical and chemical properties of ground water in Jhansi city of Bundelkhand region.

MATERIALS AND METHODS

For the present study, the area was selected in Jhansi city, Bundelkhand region. The extent of study area was falling N-latitude 24° 11' to 25° 57' and E-longitudes 78° 70' to 79° 23'. The study was conducted during the period of January 2007 to June 2007 to explore the physico-chemical characteristics of groundwater. The samples were collected from bore wells at ten sampling stations in the Jhansi city. Samples were analyzed immediately for parameters, which need to be determined instantly and rest of samples were refrigerated at 4°C to be analyzed later. For the estimation of DO water samples were fixed at the sites. Physico-chemical analysis of water was carried out referring the 'standard methods 2002'.

RESULTS AND DISCUSSIONS

The quality of water resources depends on the management of the water sources. This would include

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anthropogenic discharge as well as the natural physico-chemical properties of the area.

Temperature is basically important for the chemical and biological reactions of organism in water. The increase in temperature decreases the portability of water because of elevated temperature carbon dioxide and other volatile gases which impart taste are expelled (Karunakaran et al., 2009). The maximum temperature of ground water in the study area was found as 32°C at sampling locations S1, S7, S8, S10 in month of June and minimum was found as 12°C at location S4 in month of January. On raising the temperature pH, DO, Total Alkalinity and Bicarbonates were observed as decreasing in concentration which show a negative correlation with temperature but parameters like E.C., TDS, total hardness, carbonate and chloride were found to be increasing on increasing the temperature representing a positive correlation.

pH is considered as an important ecological factor and provides an important piece factor and piece of information in many type of geochemical equilibrium or solubility calculation (Shyamala et al., 2008). The maximum pH was recorded as 8.4 at sampling location S5 and S8 in January and minimum was 6.5 at S1 and S4 in June.

Electrical conductivity of water is a direct function of its total dissolved salts (Harilal et al., 2004). Hence it is an index to represent the total concentration of soluble salts in water (Purandara et al., 2003). The maximum value of EC was observed as 1.6 mmhos at sampling location S8 in June and minimum was 0.2 at S4 in January.

TDS values indicate the general nature of water quality and are usually related to conductivity. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, though more highly mineralized water may be used where better quality water is not available (Jain, 2002). The maximum value of TDS during the study period was

found as 280 mg/l at sampling location S3 in June and minimum was 110 mg/l at S4 and S2 in January.

The maximum value of DO was recorded as 6.9 mg/l at sampling location S9 in January and minimum was 4.3 mg/l at S10 in June.

Alkalinity value in water provides an idea of natural salts present in water. The cause of alkalinity is the minerals which dissolve in water from soil. The various ionic species that contribute to alkalinity includes bicarbonate, hydroxide, phosphate, borate and organic acids. These factors are characteristics of the source of water and natural processes taking place at any given time (Sharma, 2004). The maximum value of alkalinity was found as 230 mg/l at sampling location S9 in January and minimum 118 mg/l at S3 in June.

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water (Trivedy and Goel, 1986). The maximum total hardness value was observed as 610 mg/l at sampling location S2 in June and minimum was 230 mg/l at S4 in January.

The maximum value of Carbonate was recorded as 165 mg/l at sampling location S9 in June and minimum was 85 mg/l at S4 in January.

The Bicarbonate ion concentrations are reflected mainly in alkalinity values in drinking water (Sarapata, 1994). This buffers against acidic effect of such water (Dawodu and Ipeaiyeda, 2008). The maximum value of Bicarbonate was found as 210 mg/l at sampling location S1 in January and minimum was 116 mg/l in June.

Chloride usually occurs as NaCl, CaCl₂ and MgCl in widely varying concentration, in all natural waters. They enter water by solvent action of water on salts present in the soil, from polluting material like sewage and trade wastes (Shaikh and Mandre, 2009). The maximum value of chloride was recorded as 85 mg/l at sampling location S1 in June and minimum was 23 mg/l in January.

Table 1: Physicochemical parameters of groundwater samples in its maximum value at all sampling locations

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Temp. (°C)	32.00	31.00	30.00	30.00	31.00	31.00	32.00	32.00	30.00	32.00
pH	7.80	7.50	8.10	8.20	8.40	8.10	8.30	8.40	8.10	7.90
E.C. (mmhos)	0.90	1.30	1.30	0.90	1.20	1.30	1.50	1.60	1.50	1.50
TDS (mg/l)	260.00	230.00	280.00	240.00	240.00	230.00	260.00	270.00	230.00	260.00
D.O. (mg/l)	6.60	6.40	6.20	6.30	6.50	6.30	6.40	6.70	6.90	6.50
T.A. (mg/l)	210.00	195.00	184.00	185.00	198.00	170.00	186.00	220.00	230.00	195.00
T.H. (mg/l)	545.00	610.00	580.00	570.00	590.00	490.00	480.00	510.00	450.00	520.00
Carbonate (mg/l)	165.00	147.00	160.00	140.00	145.00	142.00	145.00	160.00	165.00	148.00
Bicarbonate (mg/l)	210.00	175.00	165.00	176.00	156.00	180.00	175.00	190.00	192.00	170.00
Cl (mg/l)	72.00	70.00	65.00	75.00	78.00	82.00	58.00	75.00	70.00	85.00

Whereas EC= Electrical Conductivity, TDS= Total Dissolved Solid, DO= Dissolved Oxygen, TA= Total alkalinity, TH= Total Hardness, Cl= Chloride

Table 2: Physicochemical parameters of groundwater samples in its minimum value at all sampling locations

