JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Major ion geochemistry of groundwater in and around Kattangur Watershed, Nalgonda District, Telangana State

Sudhakar Gundlapally* I. Panduranga Reddy* Vishnu Bhoopathi[1] M. Anjaneyulu[2]

*Department of Geology Osmania University, Hyderabad
[1]Departmnet of Applied Geochemistry, Osmania University, Hyderabad
[2]Department of Geology, Mahatma Gandhi University, Nalgonda

Abstract

Pre monsoon and Post monsoon season's of ground water samples were collected from the Kattangur watershed in Nalgonda district. The work has carried out based on geological, geomorphological and hydrogeochemical factors for the evaluation of major ions in ground water for drinking and irrigation use in a hard rock shallow aquifer. The physico-chemical parameters and major ion chemistry of the collected samples were analyzed. Based on the analytical results Wilcox and Gibbs diagram were plotted and distinguished ground water quality for the drinking and irrigation use. Wilcox plot suggest that most of the samples are within the permissible limits for drinking and irrigation use. The Gibbs plots have shown that the samples are rock dominance field mechanism for the grounds water chemistry in the Kattangur watershed. All the major ion parameters are shown within the permissible limits. It has been concluded that, the water from the study area is good for drinking and irrigation use, apart from few samples which are exceeded the limits due to anthropogenic activities and those samples were indisposed for irrigation.

Keywords: Kattangur watershed, Major ions, Wilcox diagram, Gibbs Diagram and Fluoride.

Introduction

Groundwater is one of the most important natural resources on Earth. Groundwater systems offer a variety of services to humankind, either by providing water that can be abstracted and used, or by various in situ functions, such as climate buffering and sustaining wet environments. (Jac van der Gun, in Global Groundwater, 2021). Groundwater depletion is becoming a global problem with increasing populations and industrialization coupled with changing climate and hydrologic cycles. Deep groundwater sources are increasingly being considered for water supply sources as they are readily available on-site and are treated with minimum specific energy consumption.(Veera Gnaneswar Gude, Anand Maganti, in Global Groundwater, 2021).The anthropogenic disturbances through industrial and agricultural pollution, increasing consumption and urbanization degrade the groundwater and impair their use for drinking, agricultural, industrial and domestic uses (Carpenter et al. 1998; Jarvie et al. 1998; Simeonov et al. 2003; Satish Kumar et al 2016; V. Satish Kumar et al. 2016). The problems with groundwater quality are more acute in areas that are densely populated and thickly industrialized and have shallow groundwater tube wells (Shivran et al. 2006; V. Satish Kumar et al. 2016). Geochemical studies of groundwater provide better understanding of possible changes in quality as development progresses. The suitability of groundwater for domestic and irrigation purposes is determined by its geochemistry (V. Satish Kumar et al. 2016). Naik et al. (2009) carried out the groundwater study in Koyna river basin and conclude that the ground- water samples are dominated by alkaline earth elements, the shallow aquifers groundwater samples are generally Ca–HCO_3 and Ca–Mg–HCO_3 type, whereas deeper aquifer groundwater samples are

Ca–Mg–HOC_3 and Na–HCO_3 type. Purushotham et al. (2011) has carried out similar studies of groundwater and conclude that the groundwater deteriorated due to rapid urbanization.

Recent various researchers have carried out ground- water study for drinking and irrigation water standards using different indices and plots (Rao and Rao 2010; Rao et al. 2012; Bhardwaj and Sen Singh 2011; Prasanna et al. 2011; Akbal et al. 2011; Nosrati and Van Den Eeckhaut 2012; Sharma et al. 2012; Gupta et al. 2012; V. Satish Kumar et al. 2016). Besides these, Machender et al. (2013) have carried out groundwater and surface water study in a Chinnearu river basin to distinguish the groundwater and surface water for drinking and irrigation use.

The main objective of the article is to determine the groundwater quality for drinking and irrigation purposes, and compared the chemical analysis data of the groundwater with the water quality standards.

Geology and hydrology of the study area

The area comprises mainly of granitoids of Precambrian age which form a part of the unclassified crystalline topography of Peninsular Gneissic Complex (PGC). The outcrops include a variety of pink granites, gneissic grey granites and migmatitic rocks, the migmatites are strongly foliated and contain abundant relict primary structures. Coarse-grained pegmatite veins, quartz veins and epidote veins are observed cross-cutting or being parallel to the foliation in granitoids and are sometimes folded and deformed. Dolerite dykes crosscut the granitoids. The dykes strike in NE-SW, ENEWNW, NE- SW and N-S directions, and are seen as persistent linear ridges extending for several kilometres with varying width. (Anjaneyulu et al 2017, 2018 and 2019)

Materials and methods

In order to assess the physico-chemical parameters, a total of 35 groundwater samples were collected covering the Kattangur watershead area, Nalgonda District, Telangana, have been selected (Fig. 1). The water samples were collected for pre monsoon (October, 2020) and post monsoon (April, 2021) seasons with in situ measurement of pH and EC. Water samples were collected in a plastic container of 1-L capacity for detailed chemical analysis from all observation dug wells. These containers were washed thoroughly with distilled water and dried before being filled with water samples. The containers were numbered serially along with a proper record of well sample location and prior to the sampling. Groundwater samples were collected after the well was subjected to pumping for at least 2-3 min to obtain the composite sample. The pH and EC of the groundwater samples were measured and its in situ values are recorded. Total dissolved solids (TDS) were calculated from EC with cation factor of multiple 0.64 (Brown et al. 1970). Water samples collected in the field were analyzed for chemical constituents, such as Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca), Magnesium (Mg), Carbonates (CO_3), Bicarbonates (HCO_3), Sodium (Na), Potassium (K), Chloride (Cl), and Sulfates (SO_4), were analyzed following the standard procedure of (APHA 1995). The analytical results were evaluated in detail and compared with water quality guidelines of WHO (2004). A brief description of the physicochemical attributes of groundwater is discussed. EC, pH, chloride (Cl^-) and fluoride (F^-) were analyzed using multiple parameters ion meter. Sulfate (SO^{-2}) was measured using a double beam UV–Vis spectrophotometer. Sodium (Na^{+}), potassium (K^{+}), calcium (Ca^{+2}), and magnesium (Mg^{+2}) were analyzed using flame photometer. Total hardness was determined by EDTA titrimetric method. TDS was measured gravimetrically. Total carbonate and bicarbonate alkalinities were measured by acid–base titration

