ASSESSMENT OF GROUNDWATER QUALITY FOR IRRIGATION USE

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Abstract

The availability of groundwater, namely fresh water is too less. This situation provokes the scientific community to further research in the field groundwater exploration of fresh water and natural recharge estimation, which are the most important components essential to formulate dependable groundwater management strategies in scarcity, affected regions. Hydrochemical studies were conducted in Chinnaeru river basin of Nalgonda District, Andhra Pradesh, India. Water samples from 28 locations were collected from bore wells during May 2011 and analyzed for different physico-chemical parameters. Based on various indices and water quality standards, the water is classified for safe drinking and irrigation uses. The concentration of fluoride in groundwater ranges from 0.4-2.9 mg/l. Piper diagram reflect that the water belong to Ca^{+2}–Mg^{+2}–HCO_3^- to Na^+–HCO_3^- types. The Wilcox diagram suggests that most of the samples are within the permissible limits which can be used for irrigation. High fluoride content in groundwater can be attributed to the continuous water rock interaction during the process of percolation with fluorite bearing country rocks under arid, low precipitation and high evaporation conditions of the study area. The low calcium content in rocks and soils and the presence of high levels of sodium bicarbonate in soils and waters are important factors favouring high levels of fluoride in waters. The basement rocks provide abundant sources of fluoride in the form of amphibole, biotite, fluorite and apatite. The high fluoride concentration areas are demarcated and de-fluoride plant were installed to treat the water for safe drinking purposes.

Index Terms: Groundwater, Bore wells, Wilcox diagram, Piper diagram, Fluoride content.

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1. INTRODUCTION

Water is one of the most indispensable resources and is the elixir of life and primary cause for the origin of life on earth planet. Water constitutes about 70% of the body weight of almost all living organisms. Life is not possible on this planet without water. It exists in three states namely solid, liquid and gas. It acts as a media for both chemical and biochemical reactions and also as an internal and external medium for several organisms. About 97.2% of water on earth is salty and only 2.8% is available as fresh water from which about 20% constitutes groundwater. The main source of water in the earth is through rivers, lakes, oceans and the subsurface groundwater aquifers. Groundwater is highly valued because of certain properties not possessed by surface water. Water can be used for various purposes like domestic, agriculture, industrial and etc.

Due to increase in human population and technology growth day by day, the available storage of groundwater is over exploited without considering its adverse effect on the aquifer system, which causes depletion in water level and deterioration in quality of groundwater. The availability of groundwater, namely fresh water is too less. The storage of groundwater mostly depends on the rainfall and how much recharge is taking place during rains. But due to non-uniform distribution of rainfall and failure of monsoon in our country, the existing available groundwater resources are not able to meet the increasing demand of human population.

This situation provokes the scientific community to further research in the field groundwater exploration of fresh water and natural recharge estimation, which are the most important components essential to formulate dependable groundwater management strategies in scarcity, affected regions. The present study gives out the objectives, to estimate the cations and anions for the groundwater samples and to assess the groundwater quality by Pipers diagram and Wilcox diagram.

2. LOCATION AND EXTENT

In order to assess the groundwater quality for irrigation uses a Chinnaeru river basin is selected. The basin is situated 30 km away from Hyderabad, the capital of Andhra Pradesh State, India. Geologically the area consists of granites, gneisses and pegmatite of igneous origin belonging to the Archaean age. The study area is located between 170.38' N – 170.50' N latitude and 780.78' – 790.96' E longitude. The granites are pink and grey in color, hard massive to foliated and well jointed. The soil cover is of well developed residual soil of weathered granite. The soil is fairly permeable with brown-reddish colour. The soil can absorb most of the rain except for more intensive rains, which can cause considerable surface flow and erosion.

The groundwater occurs in the weathered granite under semi-confined conditions and the fractured solid bedrock under the groundwater table. The average depth of groundwater is about 10-12 meters. These rocks posses negligible primary porosity

