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Seasonal variation of groundwater quality of Akola city, Maharashtra, India

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ABSTRACT

The Akola city, Maharashtra, India, is selected to study the seasonal variation of groundwater quality, where the groundwater is the main source for household and drinking purposes. Groundwater samples collected seasonally in summer, Monsoon and winter, during the years 2013 from ten bore wells and analysed for pH, EC, TDS, DO, TA, TH, Ca++, Mg++, Na+, K+, Cl^-, $NO3^-$ and $SO4^{--}$. The ground waters mainly belong to carbonated alkali type and are controlled by evaporation dominance, due to the influence of tropical savannah climate and anthropogenic activities. A comparison of the groundwater quality in relation to drinking water quality standards proves that most of the water samples are not suitable for drinking purposes, especially in pre-monsoon period. These conditions are caused due to leaching of salts from the overlying materials by infiltrating recharge waters.

Keywords: Groundwater quality, Akola city, Seasonal variation, hard water.

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INTRODUCTION

The ground water is used for domestic, agriculture and industrial purposes in almost all parts of the world [1]. The ground water quality is related with the environmental and geological conditions of the area. The ground water level change by regular withdrawal and climatic conditions, hence quality of ground water reported seasonally as well as annually[2]. In India, most of the population depends on ground water as the only source of drinking water supply. But the availability of groundwater resource has become critical day to day. The prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the ground water to become polluted and created health problems[3].

MATERIALS AND METHODS

The ground water samples were collected from ten different locations of Akola city from bore wells in fluorinated plastic bottles of capacity 1 litre in three different seasons namely summer, monsoon and winter season during the year 2013. The parameters like temperature, pH, electrical conductivity (EC), total dissolved solids (TDS),dissolved oxygen (DO), total alkalinity (TA),total hardness (TH), calcium (Ca^{++}) magnesium(Mg^{++}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), nitrate (NO_3^{-}) and sulphate (SO_4^{--}) using standard methods. All the reagents used were AR grade. The details of different sampling locations are shown in the **Table.1**.

Table 1: Sampling locations of Akola city

Sample. No.	Type of Source	Area
S1	Bore well	Shivaji Nagar, Old City
S2	Bore well	RLT College of Science
S3	Bore well	Near SantTukaram Hospital
S4	Bore well	Shanti Nagar, Old City
S5	Bore well	Near Court
S6	Bore well	Near Krishna Temple, Kaulkhed
S7	Bore well	Near Gayatri Temple, Kaulkhed
S8	Bore well	Near Kaulkhed Square
S9	Bore well	Gayatri Nagar, Kaulkhed Road
S10	Bore well	Sindhi Camp

