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WATER QUALITY ASSESSMENT OF NACHARAM AREA, RANGA REDDY DISTRICT, ANDHRA PRADESH

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Abstract

Quality assessment of water is essential to ensure sustainable safe use of it for drinking, agricultural and industrial purposes. For the same purpose the study was conducted for the samples of water of Nacharam area. The study area is characterized by semi arid climate and due to absence of surface water resources ground water is the main supply in this region. In order to evaluate the suitability of ground water in Nacharam area for using drinking and irrigation purposes. APHA were used to analysis 10 water samples were collected only from hand pumps and analyzed pH, electrical conductivity, total dissolved solids, Na^+, K^+, Ca^{2+}, Mg^{2+}, HCO_3^-,$Cl^-$and SO_4^{2-}. To understand the water quality indices parameters like, Sodium absorption ratio, salinity diagram, and piper tri linear diagram was calculated based on physic chemical results and observed that the higher concentration of total dissolved solids, total hardness, nitrates, chlorides, calcium, magnesium rendering unsuitable for drinking purposes. The values of electrical conductivity and SAR were plotted in the US salinity laboratory diagram, most dominant classes C4S1, C4S2, C3S1 were found. The quality of groundwater with high salinity and medium sodium, SAR in most water samples has restricted water quality for irrigation purpose.

Keywords: *Groundwater quality, Piper trilinear diagram, US salinity laboratory diagram.*

Introduction

Water is very vital for nature and can be limiting resource to men and other living beings. Without a well functioning water supply, it is difficult to imagine productive human activity be it agriculture or livestock. Water quality is influenced by natural and artificial effects including local industrial waste pollutants, geology and irrigation practices the hydrogeochemistry of water is important to quality in water supply planning for living areas. The geochemical character of any groundwater determines its quality and utilization. The quality is function of the physical, chemical and biological parameters and it should be subjective, since which depends on a particular intended use.

The various on hydrogeochemistry of water quality have been carried out by various members. Laluraj et al.(2005) have been studied ground water chemistry of shallow aquifers in the costal zones of Cochin and concluded the ground water present in the shallow aquifers of some of the stations were poor in quality and beyond the potable limit as per the standard by World Health Organization (2004). Rapid increase of urbanization and industrialization leads to deterioration in hydrogeochemistry of ground water quality. Srinivas et al. (2000) and Jha and Verma (2000) have reported the degradation of the water quality in Hyderabad and Bihar, Respectively, Patnaik et al (2002) have studied water pollution generated from major industries similarly, waste pollutants or effluents. Discharged into streams may enter the aquifer body down stream. This also affects the ground water geochemistry. The studies on trace metals have been carried out (Jangir et al. 1990; Sharma et al.)Sharma et al (2004) Singh and Chandel (2003, 2006) pollution problems in ground water and industrial waste water have been studied. The specific objectives of the present study area 1) the investigations and interpretation of hydrogeochemistry of Nacharam and adjoining areas. 2) Find out the suitability of groundwater for irrigation and drinking purpose and 3) establish significant correlation among ton parameters of ground water samples.

Table No. 1. Estimation of various physicochemical parameters by differential methods.

Parameters	Method used		Method used
Chloride (as Cl^- in mg/l)	Argentometric titration		
Bicarbonate (as HCO_3^- in mg/l)	Titrimetry	Magnesium (as Mg^{2+} in mg/l)	EDTA titration
Calcium (as Ca^{2+} in mg/l)	EDTA titration		
Sodium (as Na^+ in mg/l)	Flame photometric method		
Potassium (as K^+ in mg/l)	Flame photometric method		
Sulfate (as SO_4^{2-} in mg/l)	Spectrophotometric method		
Nitrates (as NO_3^- in mg/l	Spectrophotometric method		
EC Systronics			
pH Systronics			

Method

Nacharam area is located at Hyderabad city (dist. Rangareddy) in the NE of Andhra Pradesh state, is undergoing rapid urbanization and industrialization.

