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Short Communication

Assessment of Physico-Chemical Status of Ground Water Samples of Akola city in Premonsoon Season - A Case Study

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ABSTRACT

Physicochemical analysis of bore well water samples was carried out from ten sampling sites of Akola city, Maharashtra, India in premonsoon season of year 2013. The analysis of different parameters namely pH, EC, TDS, DO, TA, TH, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, NO_3^{-} and SO_4^{2-} were carried out using standard methods. The results compared with Drinking water standards of ISI and WHO. The results indicate that TDS and TH were very high in all sampling sites while TA in some sampling sites was found above the permissible limits. Hence, groundwater was very hard and unfit for drinking and domestic purposes.

Keywords: Ground water, Akola city, Physico-chemical parameters, Potable water.

INTRODUCTION

The groundwater is believed to be comparatively much clean and free from pollution than surface water. In India, most of the population is dependent on groundwater as the only source of drinking water supply [1]. The groundwater contamination occurs due to natural causes, anthropogenic activities or manmade activities and created health problems [2, 3]. The rapid growth of urban areas has affected groundwater quality due to overexploitation of resources and improper waste disposal practices [4]. High concentrations of priority toxic pollutants severely limit the beneficial use of water for domestic and industrial applications. Hence, need regular monitoring of water quality to device ways and means to protect it [5].

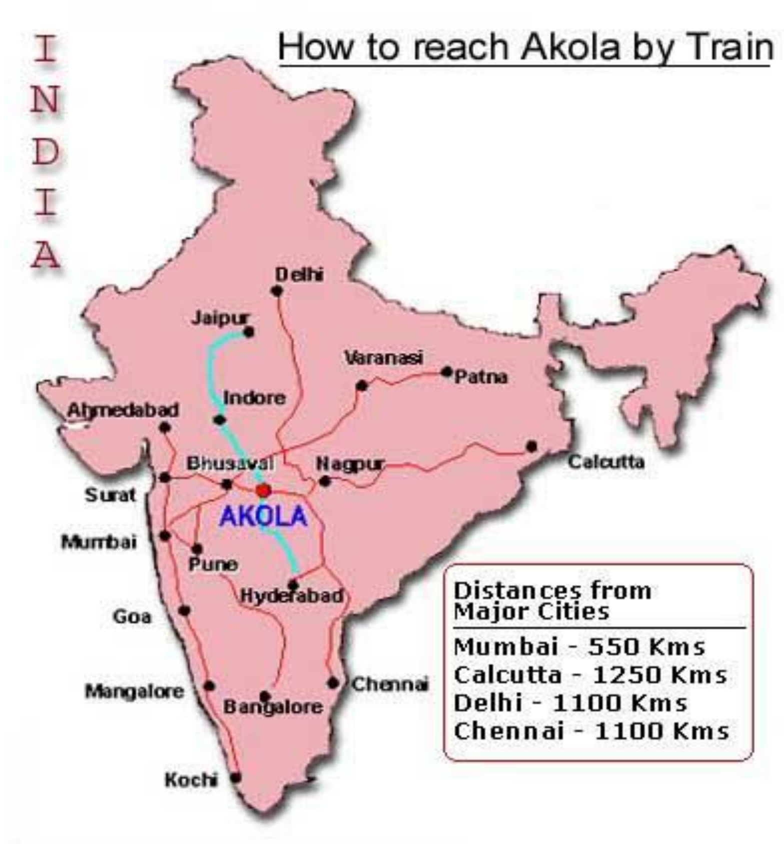
The most of water bodies in India needs to be treated before using it for domestic purpose. Ground water contains high amount of various ions, salts etc. so if we were using such type of water as potable water then it leads to various water-borne diseases [6]. The consequence of urbanization and industrialization leads to spoil the water quality. For agricultural purposes ground water is explored in rural areas especially in those areas where other sources of water like dam and river or the canal is not available. During last decades, the ground water gets polluted drastically because of increased human activities. Hence, it is very essential to maintain the quality of ground water for human consumption. [7].

Akola is a growing industrial city of Maharashra state spreading on an area of 10 Sq. km. It is located at latitude 20.7° North and longitude 77.07° East. It is at an altitude of 282 m above the sea level. Akola has a tropical savanna climate. Annual temperatures range from a high of 48°C to a low of 10°C. Akola lies on the Tropic of Cancer and becomes very hot during the summer, especially in May. Although it can be very hot in the day, it is cooler at night. The annual rainfall averages 800 mm. Most of the rainfall occurs in the monsoon season between June and September, but some rain does fall during January and February. As per 2011 India census Akola City had a population of 4,27,146 and the Akola urban area including the neighbouring areas of Khadki, Malkapur, Shivani had a population of about 7,21,849. The Morna River flows through Akola city and is the main source of water [8].

