ISSN (Print 0974-2115) (Online 2349-8552)
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Hydrogeochemical characterization and assessment of groundwater quality in Nalgonda District, Telangana State of India

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ABSTRACT

In this research study, hydrogeology in the District and surrounding areas is explained. The physical and chemical parameters of groundwater in the study area were analysed and then correlated with those of World Health Organization Standards. Electrical Conductivity (EC), Total Dissolved Solids (TDS) were assessed and compared with their respective standard limits. The assessment of groundwater samples were carried out to study incrustation and corrosivity in areas and also indicate that they can be used for drinking, farming and industrial purposes except for few locations which exceed the permissible limits.

KEY WORDS: Hydro Geochemistry, Groundwater quality, EC & TDS, Nalgonda.

1. INTRODUCTION

Water is an essential part of our environment. The fluoride content of groundwater in Nalgonda ranges from 1 to 3.8 PPM. Sometimes the content is more than 4ppm. Water is an essential natural resource for sustaining life and environment. The geology of the area in general comprises of granites and gneisses of Peninsulargnessic complex of Archean age. Fluoride primarily effects on skeletal tissues (Somboon and Chinpitak, 2005). Skeletal fluorosis is observed when drinking water contains 3-6 mg/l .Severe crippling skeletal fluorosis is observed when the intake exceeds 10 mg/l of fluoride (WHO, 1996). Andhra Pradesh (Jamode, 2005), Tamilnadu (Shivakumar, 1977), Rajasthan (Guptha, 1986) and Madhyapradesh (Murugan and Subramanian, 2006), are the fluoride affected states in India. Various defluoridation techniques (Hu and Dickson, 2006; Akthar, 1995; Garmes, 2002; Venkata Mohan, 2002; Prakasam, 1998; Jamode, 2004; Arjun Khandare, 2004; Lakshmaiah, 2002), for removal of fluoride have been reported. Hence, the present investigation was done and the results are discussed.

2. MATERIALS AND METHODS

We performed different tests under various quality parameters to check fluoride and other parameters in Bore and hand pumps. The details of the data which are given in the table.1. Water samples of bore-wells were collected from above mentioned sampling stations using standard sampling procedure. The samples were collected during summer season. The fluoride content and other parameters were determined using a commercially available kit.

3. RESULTS AND DISCUSSION

Sriramnagar borewell (3.5 ppm) water samples showed higher levels of fluoride followed by Ramakrishnanagar water samples (2.8ppm) (Table.1). TDS was to be high in Srinagar colony bore water. Higher Chloride levels were seen in Ramakrishnanagar colony. Sheshammagudem water samples showed higher nitrate levels. Total hardness recorded was high in Sheshamagudem and Sriramnagar colony. No fluoride was seen in E-seva, Srinagar colony, headquarters and Shivajinagar. No Nitrite was detected in all the samples tested. Ramakrishnanagar and Sheshammagudem samples showed the presence of ammonium. Shivajinagar II sample showed residual chlorine and was absent in other samples. Sample preservation is not required but it is the total hardness (TH) represents the concentration of calcium and magnesium. The permissible limit of chloride content in water is 1000mg/l. as per the Indian Standard Institute (ISI). TH of the bore well water and sewage water of all the above three places were high when compared with the desirable limit. The desirable range of pH in drinking water is 6.5 to 8.5 as per Bureau of Indian Standards (BIS, 1991) and while of the Central Public Health and Environmental Engineering Organization (CPHEEO, 2005 & 1991) standards of the pH value suitable for drinking water is 7.0 to 8.5. In the study area, the groundwater samples of shows have higher pH values (6.8 to7.4). The mean pH value in the study area is 7.0 (Table.5 and Fig.2) and the pH is generally an alkaline/basic in nature in the basin. The pH of groundwater samples is considerably high at Suryanagar colony and Gandhinagar.