Groundwater samples collected from different hand pump, tube wells and ponds at 10 sampling points were analyzed. Samples were collected in good quality polythene bottles of 1-1 capacity. Sampling was carried out with out adding any preservatives in rinsed bottles for avoiding any contamination and brought to the laboratory. Only high pure (anal R Grade) chemicals double distilled water was used for preparing solutions for chemical analysis. Physical parameters like Ph, total dissolved solids, and electrical conductivity were determined at site with the help of digital portable analyzer kit. The samples collected and as per procedure (APHA 1995).

The total hardness (TH) in mg/l was determined by following equation (Todd 1980)

$$TH = 2.497\ Ca^{2+} + 4.115\ Mg^{2+}$$

Determination of cations and anions were in the laboratory using the analytical methods shown in table 1. The accuracy of chemical analysis was verified by calculating ion-balance errors (Lloyd and Healthcote 1985; Mandal and Shiftan 1981), the respective values for all these parameters and reported in table 2. All the results compared with standard limits recommended by world health organization (WHO 2004).

Results and Discussions

Understanding the groundwater quality is very important as it is the major factor determining its suitability for domestic, agricultural and industrial purposes. The data revealed that there were considerable variations in the examined sample from different sources with respect to their chemical characteristics. Physical and chemical parameters including statistical measures such as minimum, maximum and average are summarized in Table 2. Correlation matrix along 12 parameters of groundwater in the study area is presented in Table 3. Sodium adsorption ratio and Percentage of sodium (%Na) parameters are given in Table 4.

Hydrogeochemistry of ground water

The pH values of groundwater of study area between 6.7 and 7.3 with an average value of 6.97, indicates the slightly acidic nature of water samples. Electrical conductivity and total dissolved solids in some samples are exceeds the permissible limits by WHO (2004) conductivity values varied from 2,150 to 1,400 µs/cm. the maximum limits of EC in drinking water is described as 1,500 µs/cm as per WHO standard. The maximum value in GW – 1 sample was recorded, 3,460 µs/cm. The TDS value range from 1305 to 2214 µs/cm. The TDS values all are fall in Blackish phase (On the basis of salinity classification). The mean concentration of cations is order $Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}$ while for anion it is $NO_3^{-}>Cl^{-}>SO_4^{2-}>HCO_3^{-}$. Sodium varied from 100 to 250 mg/l with an average value 176.25 mg/l, Potassium varied from 40 to 100 mg/l with an average value 70.5 mg/l, Magnesium ion concentration varied from 25 to 385 mg/l with an average value 162.08 mg/l, the desirable value of Mg^{2}+ for 50 mg/l, nearly 80% of samples exceed the desirable the desirable limit. Calcium concentration varied from 28 to 390 mg/l, with an average value137.5 mg/l. the desirable limits for Ca^{2+} for drinking water is 75 mg/l, 40% of groundwater samples from the study area are within permissible limits as per WHO (2004) standard. The Carbonate content is nil, where as Bicarbonate range between 45 mg/l to 111 mg/l, Chloride ion concentration varied from 145 to 889 mg/l, the desirable limit of Cl^{-} for drinking water is specified as 200 mg/l, and 90% of samples exceed the desirable limits as per WHO (2004). Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. The sulphate content changes significantly with time during infiltration of rainfall and ground water. The concentration of sulphate is likely to react with human organs if the value exceeds the maximum allowable limit of 400 mg/l and cause a laxative effect on human system with the excess magnesium in groundwater. However, the sulphate concentration varied between 50 and 200 mg/l with an average value of 108.3 mg/l and found within the maximum allowable limit in all sample locations as per WHO specification.

Table No. 2. Physicochemistry parameters of groundwater samples from hand pumps of Nacharam area.