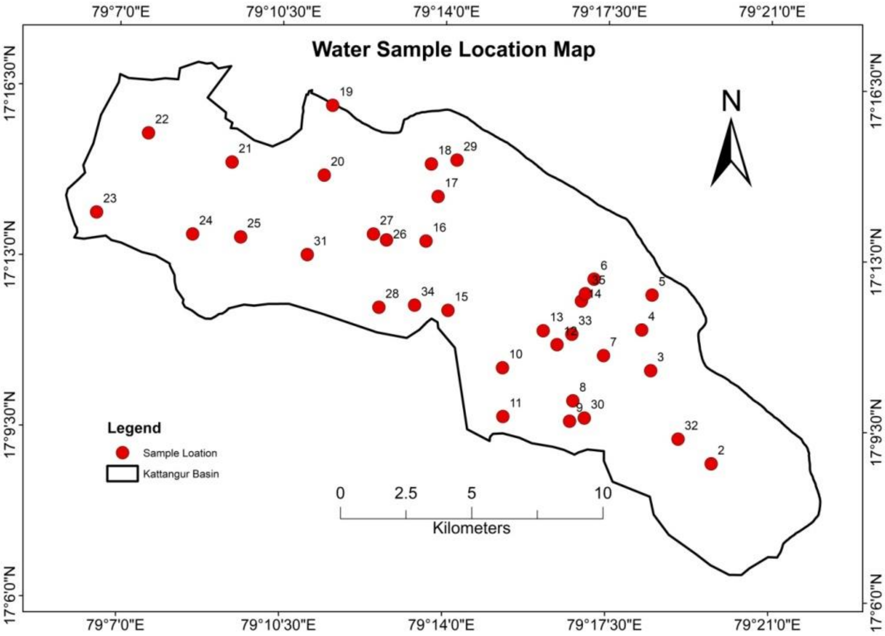


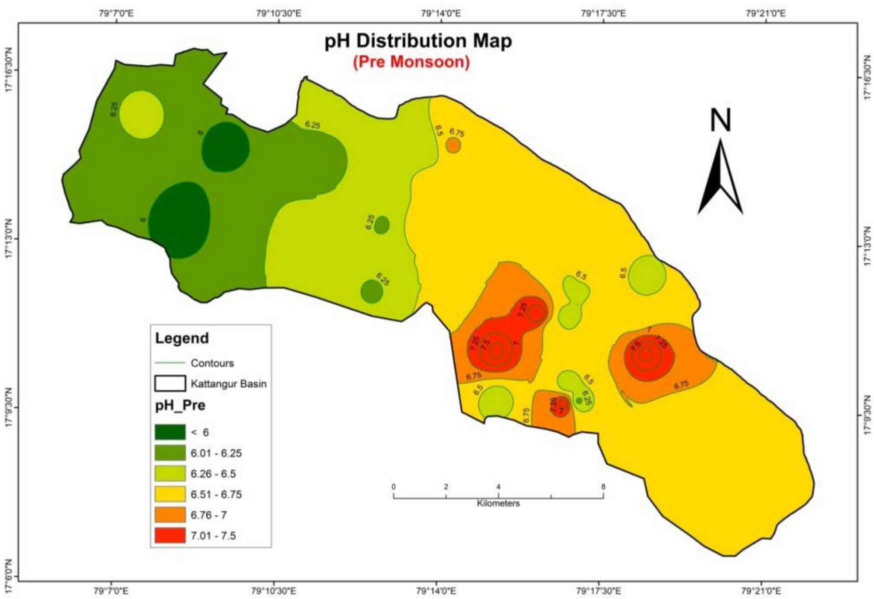
Fig. 1 sample location of the Kattangur watershed

Result and discussion

The analytical results of physical and chemical parameters of the groundwater of the present study are shown in Tables 1 and 2. These were compared with the standard guideline values as recommended by the BIS (2012) and WHO (2004) for drinking and public health purposes. TDS concentration is also very low it effects on ground water depths pre monsoon and post monsoon respectively. A brief description of the important physicochemical attributes of groundwater is discussed.

Hydrogen ion (pH)

The pre monsoon, pH value ranging from 6.1 to 7.7 and average is 6.5 and in the post-monsoon value ranging from 5.8 to 7.6 and an average is 6.5 in the post monsoon respectively table 1 and table 2.This low value of pH (Fig. 2 & 3) is to some extent the influences of fertilizers like ammonium sulfate and super phosphate inagriculture (Appelo and Postma 2005).