Generally, the water with hardness of less than 50 ppm is rated as soft water and it is suitable for domestic purposes. As per BIS (1991), desirable limit in drinking water is 300 mg/l and permissible limit 600 mg/l. In the study area, the hardness of groundwater in the season varies from 90 to 790mg/l and a mean of 475 mg/l. (BIS, 1983). The total dissolved solids of groundwater contain all ionized and non-ionic materials. It is directly proportional to specific conductivity. Karanth (1987), stated that the heavy metals and radioactive constitutes occurring in trace quantities. Majority of samples were suitable for drinking and irrigation as per WHO standards (Table.4). The general formula adopted to calculated the TDS is delta ∂ = KA where ∂ is the total dissolved salts, K is the conductance in micro-Siemens/cm and the conversion factors for the value of A is taken as 0.64 (Brown et.al., 1970) and then the

TDS is in mg/l = 0.64 x EC in micro Siemens/cm. The quality of groundwater of the study area was assessed with its standard specification given in world health organization (WHO, 1984) (Tables.1&4). The groundwater from the study area is described as alkaline character with pH >7 (Table.1&4). The groundwater samples pH are within the permissible limits (WHO, 1984), except two water samples at Suryanagar colony and Gandhinagar. With a pH of 7.4 therefore, the water is not suitable for drinking. All the groundwater samples from the study area are suitable for drinking as per the WHO'S specification. A few samples (12 nos.) in the study area contain higher TH (>500) and therefore the water samples are very hardness. The groundwater is classified (Table.2 & Fig.2) as fresh water as per the TDS values in summer season periods, expect a few with brakish character.

The groundwater samples of study area have lower average EC (372μ-mhos /cm) (Tables.1, 3 & 4). The both EC and TDS concentration are high at Cherlapally and Gandhinagar villages in the area. The water logging may cause for the increasing of EC and TDS concentrations in the area.EC is an assessment of all soluble salts in samples. Based on the EC the groundwater of Nalgonda town has been classified into 4 classes after Handa, 1969 (Table.3 and Fig.2). Correlation matrix (Table.6) of the major elements data indicates strong positive correlations (r^2 {0.50}) between EC with Cl^- (0.64); TDS with pH (0.63) and Cl- (0.57); and weak positive correlation (r^2 0.50 to 0.46) among ph with Cl^- (0.31); EC with TDS (0.31) TDS with NO_2^- (0.46) and F^- (0.38); TH with Cl^- (0.36) and F^- (0.33); Cl^- with NO_2^- (0.34) vice versa. The significant positive correlations within these ions reveal their common source, viz., natural geogenic processes and excessive use of pesticides or fertilizers, which sink in soils and water of the study area. The EC values of the ground water in the study area reveals that the salinity is medium to high and hence the groundwater is doubtful for irrigation. However, the TDS of the groundwater suggest that it was classified as fresh water for many samples in the basin. The Total Hardness (TH) of the groundwater indicates that the majority of samples are suitable for domestic purposes due to low to medium Hardness; however some samples (12 Nos out of 18) in summer season contain >500 mg/l TH and therefore these groundwater samples are described as very Hardness, then they are unsuitable for domestic use and for drinking and irrigation purposes. The Fluoride (F^-) concentration varies from 1 - 5 mg/l in groundwater during summer season. < 1.5 ppm and therefore these groundwater samples are good for human beings. However a few groundwater samples contain > 1.5 ppm fluoride at Narkatepally (5.0), Yellareddygda (3.8), V.T. Colony (3.0) and Panagal (2.5) in the north of the basin. The average F^- content (1.9) in the study area is far less than that of wailapalli in Nalgonda district (Sugreeva Reddy, 2010), where people are affected by fluorosis due to high fluoride content (avg.2.96). The water–rock interaction and evapo–transpiration and atmospheric precipitation and arid to semi–arid climatic conditions are played major role in the increase of Fluoride concentration.