Sample NO	pH	EC	TH	TDS	Mg^{2+}	HCO_3^{-}	Cl^{-}	Na^{+}	K^{+}	CO_3^{-}	NO_3^{-}	SO_4^{2-}	Ca^{2+}
GW-1	7.3	3460	968	2214	100	90	841	250	100	NIL	260	200	202
GW-2	6.9	2047	1408	1310	125	111	889	100	40	NIL	252	100	390
GW-3	6.9	2510	272	1606	70	45	145	190	76	NIL	660	100	40
GW-4	7	2600	728	1664	165	48	550	230	92	NIL	160	200	116
GW-5	7.3	2690	848	1721	385	90	823	185	74	NIL	260	100	58
GW-6	7.25	2040	600	1305	305	72	269	140	56	NIL	1300	50	28
GW-7	6.7	3000	784	1920	105	78	802	235	94	NIL	240	150	154
GW-8	6.7	2910	544	1862	115	90	553	110	44	NIL	880	50	90
GW-9	7	3020	368	1932	140	111	603	125	50	NIL	1280	50	52
GW-10	6.7	2710	368	1734	25	81	589	200	80	NIL	580	50	102
Min	7.3	3460	1408	2214	385	111	889	250	100	NIL	1300	200	390
Max	6.7	2040	272	1305	25	45	145	100	40	NIL	160	50	28
Average	6.9	2707.25	714	1732.2	162.8	81	591.5	176.2	70.5	NIL	611	108.3	137.5

Table No. 3 Correlation matrix along 12 parameters of groundwater in Nacharam area

	pH	EC	Ca^{2+}	TDS	Mg^{2+}	K^{+}	HCO_3^{-}	Cl^{-}	Na^{+}	NO_3^{-}	SO_4^{2-}	TH
pH	1.000											
EC	-0.01	1.000										
Ca^{2+}	-0.13	-0.13	1.000									
TDS	-0.01	1.00	-0.13	1.000								
Mg^{2+}	0.70	-0.32	-0.29	-0.32	1.000							
K^{+}	0.14	0.51	-0.11	0.51	-0.16	1.000						
HCO_3^{-}	0.04	0.16	0.44	0.16	0.06	-0.53	1.000					
Cl^{-}	0.06	0.36	0.66	0.36	0.05	0.13	0.66	1.000				
Na^{+}	0.14	0.51	-0.11	0.51	-0.16	1.00	-0.53	0.13	1.000			
NO_3^{-}	0.03	-0.17	-0.55	-0.17	0.11	-0.58	0.16	-0.60	-0.58	1.000		
SO_4^{2-}	0.26	0.37	0.34	0.37	-0.09	0.76	-0.34	0.36	0.76	-0.76	1.000	
TH	0.26	-0.17	0.86	-0.17	0.21	-0.06	0.42	0.73	-0.06	-0.59	0.44	1.000

All the samples were below the permissible limit as per WHO (2004) standard. Nitrate contamination in groundwater is one of the major issue in water quality studies (Schilling and Wolter 2007; Raju et al. 2009). The concentration of nitrogen in groundwater is derived from the biosphere. Nitrogen is originally fixed from the atmosphere and mineralized by soil bacteria into ammonium. The concentration of nitrate in the study area varies from 160 to 1300 mg/l with an average value of 611 mg/l. It is found that only all groundwater samples were exceed the desirable limit of 45 mg/l as per WHO (2004) standard. The high concentration of nitrate in drinking water is toxic and causes blue baby disease/methemoglobinaemia in children and gastric carcinomas (Comly 1945; Gilly et al. 1984). The high concentration of nitrate is due to the intensive urbanization and rapid industrialization (Raju et al. 2009).

Major cations and anions such as Ca^{2+}, Na^{+}, Mg^{2+}, k^{+}, CO_3^{2-}, HCO_3^{-}, SO_4^{2-} and Cl^{-} in mg/l, were plotted in Piper trilinear diagram (Piper 1944) to evaluate the hydrochemistry of groundwater quality of Ncharam area. The most of groundwater sample fall in SO_4^{2-}, Cl^{-}, and Mg^{2+} type water.

Correlation studies for hydrogeochemistry parameters of water samples explains that Correlation coefficient is commonly used to measure the established the relation between independent and dependent variable. (Nair et al 2005). The correlation matrixes of 12 parameters were prepared for groundwater of Nacharam area Table 3.