but due to secondary porosity by deep fracturing and weathering, they are rendered with a porosity and permeability, which locally form potential aquifers in the study area. The location map of the study area is shown in fig. (1).
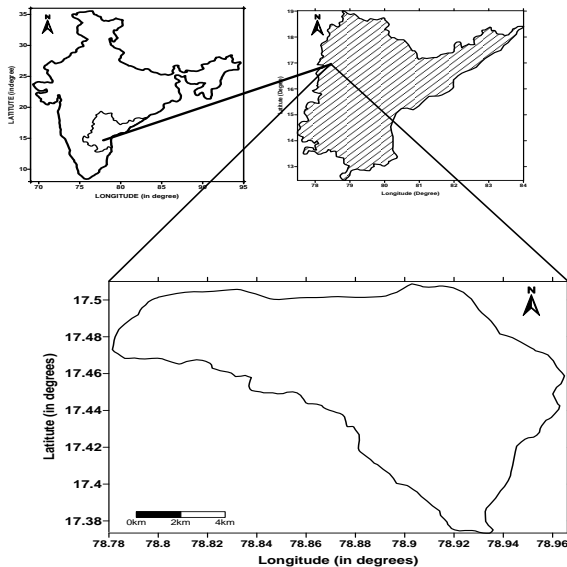

Fig.1 Location Map of the Study Area

3. RESEARCH METHODOLOGY

Groundwater samples were collected in pre-cleaned 1 litre polyethylene bottle following APHA, 1995 method from the bore wells, which are used for the irrigation purposes during May 2011 period. The water samples from the wells were collected after pumping out water for about 10 min to remove stagnant water from the well. Twenty eight groundwater samples are collected and analysed for major cations and anions. The groundwater sample locations in the study area are represented in fig. (2). The various groundwater quality parameters like pH, Total Dissolved solids, Potassium,

Magnesium, Calcium, Chlorides, Sulphates, Carbonates, Bicarbonates, Nitrates and Fluorides are analyzed as per BIS standards. Piper diagram is also plotted to analyse the groundwater parameters. The sodium adsorption ratio in the study area is estimated by Wilcox diagram.
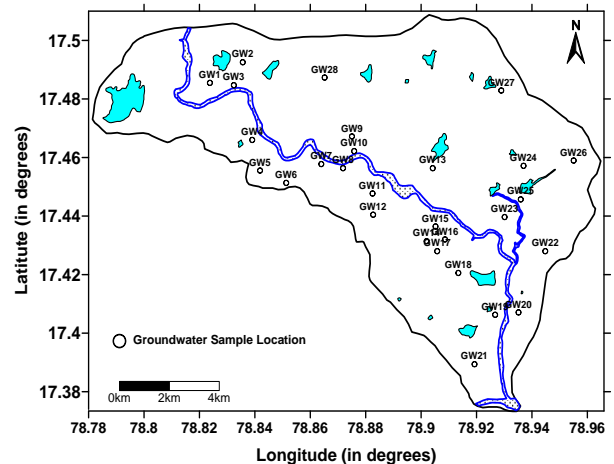

Fig.2 Groundwater Sample Locations in the Study Area

4. RESULTS

It has been observed from the analysis that the Nitrate concentration is exceeding the permissible limits in the groundwater samples collected at Erravattet Thanda, Gollaguda Village, Madhram Thanda 1, Madhram Thanda 3, Nagireddy palli Village, Erram palli Village and Tukkapuram Village. At Gudur Thanda, Pagidipalli Village, Gudur Village, Anamptla Village, Makhdumpalli Thanda, Madhram Thanda 3, Srinikunta Village, Bollapalligandinagar Village, Bollapalligandinagar Thanda, Suryapalli Village and Nandanam Village the fluoride concentration is exceeding the permissible limit. The groundwater quality parameter values in the study area are shown in the Table1. The average values of the each quality parameter are shown in the Table (2).