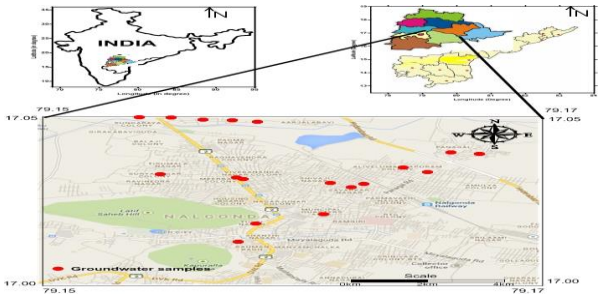

Fig.1. The location map of groundwater samples from the study area

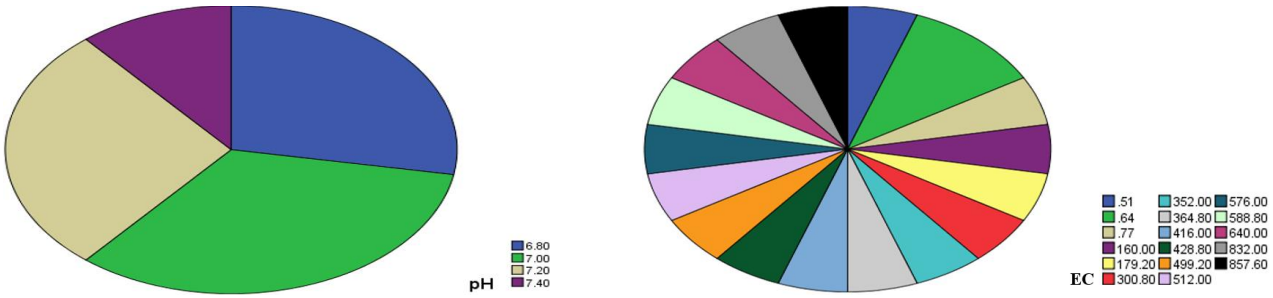

Fig.2. The physicochemical parameters concentration in Pie diagrams (a, b)

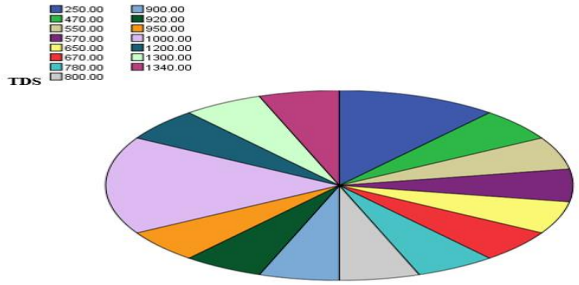

Fig.3. Spatial Distribution map of NO_3^- mg/l in groundwater samples in the study area (Nalgonda town)

Table.1. Fluoride and other parameters estimated in the study area (Nalgonda town) (n=18)

Sample	pH	EC	TDS	TH	Cl^-	R-Cl^-	NO_2-	NO_3	NH_4	F^-
GW-01	6.8	0.768	1200	750	200	0.1	10	1	-	5
GW-02	6.8	0.64	1000	750	100	0.2	10	1	5	3.8
GW-03	7.2	0.64	1000	450	190	0.2	30	-	-	1.5
GW-04	7	857.6	1340	450	700	0.1	40	-	-	1.5
GW-05	7.2	0.508	950	650	330	0.1	15	-	-	1.5
GW-06	7.4	428.8	670	500	320	0.2	16	-	-	1
GW-07	6.8	588.8	920	530	300	0.1	10	1	-	3
GW-08	7.2	352	550	100	200	0	0	0	0	1
GW-09	7.4	832	1300	790	670	0.2	3.5	-	-	1.5
GW-10	7	512	800	690	620	0.1	5	-	-	1.5
GW-11	7.2	640	1000	650	250	0	-	-	-	1.5
GW-12	7	576	900	650	170	-	-	-	-	1
GW-13	7	364.8	570	120	220	-	20	-	-	2.5
GW-14	6.8	416	650	500	200	-	5	-	-	3
GW-15	7	160	250	520	120	0.1	5	-	-	1
GW-16	7.2	179.2	250	90	130	1	0-2	-	-	1
GW-17	6.8	499.2	780	120	140	1	0.1	-	-	2
GW-18	7	300.8	470	250	120	-	0	-	-	1
Min.	6.8	0.5	250	90	100	0	0	-	-	1
Max.	7.4	857.6	1340	790	700	1	40	-	-	5
Avg.	7	372.8	811.1	475.6	276.7	0.2	9.4	-	-	1.9
Std. dev.	0.2	275.3	319.5	241	190.7	0.3	11.3	-	-	1.1
Standards BIS, 1991	6-8	-	2000	600	1000	-	-	45	-	1.5
CPEEO, 2005	6.5-9.2	-	1500	600	1000	-	-	45	-	1.5

EC- μ-mhos/cm or micro Siemens per cms (µs/cm), expect pH all are mg/l.