Alkalinity hazards

The sodium/ alkali hazard is typically expressed as the sodium adsorption ratio (SAR). This index quantifies the proportion of sodium to calcium and magnesium ions in sample sodium hazard of irrigation water can be well understood by knowing SAR. The SAR values for each water sample were calculated by using following equation (Richard 1954)

$$SAR = Na/\sqrt{(Ca+Mg)/2}$$

The concentrations are reported in meq/l. SAR varied from 1.1 to 4.8 meq/l.

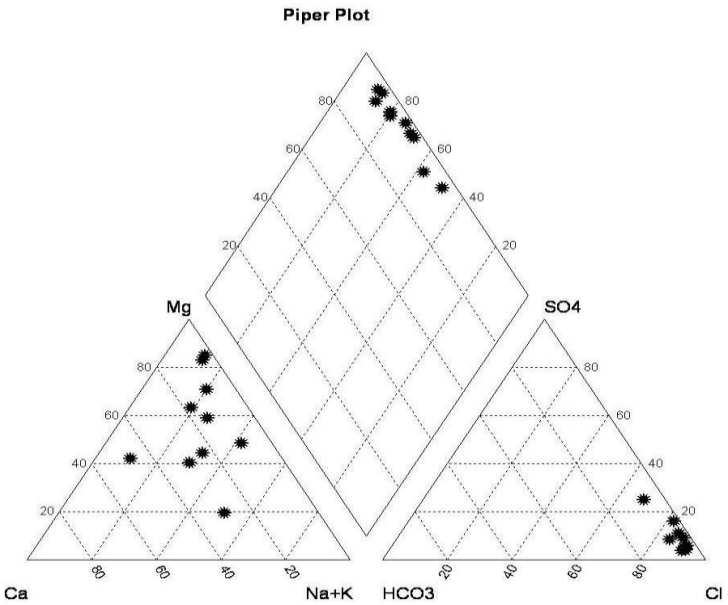

Fig 1 Piper trilinear diagram of groundwater quality samples of study area.

Table 4 Hydrogeochemical parameters for Irrigation purpose (meq/l).

Sample No	SAR	EC	%Na
GW-1	3.3	3460	40.7
GW-2	1.1	2047	15.3
GW-3	2.3	2510	57
GW-4	3.3	2600	38.4
GW-5	1.3	2690	22.1
GW-6	1.6	2040	21.8
GW-7	3.6	3000	43.7
GW-8	1.8	2910	29.5
GW-9	2	3020	31.8
GW-10	4.8	2710	11.2

Salinity Hazard

Electrical Conductivity is a good measurement of salinity hazard to crop as it reflects the TDS in groundwater. No one sampling point found suitable with respect to EC for irrigation purpose. According to Wilcox diagram and classification (Wilcox 1955) the groundwater in study area are ranging in doubtful, it is not for irrigation. The primary effect of high EC reduces the osmotic activity of plants and interferes with the absorption of water and nutrients from the soil.

Total Hardness

Total hardness varied from between 272 to 1408 mg/l maximum allow able limit of TH for drinking water is specified 500 mg/l, and the most desirable limit is 100 mg/l as per WHO (2004) standard. All the sampling location points are exceeded on total hardness, the groundwater samples were fall in the hard to very hard category, because of the study area located at near by the industries, due to that reason all the sampling locations were exceeds the total hardness.

Percentage of Sodium (%Na)

Percentage of sodium is widely used for evaluating the suitability of water quality for irrigation. High sodium content in irrigation water causes exchange of Na^+ in water for Ca^{2+} and Mg^{2+} in soil and reduces the permeability and eventually results in soil with poor internal drainage (Saleh et al. 1999). The sodium percentage (%Na) in the water samples is calculated with respect to relative proportions of cations present (%Na = $Na^+ + K^+$/ (Ca^{2+}+Mg^{2+}+ Na^+ +K^+) X 100) in water. Here all the concentrations are expressed in meq/l. the values Na % varies from 11.2 to 57; meq/l (Table 4). All sampling stations were found to be suitable for irrigation purpose (Table 5).