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Temp	14.00	13.00	16.00	12.00	13.00	15.00	16.00	14.00	13.00	15.00
pH	6.50	6.60	6.80	6.50	7.20	6.70	7.10	7.30	6.80	6.60
E.C. (mmhos)	0.30	0.40	0.40	0.20	0.30	0.40	0.50	0.30	0.30	0.50
TDS (mg/l)	120.00	110.00	140.00	110.00	120.00	140.00	150.00	130.00	120.00	140.00
D.O. (mg/l)	5.10	4.70	4.80	4.80	5.10	5.20	4.90	4.70	4.80	4.30
T.A. (mg/l)	125.00	135.00	118.00	130.00	132.00	140.00	130.00	154.00	142.00	140.00
T.H. (mg/l)	230.00	370.00	280.00	340.00	290.00	310.00	350.00	340.00	280.00	310.00
Carbonate (mg/l)	89.00	98.00	110.00	85.00	112.00	92.00	105.00	132.00	135.00	105.00
Bicarbonate (mg/l)	116.00	152.00	135.00	130.00	130.00	158.00	140.00	153.00	154.00	148.00
Cl (mg/l)	35.00	23.00	38.00	40.00	42.00	48.00	35.00	49.00	38.00	44.00

Whereas EC= Electrical Conductivity, TDS= Total Dissolved Solid, DO= Dissolved Oxygen, TA= Total alkalinity, TH= Total Hardness, Cl= Chloride.

Table3: Average value of physicochemical parameters at all sampling locations

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Temp	24.50±7.09	23.67±7.87	24.33±5.47	23.17±7.22	22.50±7.06	25.17±6.71	24.17±6.79	24.17±7.28	23.50±7.01	24.33±6.80
pH	7.03±0.51	7.00±0.33	7.33±0.52	7.28±0.63	7.87±0.45	7.37±0.54	7.75±0.43	7.83±0.39	7.37±0.46	7.28±0.51
E.C. (mmhos)	0.67±0.24	0.88±0.33	0.85±0.35	0.55±0.27	0.73±0.34	0.92±0.38	1.00±0.40	1.03±0.49	0.98±0.52	1.02±0.41
TDS (mg/l)	191.67±63.61	177.50±44.92	202.50±54.75	172.50±52.13	190.00±49.80	184.17±35.84	208.33±44.91	200.00±57.62	181.67±41.67	205.00±49.30
D.O. (mg/l)	5.90±0.58	5.62±0.65	5.57±0.55	5.55±0.67	5.80±0.49	5.65±0.46	5.72±0.60	5.68±0.79	5.70±0.79	5.43±0.88
T.A. (mg/l)	164.67±34.65	169.17±24.56	146.33±28.30	157.00±19.70	161.50±23.04	152.00±12.57	158.17±20.30	190.00±25.62	179.50±34.05	168.83±20.11
T.H. (mg/l)	405.83±116.55	494.17±105.47	426.67±123.72	455.00±85.03	465.00±116.06	410.83±67.41	414.17±57.31	424.17±69.02	381.67±61.78	416.67±82.87
Carbonate (mg/l)	121.33±28.58	122.50±20.45	139.00±19.45	114.50±21.15	130.50±13.19	120.50±19.84	126.00±16.00	148.67±10.48	153.17±10.82	126.83±17.53
Bicarbonate (mg/l)	163.00±36.72	163.00±9.17	151.17±11.55	149.50±19.10	142.83±10.44	167.50±8.19	157.00±13.39	170.67±14.76	172.00±14.85	159.00±8.25
Cl (mg/l)	52.00±15.27	48.50±17.42	50.00±10.45	57.17±13.29	57.00±13.48	63.83±13.83	46.33±8.64	61.50±10.01	55.17±12.19	68.17±15.61

Table 4: Average value of monthly variation in Physico-Chemical characteristics of groundwater at all sampling locations

Parameters	Jan	Feb	March	April	May	June
Temp	14.10	17.90	22.90	27.80	29.90	31.10
pH	8.08	7.76	7.52	7.27	7.03	6.81
E.C. (mmhos)	0.36	0.57	0.74	1.02	1.19	1.3
TDS (mg/l)	128.00	148.50	174.50	211.50	235.50	250.00
D.O. (mg/l)	6.48	6.20	5.88	5.46	5.11	4.84
T.A. (mg/l)	197.30	185.10	170.20	154.90	146.20	134.60
T.H. (mg/l)	310.00	358.00	400.00	472.50	501.50	534.50
Carbonate (mg/l)	106.30	115.70	125.80	137.50	144.80	151.70
Bicarbonate (mg/l)	178.90	171.80	162.90	156.20	146.00	141.60
Cl (mg/l)	40.60	46.70	53.60	60.60	68.70	74.70

Table 5: A correlation between physicochemical characteristics of groundwater

	Temp	pH	E.C.	TDS	D.O.	T.A.	T.H.	Carbonate	Bicarbonate	Cl
Temp	1.000									
pH	-0.985	1.000								
E.C.	0.992	-0.995	1.000							
TDS	0.990	-0.993	0.999	1.000						
D.O.	-0.982	0.995	-0.997	-0.998	1.000					
T.A.	-0.991	0.997	-0.997	-0.996	0.996	1.000				
T.H.	0.993	-0.994	0.999	0.998	-0.995	-0.997	1.000			
Carbonate	0.993	-0.997	0.999	0.998	-0.997	-0.999	0.999	1.000		
Bicarbonate	-0.983	0.996	-0.994	-0.995	0.997	0.994	-0.991	-0.995	1.000	
Cl	0.978	-0.996	0.994	0.995	-0.999	-0.995	0.991	0.995	-0.998	1.000

CONCLUSION

The analysis of the water quality parameters of ground water from ten different locations in Jhansi city shows that the pH, chloride ion and TDS were within permissible limit. Slightly exceeded value of alkalinity and total hardness were reported at some locations of study area.

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