The water used for drinking purposes should not contain excessive amount of minerals that may be harmful to health. Keeping this in focus, the quality aspects of ground water of Akola city were analyzed for general water quality. It is highly essential to examine quality of groundwater before it is used for drinking. Thus, a survey has been done for the ground water quality because of its effect on human health after drinking the water like indigestion, omitting, fever etc. faced by the people.

MATERIALS AND METHODS

Sample Collection: Water samples were collected from ten different sites of Akola city from bore wells during May 2013. A fluorinated plastic bottles of capacity 1L were used for sample collection. The temperature was noted, DO was fixed and pH was measured on the spot. The samples after collection were immediately placed in dark boxes and processed within 6 h of collection. The sampling sites of the city depicted in the fig. 1.



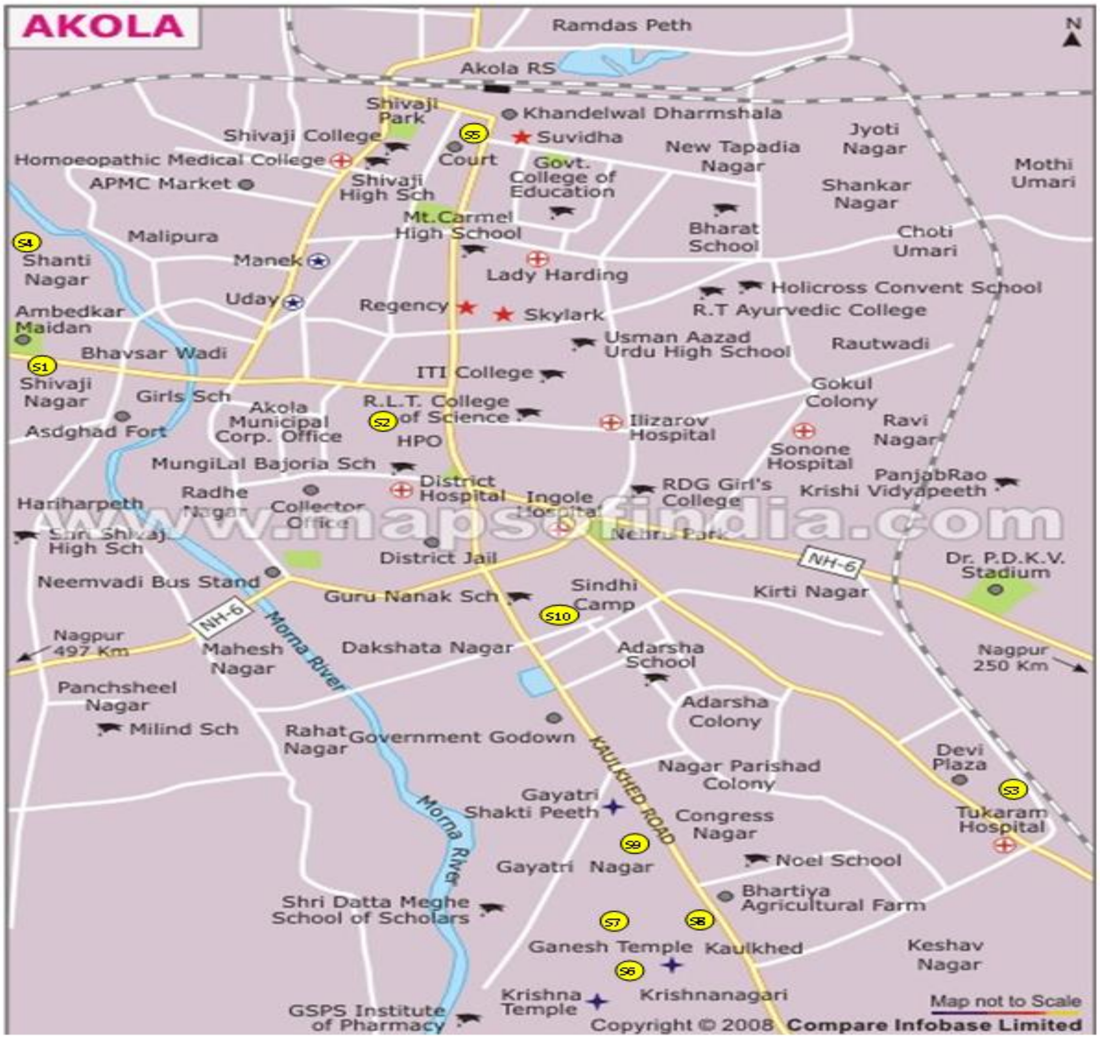


Fig. 1: A map view of Akola city as sampling sites S1 to S10.