Table 5 Classification of groundwater quality on the basis of Na%, SAR, EC, TH and TDS

Parameters	Range	Water Class	Samples
Na% (Wilcox 1955)	0-20	Excellent	GW-2,10
	20-40	Good	GW- 4,5,6,8,9
	40-60	Permissible	GW-1,3,7
	60-80	Doubtful	NIL
	>80	Unsuitable	NIL
SAR (Richard 1954)	10	Excellent	All samples
	10-18	Good	NIL
	18-26	Doubtful	NIL
	>26	Doubtful	NIL
EC(Wilcox 1955)	250	Excellent	NIL
	250-750	Good	NIL
	750-2,000	Permissible	NIL
	2000-3000	Doubtful	All Samples
	3000	Unsuitable	NIL
TH (Sawyer GN, McCartly DL, 1967)	<75	Soft	NIL
	75-150	Moderately hard	NIL
	150-300	Hard	NIL
	>300	Very hard	All Samples
TDS (Freeze RA, Cherry JA, 1979)	<1,000	Fresh	NIL
	1000-10,000	Brackish	All Samples
	10,000-100,000	Saline	NIL
	>100,000	Brine	NIL

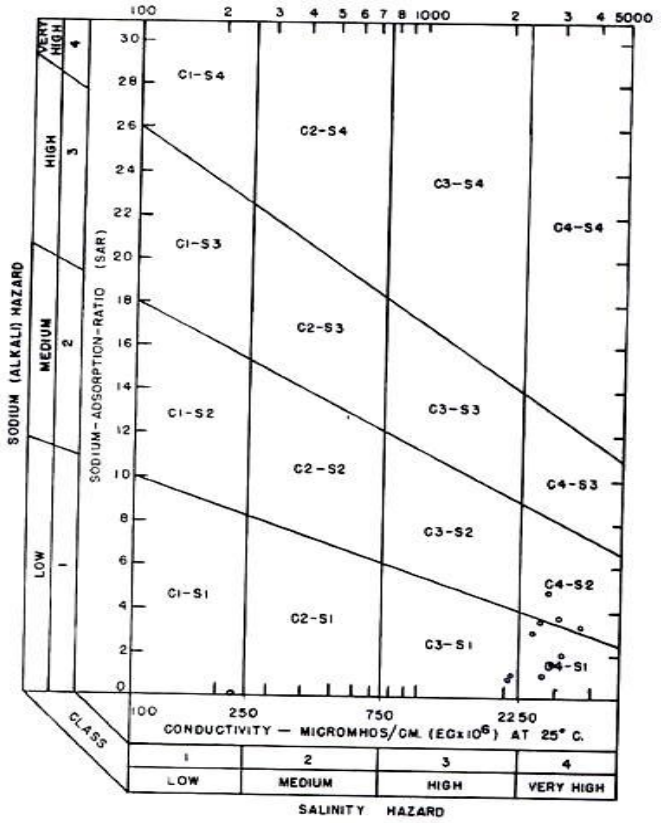

Fig 2 Rating of the quality of groundwater samples in the relation to salinity and sodium hazard

Conclusion

Interpretation of Hydrogeochemical data shows that category hard, slightly acidic nature. This reveals that the groundwater samples of study area fall in hard to very hard category, trilinear diagram shows that all of the samples fall in the field of SO_4^{2-}, Cl^-, Mg^{2+} type water. US salinity diagram illustrates that only two groundwater samples were fall in (C3S1) of field, indicating high salinity and low sodium, five samples were fall in (C4S1) of field, indicating very high salinity and low sodium field, three samples were fall in (C4S2) of field, indicating the very high salinity and medium sodium of water, Totally the quality of groundwater is not danger for usage, which can be used for domestic and irrigation purposes, almost all type of soil with little danger of exchangeable of sodium.

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