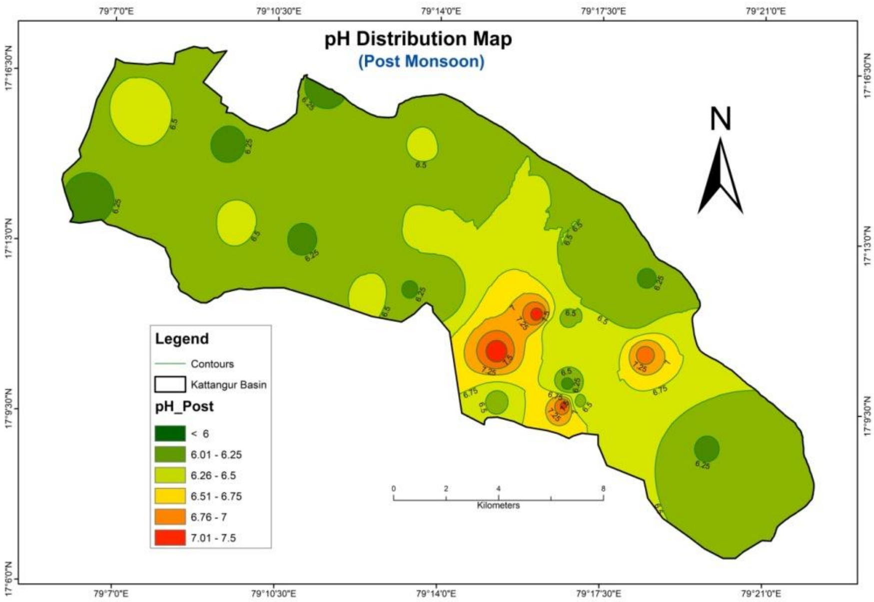
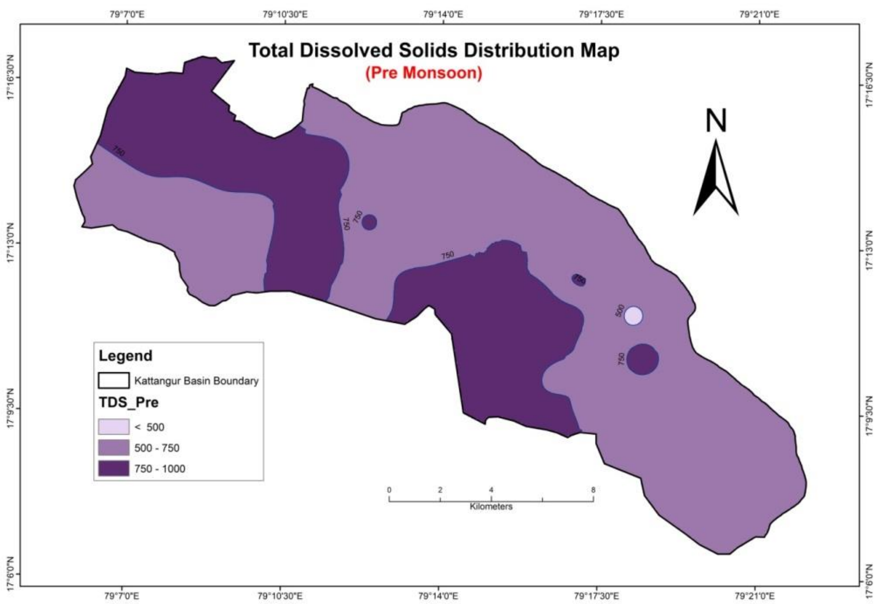


Fig. 2 and Fig. 3 Variation of pH for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

Total dissolved solids (TDS)

The value of TDS plays a vital role in the groundwater whether the water is potable or for domestic use. The samples are falling exceed limits of the permissible limits (500–2,000 mg/L). The pre monsoon samples 34 of 35 and in post monsoon samples 34 of 35 are exceeding the limits (Table 5). EC is directly related to TDS, the locations showing high contents of EC support higher TDS concentration (Fig. 4 & 5). The major source for TDS is due to dissolved minerals, landfills, iron and manganese and livestock waste.



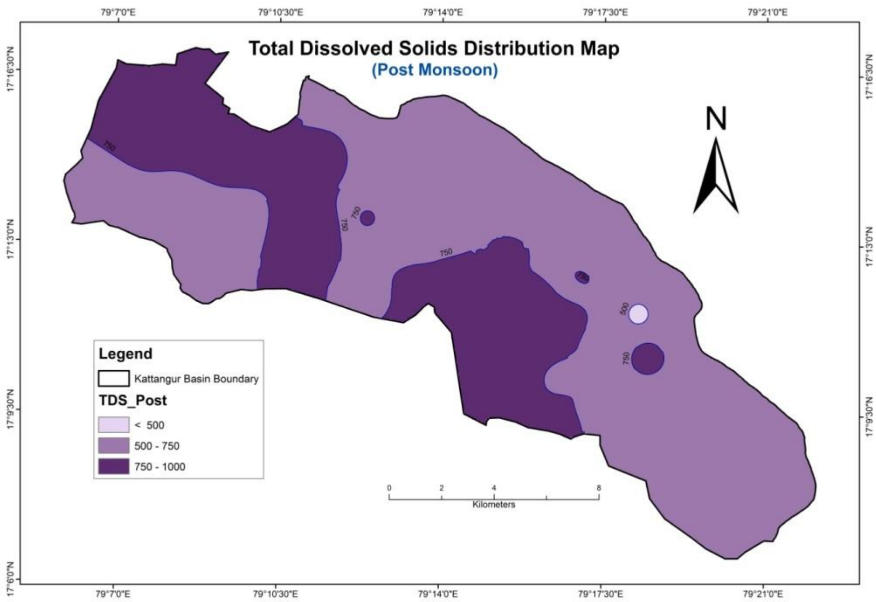
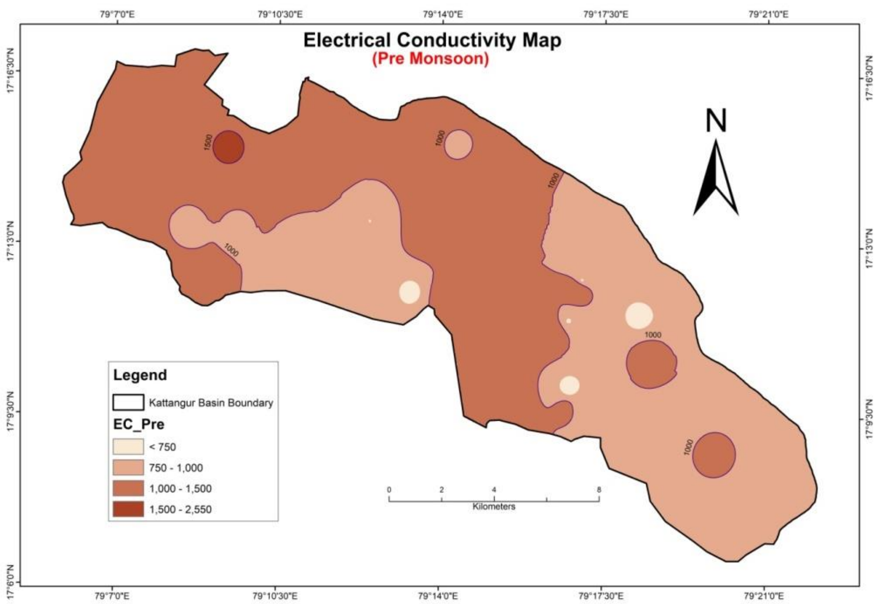


Fig. 4 and Fig. 5 Variation of TDS for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

Electrical conductivity (EC)

The EC values in premonsoon are ranging from 593 to 1592 ms/cm and as so in post monsoon from 593 to 1589 mS/cm. The average EC value in post monsoon is 1028.9 mS/cm and pre-monsoon value is 1027 mS/cm. The EC values in pre-monsoon shown 100% of wells out oflimit and in post monsoon 100% of wells (Fig. 6 & 7) are out of limits as there are some anthropogenic activities been carried out.