Well No.	Sample Location	pH	EC (µs/cm)	TDS (mg/l)	Na$^+$ (mg/l)	K$^+$ (mg/l)	Mg^{+2} (mg/l)	Ca^{+2} (mg/l)	Cl$^-$ (mg/l)	SO$_4^{-2}$ (mg/l)	HCO$_3^-$ (mg/l)	CO$_3^-$ (mg/l)	NO$_3^-$ (mg/l)	F$^-$ (mg/l)
GW1	Gudur Thanda	7.73	878	526.8	137	2.1	20.1	22.5	101	30.5	135.3	14	17.2	2.1
GW2	Pagidipalli Village	7.56	1438	862.8	189	3.1	41.5	116	418	55.9	147.2	15	52.4	2.7
GW3	Gudur Village	7.82	1370	490.2	275	2.8	40.1	63.1	240	72.8	320.4	32	27.6	2.8
GW4	Anamptla Village	8.23	635	381	131	6.6	37.5	85.2	102	50.2	342.3	61	93.5	1.6
GW5	Erravattet Thanda	7.36	1158	694.8	90.8	1.8	83.1	235	395	120	113	13	395	0.4
GW6	Gannegani Thanda	7.64	619	371.4	75	1.8	39.1	34.8	31.5	21.9	191.9	17	16.2	0.9
GW7	Makhdumpalli Village	7.59	535	321.4	53	1.7	25.1	46.8	11.9	10.4	302.2	32	13.9	1.4
GW8	Makhdumpalli Thanda	7.59	958	574.8	123	6.7	43	20.1	96.3	48.9	323.8	43	22.3	1.6
GW9	Gollaguda Village	7.48	1775	1065	169	117	42.9	47.7	202	101	214.3	35	189	0.4
GW10	Gollaguda Thanda	7.4	595	357	126	19.7	28.3	61.8	95.3	39.6	296.3	31	30.9	1
GW11	Ravipadu Thanda	8.17	630	380	76	1.7	40.6	34.3	44.7	35.2	342.5	32	20.8	1.3
GW12	Ravipadu Village	7.72	650	390	71	2.4	41.8	92.8	122	59.8	1557	19	66.3	0.8
GW13	Anjpur Village	7.39	738	442.8	164	4	40.8	48.7	182	58.2	243.8	34	50.8	1.3
GW14	Madhram Village	7.73	1095	657	101	3	47.9	45.2	138	102	207.8	19	37.2	1.4
GW15	Madhram Thanda 1	7.55	939	563.4	73	5.2	45.2	113	153	126	165.4	18	141	0.6
GW16	Madhram Thanda 2	7.54	534	320.4	61	4	40.2	69.8	71.9	31.8	172.4	30	50.8	0.9
GW17	Madhram Thanda 3	7.52	811	486.6	161	45.8	63.8	78.9	145	55.7	539	56	122	2
GW18	Srinikunta	8.33	1227	736.2	255	4	36.4	48.2	153	77.8	540.3	70	14.9	2.2
GW19	Bollapalligandinagar Village	8.04	1676	1006	306	11.4	49.8	27.8	239	96.5	482.4	52	31.9	2.9
GW20	Bollapalligandinagar Thanda	7.99	1528	916.8	286	8.7	43.2	32.7	206	94.8	345.8	47	18.5	2.9
GW21	Suryapalli Village	7.48	1409	845.4	477	8.9	84.5	46.2	711	126	357.2	43	8	2.7
GW22	Nagiredd palli Village	7.36	998	598.8	167	2.6	55.3	114	365	109	98.4	16	172	0.8
GW23	Nandanam Village	7.78	1946	1168	347	3.3	45.9	31.8	301	112	409.7	47	40.5	2.5
GW24	Nyamatupalli village	7.51	1283	769.8	288	2.8	104	95.3	667	127	189.8	31	71.6	1.4
GW25	Nyamatupalli Thanda	10.16	204	122.4	36.7	4.7	6.9	6.2	14.8	2.9	119.3	8	34.2	0.8
GW26	Erram palli Village	7.58	1479	887.4	113	3.2	54.2	134	151	85.9	284.2	23	186	1.3
GW27	Tukkapuram Village	7.58	1419	851.4	148	2.2	46.8	107	261	71.9	177.3	17	107	1.2
GW28	Bommaipalli Village	7.65	1191	714.6	129	2.8	31.4	23.4	162	60.2	232.4	28	54.2	0.8

**TABLE (1)** Groundwater Quality Parameters in the Study Area

Table (2) Average Values of the Groundwater Quality parameters

Groundwater Parameters	Minimum values	Maximum values	Average values
pH	7.36	10.16	8.76
EC	204	1946	1075
TDS mg/l	122.4	1167	644.75
Na^+ mg/l	36.7	476.8	256.75
K^+ mg/l	1.7	116.5	59.1
Mg^{+2} mg/l	6.9	103.5	55.2
Ca^{+2} mg/l	6.2	235.2	120.7
Cl^- mg/l	11.9	711	361.45
SO_4^{-2} mg/l	2.9	126	64.45
HCO_3^- mg/l	98	540	319
CO_3^- mg/l	8	70	39
NO_3^- mg/l	8	395.4	201.7
F^- mg/l	0.4	2.9	1.65