Physico-chemical Analysis: The water quality parameters were analysed using standard methods. During the sample collection temperature was noted using thermometer [9]. Analysis was carried out for various water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), total alkalinity (TA), total hardness (TH), calcium (Ca^{2+}) magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), nitrate (NO_3^{-}) and sulphate ($SO_4^{\ 2-}$) using standard methods [10-12]. All the reagents used were AR grade and double distilled water was used for preparation of standard solutions. Total alkalinity was determined by visual titration method using methyl orange and phenolphthalein as indicator. Total hardness and calcium were measured by EDTA titrimetric method using EBT and Mureoxide indicator respectively. Chloride was determined by Argentometric method using potassium chromate indicator [13-14]. The chemical data were complied further to know location wise distribution. The details of different methods relevant to parameters are shown in the table.1.

Table 1: List of parameters and method of analysis

Sr. No.	Parameter	Method
1.	Temperature (°C)	Thermometer
2.	pH	Potentiometric
3.	EC (µS/cm)	Potentiometric
4.	TDS (mg/l)	Gravimetric

5.	DO (mg/l)	Titrimetry (using Alkali-iodide-azide)
6.	TA (mg/l)	Titrimetry
7.	TH (mg/l)	EDTA Titrimetry
8.	Ca^{++} (mg/l)	EDTA Titrimetry
9.	Mg^{++} (mg/l)	EDTA Titrimetry
10.	Na^{+} (mg/l)	Flame Emission Photometric
11.	K^{+} (mg/l)	Flame Emission Photometric
12.	Cl^{-} (mg/l)	Argentometric Titration
13.	SO_4^{--} (mg/l)	Spectrophotometric
14.	NO_3^{-} (mg/l)	Spectrophotometric

RESULTS AND DISCUSSION

The results of Physico-chemical parameters of groundwater in selected locations of Akola city were analyzed and it is shown in table 2.

Temperature: Temperature is a significant factor, which plays an important role in dissolution of minerals and concentration of dissolved oxygen in water. The groundwater temperature in study area was ranging from 23.1°C to 27.2°C.

pH: The extent of acidity or alkalinity of water is measured by pH. The pH values of water samples ranges from 6.20 to 7.84. The factors like temperature may bring about changes in pH of water. Most of biochemical and chemical reactions are influenced by pH. Most of the samples were slightly alkaline and found within the limit (6.5 - 8.5) prescribed by ISI.

Electrical Conductivity (EC): EC is the ability of water to carry electric current. It is directly related to total dissolved salts. EC values were found in the range from 959 to 1592 µS cm^{-1}. The high conductivity in S1, S4, S5 and S10 sites is likely due to geological conditions obtaining high concentrations of dissolved minerals. Most of the samples were highly conducting and not suitable for drinking purpose.

Total Dissolved Solids (TDS): The salinity of groundwater can be indicating by TDS. Water containing more than 500 mg/l of TDS is not considered desirable for drinking purposes. In present study TDS values varied from 656 mg/l to 1123 mg/l. All the sampling sites showed higher TDS than a limits (>500 mg/l) prescribed by ISI. It indicates that ground water is of this region is not suitable for drinking purposes.

Dissolved Oxygen (DO): DO is an important parameter in water quality assessment. It reflects the biological suitability water for drinking purposes. The presence of DO gives taste to drinking water. The DO values are also indicates the degree of pollution in water bodies. The levels of DO varied from 5.27 to 6.30 mg/l, which is within the range prescribed by ISI.

Total Alkalinity (TA): The alkalinity is a measure of acid neutralizing capacity of water. Total alkalinity of water is due to presence of CO_3^{2-} and HCO_3^- ions. Both ions contribute to the alkalinity of water and are associated with the hardness of water which gives an unpleasant taste. The primary source of CO_3^{2-} and HCO_3^- ions in groundwater is the dissolved CO_2 in rainwater that on entering in the soil dissolves more CO_2. Normally the natural water contains much more bicarbonates than carbonates. The TA value of water samples varies from 80 to 410 mg/l indicates that the water samples are highly alkaline.