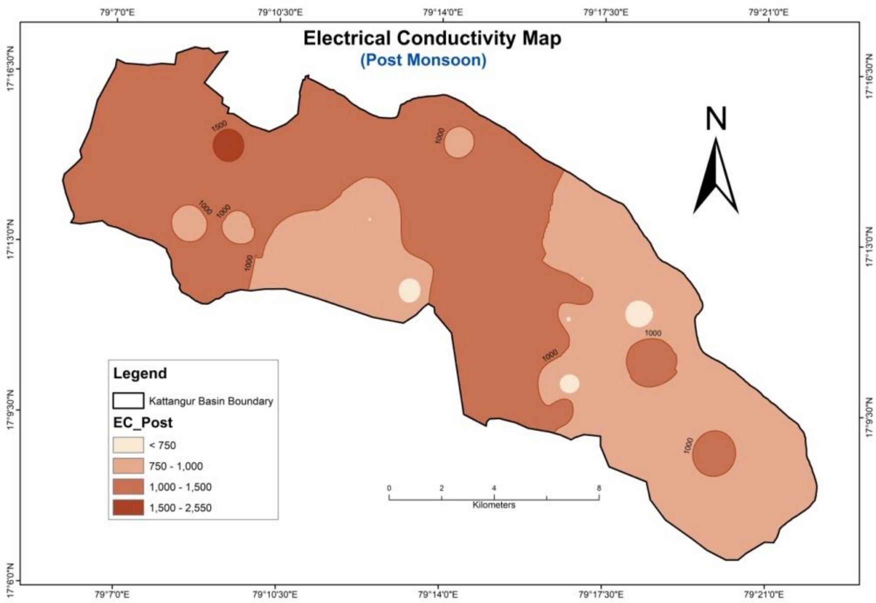
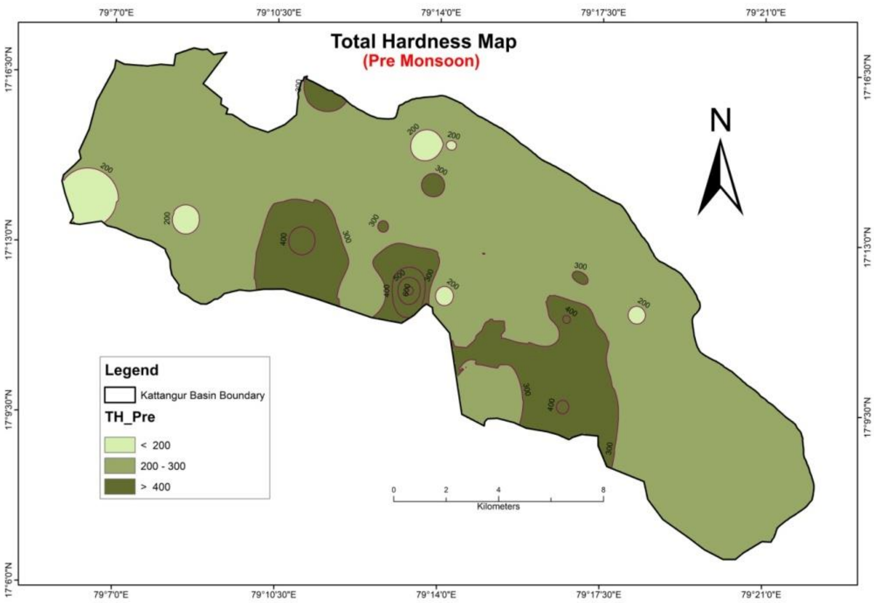


Fig. 6 and Fig. 7 Variation of EC for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

Total hardness (TH)

Total hardness value is between 150 and 300 mg/L means the water is hard and the value >300 mg/L means it is very hard (Todd 2001). The pre-monsoon samples 23 of 35 are out of limits, and in post-monsoon, 23 of 35 samples are out of limits. The major source for hardness is due to calcium and magnesium in the soil and aquifer minerals. High concentration of TH (Fig. 8 & 9) in water may cause kidney stone and heart disease in human. The maximum permissible limits of water quality for drinking as given by BIS (2012) and WHO (2004) is 600 mg/L.



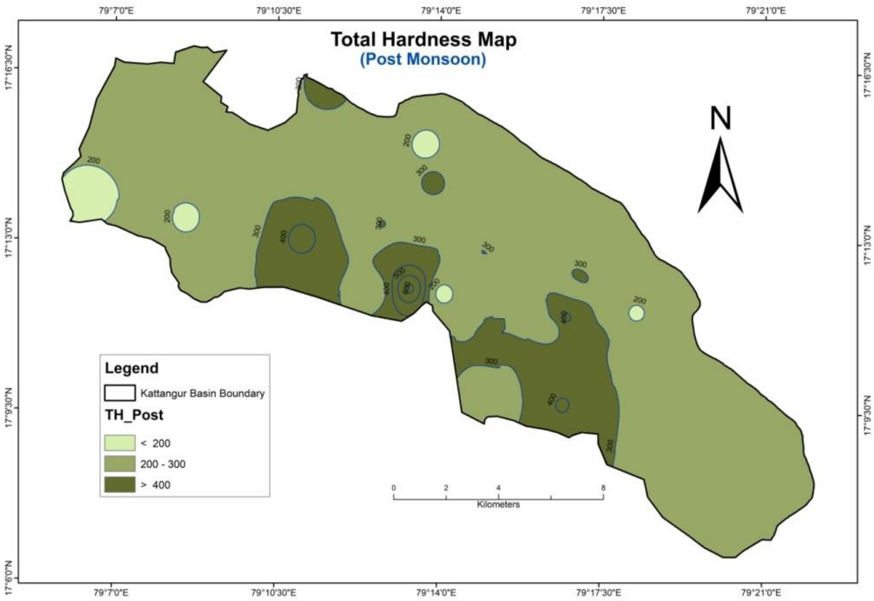


Fig. 8 and Fig. 9 Variation of TH for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

Calcium and magnesium

Among the cations, Ca content shows seasonal variation and majority of the samples in all the seasons fall withinthe permissible limit (75 mg/L). Among the total samples, 0 % in post-monsoon and 16 of 35 in pre-monsoon season's record values beyond the permissible limit. The content of Ca spreads between 43 and 137 mg/L, and 41 to 1372 mg/L averaging 31.9 and 76.7 mg/L during post- monsoon and pre-monsoon, respectively. High concentration of Ca is not desirable in washing, laundering, and bathing.