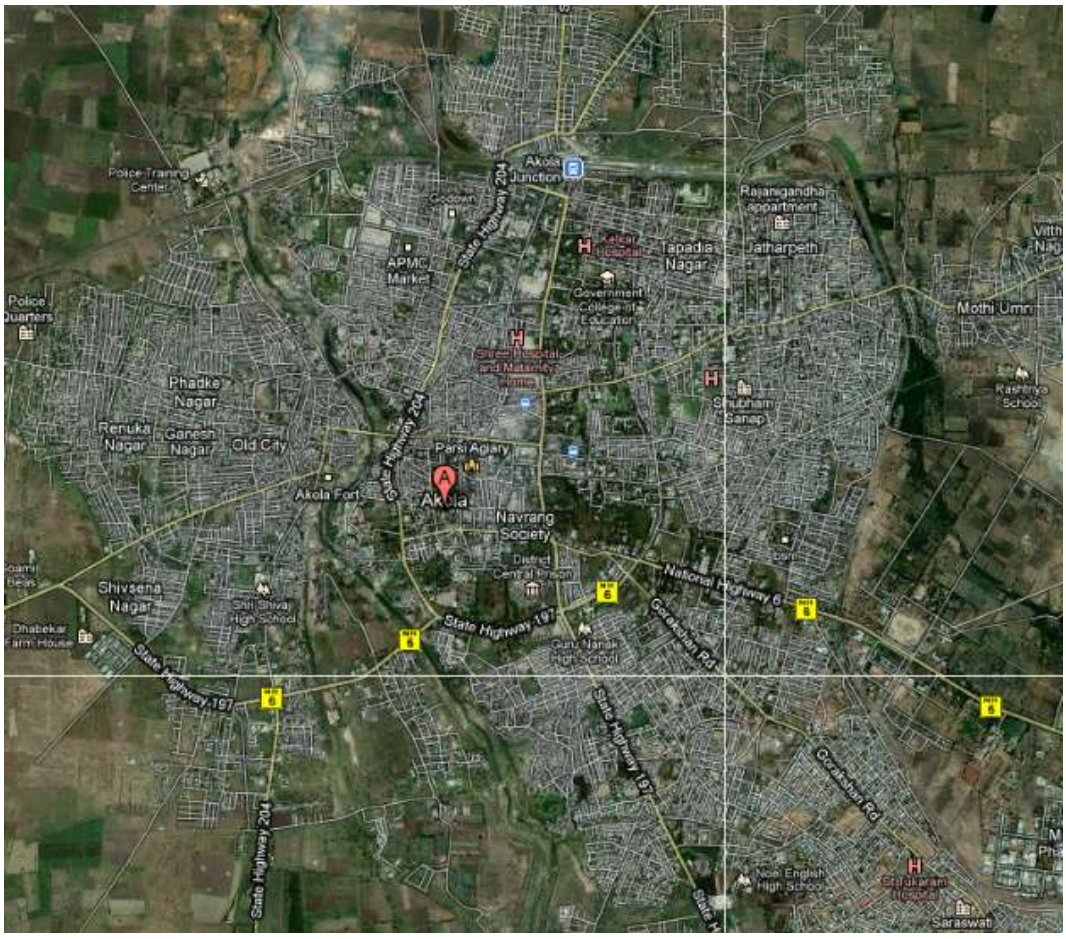

Figure 1. Akola City - A Satellite View

RESULTS AND DISCUSSION

The mean values of fourteen parameters of ground water analysed in ten stations together with their SD and CV are presented in **Table-2**. The water temperature averaged near 25°C throughout the year. pH was ranging from 6.2-7.9 with a mean value near 7.4, WHO (1984) prescribed the desirable limit of pH range between 7 and 8.5. EC ranges from 724-1592 with a mean of 1166 µS/cm. The TDS averages near 750 mg/l throughout the year. DO was ranging from 5.2-7.6 with the mean value near 6 mg/l. TH ranging from 55-410 with a mean of 227 mg/l. The mean CV values of temperature (4.44), pH (5.26), EC (15.5), TDS (14.35), DO (4.28) and TA (56.89) showed wide fluctuation throughout the year. Therefore relation of these parameters did not occur between stations. In the case of Total Hardness, Calcium, Magnesium, Potassium, Chloride, Sulphate and Nitrates, the mean values were recorded throughout the year as 391.4, 87.5, 69.0, 178.9, 0.48, 175.8, 40.6 and 0.48 mg/l respectively. All the results are within the permissible limits of ISI except Total Hardness, Calcium and Magnesium. The low coefficient of variation values of these parameters indicated there is no significant variation from one station to another [4].

The physicochemical characteristics of ground water are important in the determination of its suitability for drinking, agriculture and industrial use[5]. The important factor that serves as an indicator of pollution of water is pH. The pH varies from 6.20 to 7.84 during summer, 6.8 to 7.83 during monsoon and 6.84 to 7.93 during winter. This indicates low pH in some sampling points during summer while it remains within the range prescribed by WHO during monsoon and winter seasons.

EC is the measure of capacity of a solution to conduct electrical current. EC measurement is an excellent indicator of TDS, which is a measure of salinity that affects the taste of potable water. Waters with high TDS are of inferior palatability. In present investigation EC of ground water samples was observed to be very high in summer ranging from 959 to 1592 µS/cm and was found within the range in some sampling points. It varies from 724 to 1534 µS/cm during monsoon and 1034 to 1430 µS/cm in winter. The value of electrical conductivity was high due to more concentration of the TDS. The reason for decrease in the values of the electrical conductivity is due to dilution of minerals from rain water [6-7].

TDS indicate the salinity behavior of groundwater. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies. In the present study TDS of ground water varies from 656 mg/L to 1123 mg/L in summer showing higher values than the prescribed limit given by ISI. On the other hand it varies from 616 mg/L to 1034 mg/L in monsoon and 713 mg/L to 965 mg/L in winter indicating higher values of TDS[8-10].

DO is important parameter in water quality assessment and reflects the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. In the present investigation DO values varied from 5.2 to 6.3 mg/L in summer, 6.9 to 7.6 mg/L in monsoon and 7.0 to 7.6 mg/L in winter. This showed normal DO values[11].

Alkalinity is the measure of acid neutralization capacity water. In present investigation TA varies from 80 to 410 mg/L in summer, 113 to 356 mg/L in monsoon and 55 to 389 mg/L in winter. TA up to 400 mg/L is not considered to be a problem to human health. The high alkalinity may cause incrustation in the distribution pipes and raises the pH level[12].

Hardness is the property of water which prevents the lather formation with soap, also increases boiling point of water. Water becomes hard due to presence of calcium and magnesium salts [Akola 10]. In present investigation TH values shows range from 302 to 591 mg/L in summer, 243 to 462 mg/L in monsoon and 284 to 528 mg/L in winter[13].

Calcium (Ca^{++}) and Magnesium (Mg^{++}) are naturally found in ground water. These are directly

related to hardness. Calcium concentration ranged between 66.9 to 162.4 mg/L in summer, 51.2 to 103.2 mg/L in monsoon and 55.2 to 122.4 mg/L in winter. The calcium content of most of the samples was found above permissible limit of ISI and WHO. Magnesium content in the investigated water samples was ranging from 40.8 to 148.4 mg/L in summer, 34.8 to 85.6 mg/L in monsoon and 46.4 to 101.6 mg/L in winter, which were found above ISI limit[14-15].