Total Hardness (TH): Total hardness is an important parameter of water for its use. It is property of water which prevents leather formation with soap. Salts of Calcium and Magnesium are important sources for total hardness in groundwater [15]. The value of hardness ranges from 302.4 mg/l to 591 mg/l. High value of hardness during summer can be attributed to decrease in water volume and increase of rate of evaporation of water. In the present study, most of samples were having high amount of calcium and magnesium hardness above the highest desirable limits. Some samples were exceeding even the maximum permissible limits. Excess hardness is undesirable mostly for drinking, washing, laundering and bathing purposes.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): Calcium and Magnesium content is very common in groundwater, because they are available in most of the rocks, abundantly and directly related to hardness. The Calcium content ranges from 66.9 mg/l to 162.4 mg/l and for most of the samples it exceeds the permissible limit (<75 mg/l). Magnesium concentration varies between 40.8 mg/l to 148.4 mg/l, which were found exceed the prescribed limit (<30 mg/l). In general, Magnesium usually occurs in lesser concentration than Calcium due to the fact that dissolution of Magnesium rich minerals is slow process. But at some locations (S3, S4 and S6) the Magnesium content exceeds the Calcium content of water. It is likely due to some geological reasons. The high concentration of Calcium and Magnesium in groundwater makes it unsuitable for drinking purposes.

Sodium (Na^{+}) and Potassium (K^{+}): Sodium content was ranging from 178 mg/l to 275 mg/l. 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. Potassium content in the water samples varied from 0.12 mg/l to 0.70 mg/l. The potassium content in all sites was less.

Chloride (Cl^{-}) and Sulphate (SO_4^{2-}): Chloride is essential element for normal cell functions in plant and animal life in required concentration level. The estimated levels of Chloride concentration varies between 109.9 mg/l to 180 mg/l and it does not exceed the prescribed limit (<250 mg/l) as per ISI. 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. Sulphate content of water samples ranges 19.8 mg/l to 60.3 mg/l and it was found within the permissible limits (<200 mg/l) at all locations.

Nitrate (NO_3^{-}): Groundwater contains nitrate due to leaching of nitrate 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. The nitrate content in the study area ranges from 0.12 mg/l to 1.22 mg/l and found within the limit (<5 mg/l) prescribed by WHO.

The variation of various water quality parameters with sampling sites (S1 to S10) are shown in fig. 2-11.