The content of Mg is comparatively less than that of Ca. The Mg exhibits gradual increase in concentration from post-monsoon to pre-monsoon seasons. Among the total 20 of 35 samples, 57.1 % in post-monsoon and 20 of 35 samples about 57.1% in pre monsoon seasons recorded values beyond the BIS standards. The content of Mg spreads between 7.8 and 85.2 mg/L, and 0.0 to 8.0 mg/L averaging 31.9 and 31.7 mg/L during post- monsoon and pre-monsoon, respectively represented in the table 1 and table 2. The geochemistry of the rock types may have an influence in the concentration of Mg in groundwater.

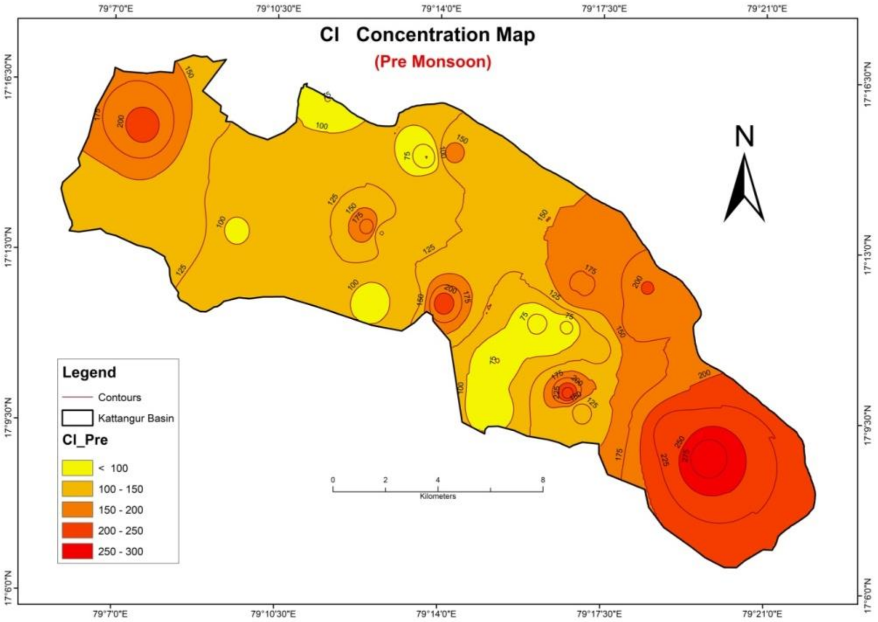
Sodium and potassium

Na is one of the important naturally occurring cations and its concentration in fresh waters is generally lower than that of Ca and Mg. But in the present investigation, the average concentration of Na is comparatively higher than that of Ca and Mg. For aesthetic reason, the guideline value given by WHO is 200 mg/L. Comparatively higher values were recorded in pre monsoon with thevalues range between 41.5 and 275.2mg/L and 27 and 182 mg/L in post monsoon with the averages of 101 and 95 mg/L, respectively.

Relatively potassium higher values were recorded in pre monsoon with the values range between 0.9 and 58.0 mg/L and 0.84 and 54 mg/L in post monsoon with the averages of 20.6 and 21 mg/L, respectively (table 1 and table 2). Though, most of the source rocks contain approximately equal amounts of Na and K, and both are released during weathering, a part of the K go into clay structure and thereby its concentration gets reduced in water. Potassium contamination in groundwater can result from the application of inorganic fertilizer at greater than agronomic rates. Loss of nutrients, including K, from agricultural land have been identified as one of the main causative factors in reducing water quality in many parts of arid and semi-arid regions (WHO, 2004; Jalali 2005; Kolahchi and Jalali 2006).

Chloride (Cl)

The principal sources of chloride are animal organic matter, sewage from drainages and refuse. The usage of huge fertilizer for paddy cultivation also plays a vital role as the source of chloride. The maximum permissible limit for Cl (Fig. 10 & 11) in drinking water is 250–1,000 mg/L (WHO, 2004). Minimum 49.4 mg/L and maximum 247.3 mg/L and average 142.3 mg/L in the pre- monsoon and 47.8 mg/L to 298.8 mg/L and an average of 142.9 mg/L in the post monsoon (Table 1 and 2).



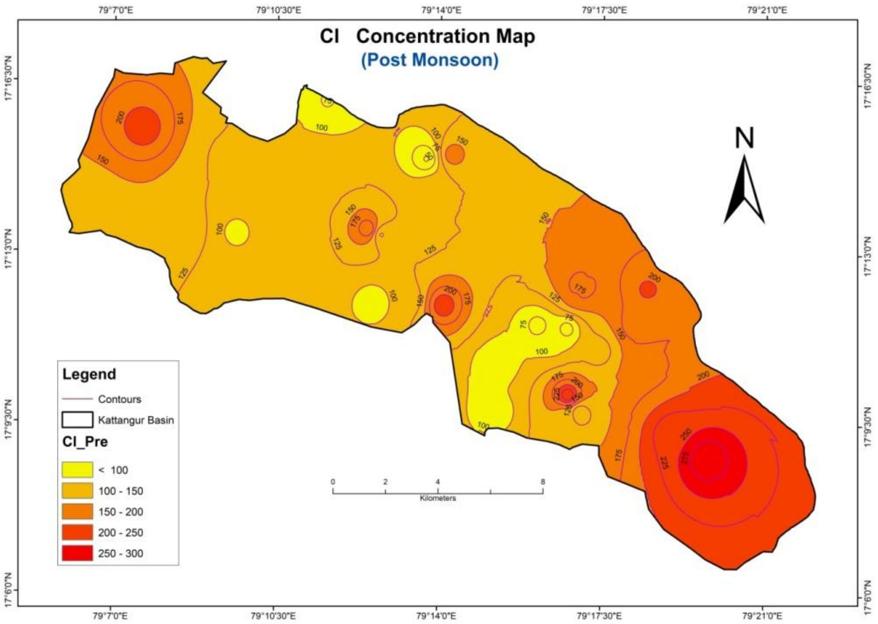


Fig. 10 and Fig. 11Variation of chlorides for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