A Piper diagram was plotted for the analyses of groundwater samples. Three types of distributions have been observed in the study area according to Piper diagram. Most of the samples are of the type of Ca^{+2}- Mg^{+2}-HCO^{-3}. The samples collected at Gudur Thanda, Pagidipalli Village, Gudur Village, Anamptla Village, Erravattet Thanda, Gannegani Thanda, Makhdumpalli Village, Makhdumpalli Thanda, Gollaguda Village, Gollaguda Thanda, Ravipadu Village, Ravipadu Thanda, Anjpur Village, Madhram Village, Madhram Thanda 1 are Ca^{+2}-Mg^{+2}-HCO^{-3}. Na^+-$HCO3^-$ type distribution is observed in Madhram Thanda 2, Madhram Thanda 3, Srinikunta Village, Bommaipalli Village, Bollapalli gandinagar Thanda, Bollapalli gandinagar Village, Suryapalli Village, Nandanam Village and Nyamatupalli Village. Nyamatupalli Thanda, Erram palli Village, Tukkapuram Village, and Nagireddy palli Village are Na^+-Cl^- type. The iper diagram for the analyses of groundwater samples is shown in fig.3.
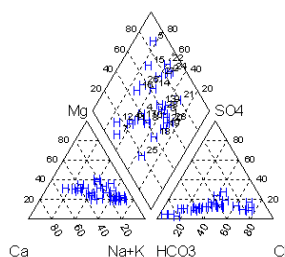
Fig. 3 Piper Diagram for the Groundwater samples in the Study Area

Wilcox diagram is drawn for the groundwater parameters in the study area in order to analyse the sodium adsorption ratio. It has been observed that C3S1, C3S2, C3S3 classification types are identified. C3S3 type classification is observed at Gudur Thanda, Pagidipalli Village, Gudur village, Anamptla Village, Erravattet Thanda, Gannegani Thanda, Makhdumpalli Village, Makhdumpalli Thanda, Gollaguda Village, Gollaguda Thanda, Ravipadu Village, Ravipadu Thanda, Anjpur Village, Madhram Village, Madhram Thanda 1, Madhram Thanda 2, Madhram Thanda 3, Srinikunta Village, Bollapalli gandinagar Village, Bollapalli gandinagar Thanda, Nagireddy palli Village, Nandanam Village, Nyamatupalli Thanda, Erram palli Village, Tukkapuram Village, and Bommaipalli Village. C3S2 type classification is observed at the Suryapalli Village and Nandanam Village and C3S3 type classification observed at Nyamatupalli Village. The salinity versus sodium absorption diagram for the analyses of groundwater quality parameters is shown in fig. 4
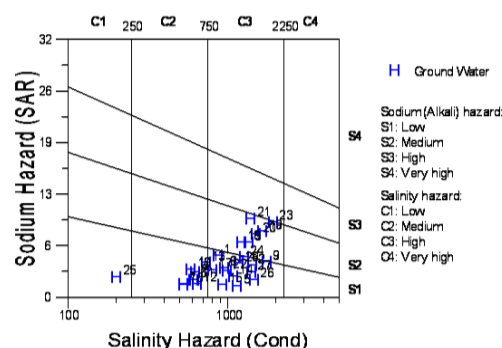
Fig.4 Wilcox Diagram for the Groundwater samples in the Study Area

CONCLUSIONS

For the groundwater samples collected in the study area the nitrate concentration values varied from 8-395.4 and the fluoride concentration values varied between 0.4-2.9. According to Piper diagram three types of classification namely Ca^{+2}-Mg^{+2}-HCO^{-3}, Na^+-$HCO3^-$ and Na^+-Cl^- are observed in the study area. 15 groundwater samples are of Ca^{+2}-Mg^{+2}-HCO^{-3} type, 9 are Na^+-$HCO3^-$ type and remaining 4 groundwater samples are of Na^+-Cl^- type of distribution. 53% of the groundwater samples shows shallow meteoric percolation type, while 47% shows deep meteoric percolation type. The overall quality of groundwater in chinnaeru river basin was found to be good according to Piper diagram. According to Wilcox diagram three types of classifications namely C3S1, C3S2, C3S3 are observed in the study area. 21 samples are C3S1 classification type, 5 samples are C3S2 classification type and 2 samples are C3S3 classification type. From the Wilcox diagram it can be concluded that the groundwater available in the chinnaeru river basin is suitable for irrigation purpose.

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BIOGRAPHY

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