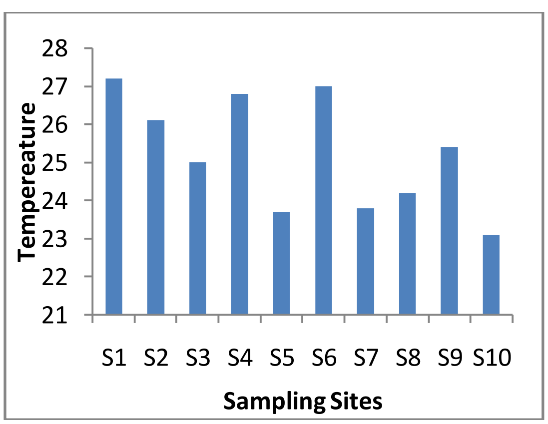


Fig. 2: Variation of Temperature

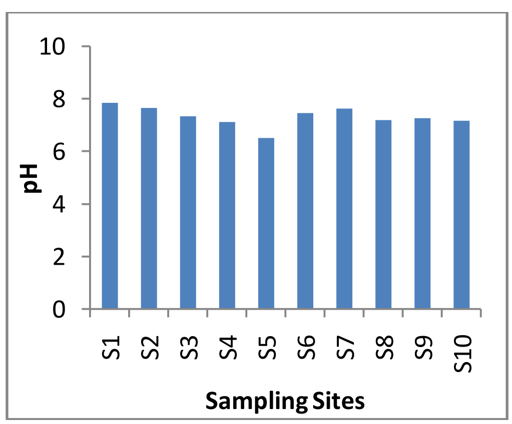


Fig. 3: Variation of pH

Table 2: Water Quality Parameters

Sr. No.	Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	ISI	WHO
1	Temperature (ºC)	27.2	26.1	25.0	26.8	23.7	27.0	23.8	24.2	25.4	23.1	--	--
2	pH	7.84	7.65	7.32	7.10	6.20	7.46	7.61	7.19	7.25	7.16	6.5-8.5	7.0-8.5
3	EC (µS/cm)	1234	993	1153	1346	1592	1141	959	1161	1233	1386	--	1400
4	TDS (mg/l)	842	660	810	904	1123	790	656	803	812	895	500	1000
5	DO (mg/l)	5.31	5.76	6.01	6.21	6.30	5.35	5.50	5.45	5.56	5.27	5.0	--
6	TA (mg/l)	86	110	80	105	95	370	320	400	410	380	200	120
7	TH (mg/l)	365.4	371.2	469.2	580	591	405.5	302.4	388.8	437.4	534.6	300	500
8	Ca^{++} (mg/l)	96.7	107.6	92.8	83.2	162.4	66.9	75.6	90.7	99.4	127.2	75	100
9	Mg^{++} (mg/l)	49.4	40.8	94.8	148.4	74.0	95.2	45.3	64.8	75.6	86.4	30	150
10	Na^{+} (mg/l)	192	224	245	275	215	195	178	189	192	185	200	200
11	K^{+} (mg/l)	0.52	0.45	0.65	0.70	0.23	0.56	0.43	0.38	0.12	0.39	--	--
12	Cl^{-} (mg/l)	148.1	159.5	131.1	163.8	180	113.4	109.9	127.6	138.2	124.7	250	250
13	SO_4^{--} (mg/l)	23.4	76.4	56.2	60.3	55.7	28.7	19.8	23.5	32.3	21.4	200	250
14	NO_3^{-} (mg/l)	0.46	0.52	0.76	1.22	0.72	0.16	0.24	0.13	0.16	0.12	45	5