Sodium content was ranging from178 to 275 mg/l in summer, 102 to 146 mg/l in monsoon and 118 to 238 mg/l in winter. All sampling sites S1 to S10 showed sodium concentration near 200 mg/l prescribed by WHO and ISI. The major source of Potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water[16]. Potassium content in the water samples varied from 0.12 mg/l to 0.70 mg/l in summer, 0.27 to 0.73 mg/l in monsoon and 0.38 to 0.65 mg/l in winter. The potassium content in all sites was less.

Chloride is essential element for normal cell functions in plant and animal life in required concentration level[17-18]. The estimated levels of Chloride concentration varies between 113.4 to 180 mg/l in summer, 116 to 254 mg/l in monsoon and 146 to 274 mg/l in winter. It exceeds the prescribed limit of ISI (<250 mg/l) at some sampling sites. Sulphate is an essential nutrient for plants and animals at lower concentration, but at higher concentrations, may cause adverse effects. Sulphate occurs naturally in water due to leaching from gypsum and other common minerals[19]. Sulphate content of water samples ranges 19.8 to 76.4 mg/l in summer, 21.5 to 74.9 in monsoon and 11.2 to 76.2 mg/l in winter. It was found within the permissible limits of ISI (<200 mg/l) at all locations.

Groundwater contains nitrate due to leaching with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates. Nitrate is the pollutant responsible for birth defects in new born babies [20]. The nitrate content of study area ranges from 0.12 to 1.22 mg/l in summer, 0.23 to 0.92 mg/l in monsoon and 0.24 to 0.72 mg/l in winter. It is found within the permissible limit (<5 mg/l) prescribed by WHO.

CONCLUSION

Deviations were observed in ground water samples of Akola city in summer, monsoon and winter seasons. The overall ground water samples showed very poor water quality. It was probably due to some geological reasons. The ground water samples are very hard throughout the year and unfit for drinking purpose. Again they showed high TDS, high alkalinity and high sodium content in some sampling stations indicating the need of some treatment for minimization of these parameters. The parameters namely Sulphate and Nitrate are found very low.

Table 2: Summary of season-wise chemical composition of groundwater samples collected from Akola city in 2013

Sr. No.	Parameter	Summer					Monsoon					Winter					ISI	WHO
		Min.	Max.	Mean	Σ	CV	Min.	Max.	Mean	Σ	CV	Min.	Max.	Mean	σ	CV		
1	Temperature (ºC)	23.1	27.2	25.23	1.50	5.95	23.1	25.7	24.19	1.04	4.31	23.5	25.9	24.68	0.83	3.36	--	--
2	pH	6.20	7.84	7.278	0.45	6.17	6.8	7.83	7.263	0.30	4.21	6.84	7.93	7.47	0.40	5.41	6.5-8.5	7.0-8.5
3	EC (µS/cm)	959	1592	1219.8	187.39	15.36	724	1534	1071	208.39	19.45	1034	1430	1208.5	130.38	10.79	--	1400
4	TDS (mg/l)	656	1123	829.5	132.46	15.97	616	1034	737.4	120.15	16.29	713	965	810.6	84.55	10.43	500	1000
5	DO (mg/l)	5.27	6.30	5.672	0.38	6.68	6.98	7.67	7.36	0.23	3.12	7.02	7.62	7.30	0.22	3.05	5.0	--
6	TA (mg/l)	80	410	235.6	150.06	63.69	113	356	228.9	104.19	45.52	55	389	218.9	134.56	61.47	200	120
7	TH (mg/l)	302.4	591	444.55	97.21	21.86	243	462	342.4	67.35	19.67	284	528	387.3	87.70	22.64	300	500
8	Ca^{++} (mg/l)	66.9	162.4	100.25	27.51	27.44	51.2	103.2	74.96	17.19	22.93	55.2	122.4	87.28	22.02	25.23	75	100
9	Mg^{++} (mg/l)	40.8	148.4	77.47	31.74	40.97	34.8	85.6	62	15.74	25.38	46.4	101.6	67.64	17.99	26.60	30	150
10	Na^{+} (mg/l)	178	275	209	30.95	14.81	102	246	162.2	42.09	25.95	118	238	165.5	31.92	19.29	200	200
11	K^{+} (mg/l)	0.12	0.70	0.443	0.18	40.18	0.27	0.73	0.497	0.15	31.20	0.38	0.65	0.52	0.08	16.98	--	--
12	Cl^{-} (mg/l)	113.4	180	139.63	22.84	16.36	116	254	187.5	40.26	21.47	146	274	200.4	36.93	18.43	250	250
13	SO_4^{--} (mg/l)	19.8	76.4	39.77	20.37	51.22	21.5	74.9	38.91	17.74	45.60	11.2	76.2	43.09	17.17	39.86	200	250
14	NO_3^{-} (mg/l)	0.12	1.22	0.449	0.36	81.00	0.23	0.92	0.513	0.19	38.32	0.24	0.72	0.49	0.16	34.11	45	5

*Where, **σ** – Standard Deviation, **CV** – Coefficient of Variation

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