GW-01-Narketpally, GW-02-Yellareddy Gudem, GW-03-Anneparthy, GW-04-Cherlapally, GW-05-Marri Gudem, GW-06-Suryanagar Colony, GW-07-VT Colony, GW-08-Thirumala Nagar, GW-09-Gandhinagar, GW-10-Ganesh Colony, GW-11-Alivelumanga Colony, GW-Hanumannagar, GW-13-Panagal- I , GW-14-Panagal- II, GW-15-Tulasinagar, GW-16-Abbasia Colony, GW-17- Louis Colony, GW-18-Gandhamvari Gudem.

Table.2. TDS classification of groundwater samples after WHO, 1985

TDS (mg/l)	Class	No.of Samples	No.of Samples in (%)
Up to 500	Desirable for drinking	03 (gw)	16
500 - 1000	Permissible for drinking	12 (gw)	66
1000 - 3000	Useful for agriculture (slightly saline)	03 (gw)	16
3000 - 10,000	Moderately saline	-	-
10,000 - 35,000	Very saline	-	-
>35,000	Braine	-	-

Table.3. Classification of groundwater based on EC after Handa, 1969

Electrical Conductivity (EC)	Salinity class	Sample falling in different % (N=18)	
		No. of samples	%
0-250	Low	05	27
251-750	Medium	11	61
751-2250	High	02	11
2251-6000	Very High	Nil	-

Table 4. Quality of groundwater samples from Nalgonda Town for drinking purpose after (WHO, 1984)

Parameters		No. of samples	Range of estimated values	Suitability for drinking
pH	6.5 to 8.5	18 (100 %)	6.8 – 7.4	Suitable
	> 8.5	-	-	-
Total Dissolved Solids (TDS)	1000	15 (83 %)	250 – 1000	Suitable
		03 (16 %)	1200-1340	Not Suitable (Sp.No. GW-1, 4 & 9)
Total Hardness (TH)	500	09 (50%)	90 – 500	Suitable
		09 (50 %)	520 - 790	Not Suitable (Sp.No. GW-1, 2, 5, 7, 9, 10, 11, 12 &15)
F-	1.5	12 (%)	1.5	Suitable
	>1.5	>1.5	>1.5	
Chloride (Cl^-)	250	23(82%)	11-667	Suitable
		5(18%)	262-711	Not suitable (SP. No. GW 5, 6, 9, 13)
R-Cl^-				
Sulphate (S_O4^{2-})	400	28	2.7-127	Suitable
NO_2-				
NO_3-	45			Suitable
				Not suitable (Sp. No GW-13)
NH_4				

Table.5. Statistical parameters of groundwater samples (n=18)

Statistical parameters	pH	EC	TDS	TH	Cl^-	R-Cl^-	NO2	F^-
Mean	7	372.8	811.1	475.6	276.7	0.2	9.4	1.9
Median	7	390.4	850	510	200	0.1	5	1.5
Mode	7	0.6	1000	650	200	.00[a]	0	1
Std. Deviation	0.2	275.3	319.5	241	190.7	0.3	11.3	1.1
Variance	0	75770	102100	58100	36350	0.1	127.7	1.3
Skewness	0.3	0.1	-0.2	-0.5	1.5	2.4	1.5	1.6
Kurtosis	-0.9	-0.8	-0.5	-1.1	1	4.9	2.1	2.1
Range	0.6	857.1	1090	700	600	1	40	4
Minium	6.8	0.5	250	90	100	0	0	1
Maximum	7.4	857.6	1340	790	700	1	40	5
Percentile 25	6.8	120.2	565	217.5	137.5	0	0	1
Percentile 50	7	390.4	850	510	200	0.1	5	1.5
Percentile 75	7.2	579.2	1000	660	322.5	0.2	15.3	2.6

Table.6. Pearson Cross-correlation matrix of major ions of Nalgonda groundwater samples

Ions	pH	EC	TDS	TH	Cl^-	R-Cl^-	NO_2	F^-
pH	1	0.149	-0.019	-0.008	0.318	-0.112	0.154	-.669**
EC		1	0.318	0.04	.643**	-0.064	0.059	-0.301
TDS			1	.631**	.576*	-0.378	0.467	0.382
TH				1	0.369	-.621*	0.058	0.333
Cl^-					1	-0.321	0.34	-0.158
R-Cl^-						1	-0.245	-0.117
NO_2^-							1	-0.02
F^-								1

4. CONCLUSION

The present study for fluoride analysis in and around Nalgonda shows the water samples can be used for drinking, farming and industrial purposes except for few locations which exceed the permissible limits.

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