Water quality for irrigation

Water quality for irrigation refers to its suitability for agricultural use. The concentration and composition of dissolved constituents in water can be determined to know its quality for irrigation use. Quality of water is an important consideration in any appraisal of salinity or alkalinity conditions in an irrigated area. Good quality of water (good soil and water management practices) can promote maximum crop yield. The suitability of water for irrigation depends upon TDS (salinity) and the sodium content in relation to the amounts of calcium and magnesium or SAR (Alagbe, 2006). The suitability of ground- water for irrigation use was evaluated by calculating salinity (EC), total hardness (TH) and major ions.

Classification of groundwater on salinity (EC)

Salinization is one of the most prolific adverse environmental impacts associated with irrigation. Salinity problem encountered in irrigated agriculture are most likely to arise where drainage is poor. The electrical conductivity (EC) of the groundwater in the study area varies from 593 to 1592 with an average 1027 µs /cm and 593-1589 with an average 1028.9 µs /cm in pre monsoon and post monsoon, respectively (Tables 1,2). Based on the EC, the groundwater of study area has been classified into four classes (Handa 1969) (Table 5). The total concentration of soluble salts in irrigation water can be expressed as low (EC = <250 µs/cm), medium (250–750 µs / cm), high (750–2,250 µs /cm), and very high (> 2250 µs/cm) and classified as C1, C2, C3 and C4 salinity zones, respectively (Richards 1954; Singh et al. 2011). While a high salt concentration (high EC) in water leads to formation of saline soil and a high sodium concentration leads to development of an alkaline soil. In Wilcox diagram, the EC is taken as salinity hazard and SAR as alkalinity hazard, shows low alkalinity hazard (S1) and Low-Medium salinity hazard (C1–C2) for majority of groundwater samples from both seasons. However one sample was spread over the S4-C4 which represents very high salinity to very high alkalinity. It seems that there is a gradual increase in both alkalinity and salinity characters from the groundwater samples during pre- to post-monsoon periods due to long term precipitation and water rock interaction in space and time (Figure 12).

Gibbs diagram

The Gibbs summarized in (1970) surface water chemistry, according to gibbs, the diagram represents the evaporation, precipitation and water and rock interaction. All these things influenced clearly scatter plot where sodium/ (calcium + sodium) ratios on x-axis are plotted against the TDS (salinity) on y-axis for and chlorides/(chlorides + bicarbonates, Fig. 13) on the x axis and TDS on y- axis (Fig. 14 & 15) in the two diagram s of the study area were plotted in the rock dominance filed. This indicates the rock- water interaction dominance field interaction between rock chemistry and chemistry of the infiltrated or percolated water under the subsurface.

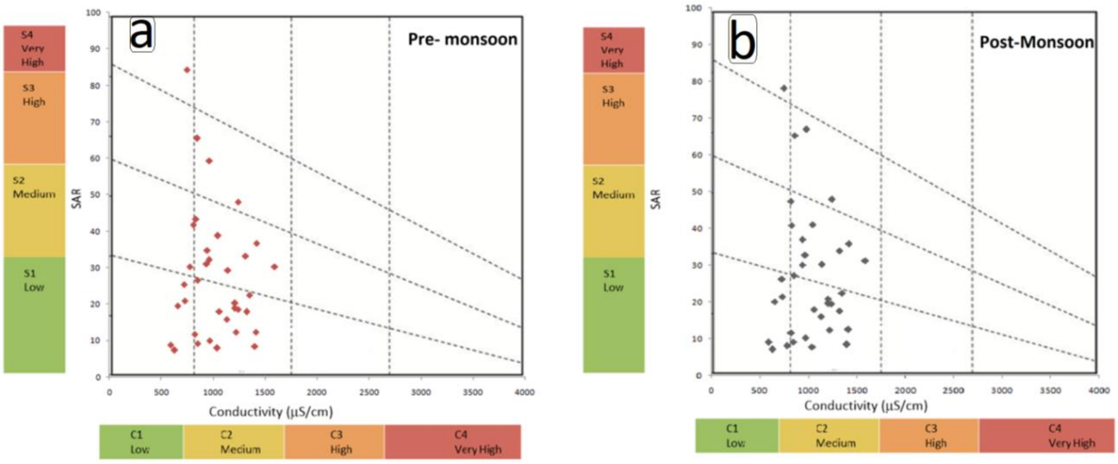


Fig. 12 Wilcox diagram for Pre-monsoon (a) (October 2020) and post-monsoon (b) (April 2021) in the study area