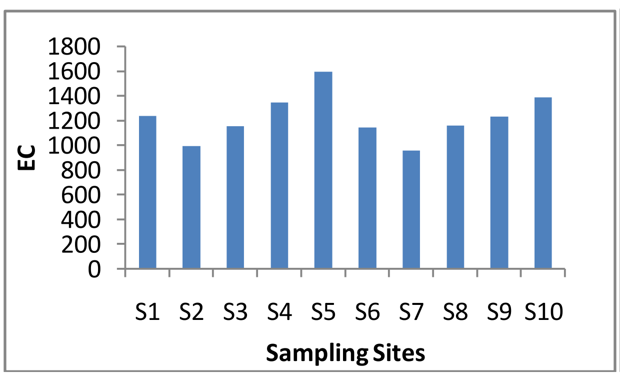


Fig. 4: Variation of EC

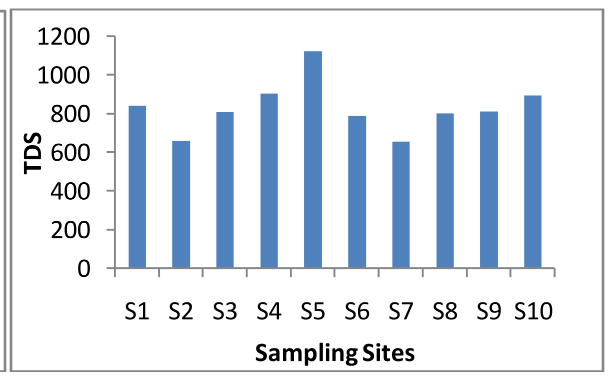


Fig. 5: Variation of TDS

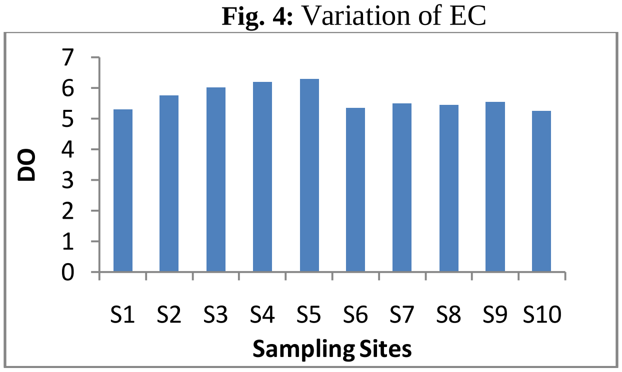


Fig. 6: Variation of DO

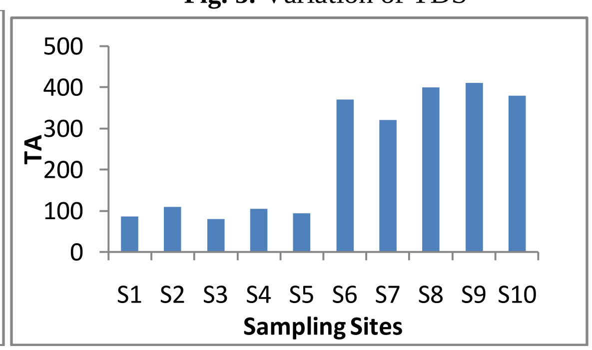


Fig. 7: Variation of TA

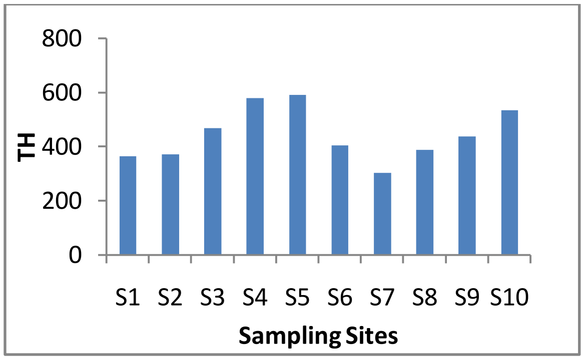


Fig. 8: Variation of TH

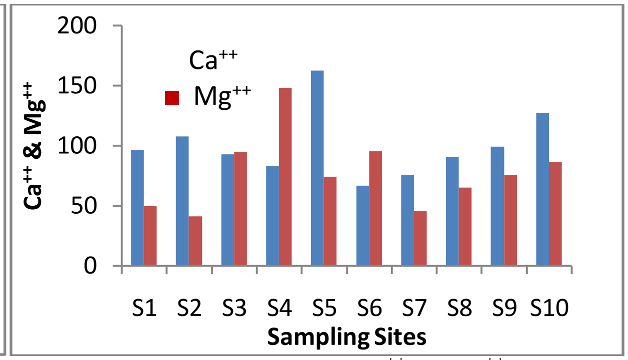


Fig. 9: Variation of Ca^{++} & Mg^{++}

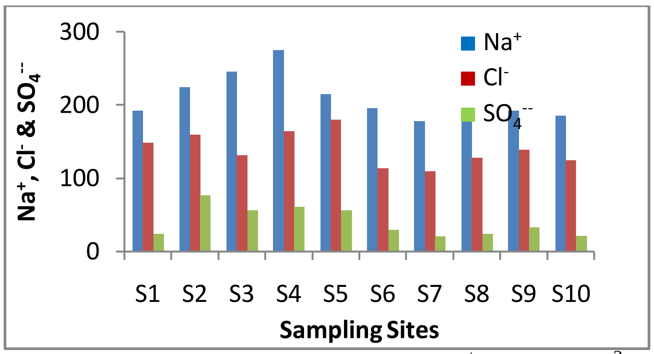


Fig. 10: Variation of Na^+, Cl^- & SO_4^{2-}

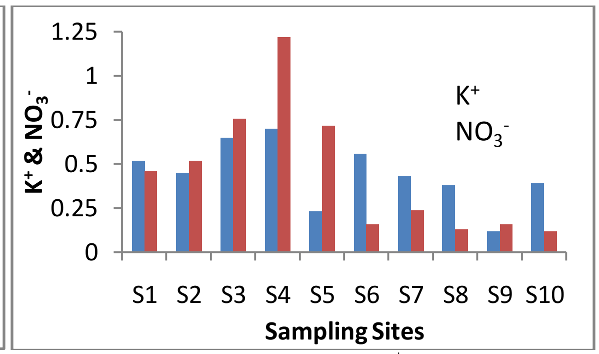


Fig. 11: Variation of Na^+ & NO_3^-

APPLICATIONS

The present study is applicable for the assessment of water quality of ground water of Akola city. From such results the potability of water is ascertained.

CONCLUSIONS

The ground water has been considered as drinking water in most part of our nation. It is estimated that 80 percent of domestic needs in rural areas and 50 percent of domestic needs in urban areas were met by ground water supply. It is found that the water samples of Akola city are not satisfying the drinking water quality standards prescribed by WHO and ISI in premonsoon season and are non-potable for human being due to high concentrations of TDS, TH, Ca^{++}, Mg^{++} and Na^+ ions. Present status of groundwater necessitates for the continuous monitoring and implementation of necessary groundwater treatment methodologies.

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