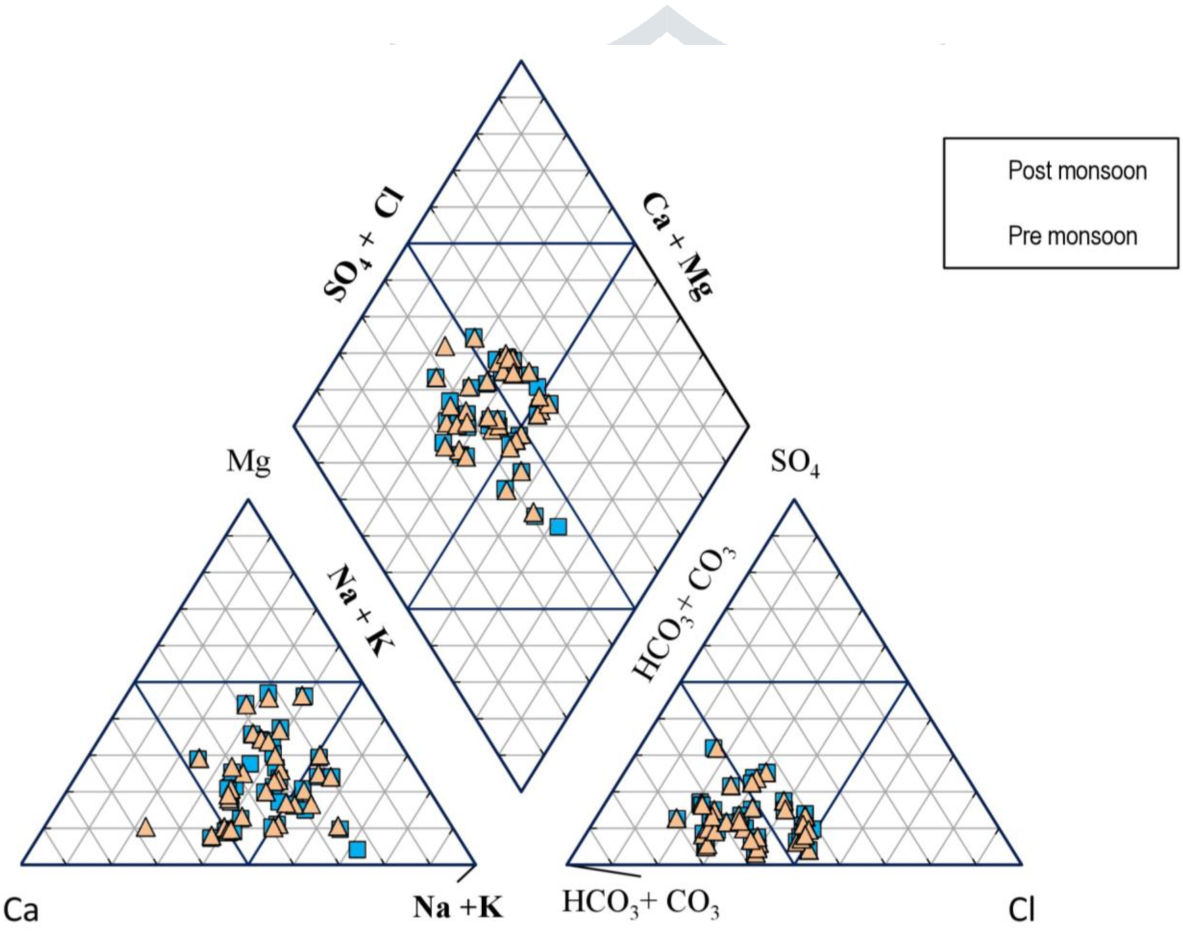


Fig. 13 Piper diagram for Pre-monsoon (October 2020) and post-monsoon (April 2021) in the study area

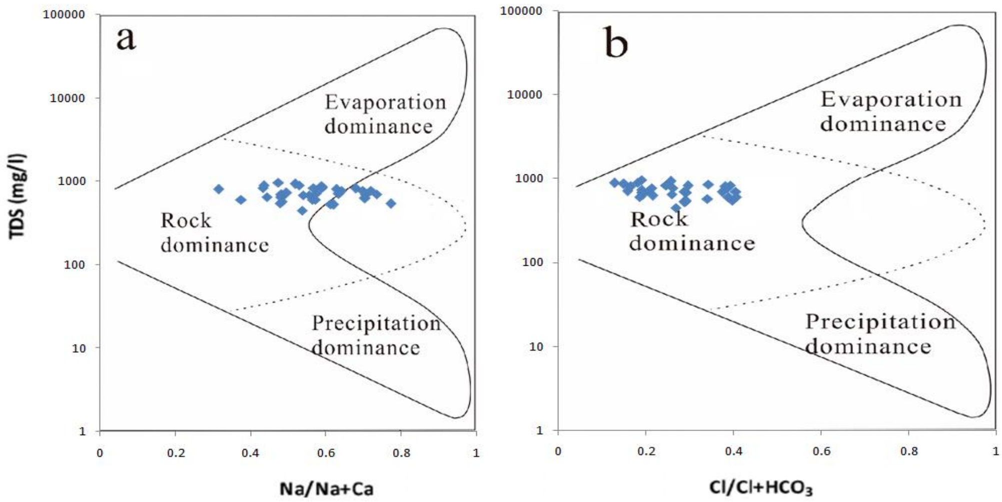


Fig. 14 Gibbs diagram for Pre-monsoon (October 2020) in the study area

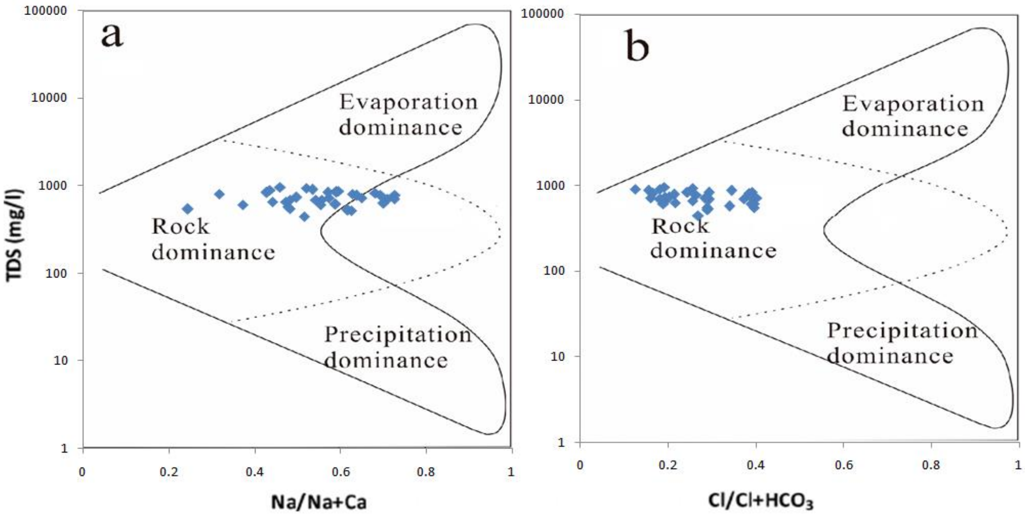


Fig. 15 Gibbs diagram for Post- monsoon (October 2020) in the study area

Table 1 Water level and physico-chemical analyses of groundwater samples of study area collected during Post monsoon mg/l

Pre monsoon	pH	EC	TDS	Na	K	Ca	Mg	CO_3	HCO_3	Cl	SO_4	F	TH
1	6.2	968	529.5	73.5	1.4	46.4	24.4	2	560.1	225.1	26.5	1.5	224.3
2	6.7	1039	693.2	63.4	0.93	68.2	20.3	3	499.6	297.8	54	1.4	280.2
3	7.6	1219	824.4	94.4	2.09	44.7	20.4	3	394.6	165.9	184	1.4	219.8
4	6.5	629	447.2	48.4	1.21	41.8	19.6	1	536.7	197.1	124.2	1.4	184.3
5	6.4	825	527.3	94.4	1.5	57.9	26.5	1	496.9	203.1	44.1	1	216.6
6	6.6	776	539.5	275.2	8.6	81.4	8.6	1	426	174.7	28.7	1.4	229.4
7	6.7	851	645.2	87.6	1.1	94.3	11.2	2	456.5	108.5	25.5	1.6	310.1
8	6.3	593	546.5	85.4	0.86	93.5	10.4	1	374.8	247.2	27	1.6	349.5
9	7.4	1129	964.1	68.6	11.4	76.1	23.5	3	566.3	133.7	112.2	1.5	424.7
10	7.6	1059	769.5	115.5	3.6	64.8	60.7	2	210	74.6	85.6	1.4	304.3
11	6.3	1411	931.3	62.3	2.7	58.2	54.5	1	249.1	86	91.4	1.7	239.1
12	6.6	1321	901	75.4	9.5	67.3	46.5	1	370.5	81.6	38.5	1.7	264.3
13	7.5	1241	865.1	101.1	11.6	70.6	12.4	2	336.8	59.3	165.6	1.6	280.2
14	6.3	1401	579.1	62.7	2.09	67.3	15.5	2	330.4	170.5	105.5	1.7	240.1
15	6.5	1204	839.6	95.4	10.6	66.7	25.6	2	341.7	220.6	86.4	1.6	164.4
16	6.7	1349	655.5	66.8	22.1	84.3	31.7	1	335.6	117.2	48	1.6	270.7
17	6.6	1210	730.1	126	17.6	128.4	21.7	0	519.9	122.6	38.6	1.5	325.5
18	6.3	1141	685.1	148.2	21.1	118.3	81.5	0	210.1	49.4	25.1	1.4	160.6
19	6.5	1311	720.5	62.2	20.1	46.2	59.6	2	288.6	74.7	35.1	1.4	320.2
20	6.1	1242	780.6	124.7	30.9	48.4	43.6	2	413.3	112.5	133	1.6	238.1
21	5.9	1592	834.2	180	32	137.2	21.7	0	377.1	122.7	73	1.6	245.3
22	6.3	1419	806.4	171	36	101.2	32.5	3.5	342.6	212	47	1.4	222.5
23	6.1	1045	704.8	128	25	53.1	34.2	6.5	194.2	132	56	1.4	185.4
24	5.8	958	688.5	122.2	36	104.2	34.5	5	329.8	136.2	37	1.2	187.4
25	6.2	964	700.5	123	39	44.5	33	8	234.7	94.4	22.4	1.4	267.8
26	6.2	833	604.2	127	48	98.2	72.7	1	428.7	98.2	71	1.6	309.5
27	6.3	747	778.5	103	58	44.5	85.2	1	310	194	62	1.4	216.7
28	6.2	810	711.4	85.6	31	49.3	15	0	429.5	80.7	93.5	1.4	229.9
29	6.8	943	609.4	99	34	74.5	22.5	0	240.1	164	45	1.6	198.3
30	6.2	848	629.4	100	45	42.1	10	0	374.5	102.8	57.6	2.1	314
31	6.4	935	833.6	98	50	128.3	14.5	0	335.5	109.9	56	1.4	429.2
32	6.6	850	599.8	78	45	130.3	10.6	0	384.6	245	56	1.2	206.4
33	6.3	730	890	65	21	84.5	24.3	3	430.5	63.3	62.4	1.3	415.2
34	6.5	660	802.5	41.5	22	90.3	34	2	536.6	106.5	112	1.2	616.3
35	6.6	720	861.3	110.4	17	76.6	48.1	2	378.2	197.5	100.9	1.5	346.7
Min	**5.8**	**593.0**	**447.2**	**41.5**	**0.9**	**41.8**	**8.6**	**0.0**	**194.2**	**49.4**	**22.4**	**1.0**	**160.6**
Max	**7.6**	**1592.0**	**964.1**	**275.2**	**58.0**	**137.2**	**85.2**	**8.0**	**566.3**	**297.8**	**184.0**	**2.1**	**616.3**
Avg	**6.5**	**1027.8**	**720.8**	**101.8**	**20.6**	**76.7**	**31.7**	**1.8**	**378.4**	**142.3**	**69.5**	**1.5**	**275.3**

Table 2 Water level and physico-chemical analyses of groundwater samples of study area collected during Pre monsoon (mg/l)

S.No. Post monsoon	pH	EC	TDS	Na	K	Ca	Mg	CO_3	HCO^3	Cl	SO_4	F	TH
1	6.3	972	519.6	74.4	1.49	44.6	23.4	2	559.4	227.6	25.6	1.3	227.4
2	6.2	1039	692.2	63.5	0.84	68.3	18.2	3	501.5	298.8	54.2	1.4	279.2
3	7.4	1219	824.2	93.4	2.11	43.7	19.6	3	396.4	164.5	184.4	1.5	219.7
4	6.3	629	445.3	47.4	1.25	44.6	17.6	0	538.6	198.2	129.4	1.5	187.4
5	6.2	824	526.3	93.3	1.5	57.9	25.7	0	498.8	205.1	43	1.4	214.6
6	6.3	781	539.5	27	7.8	83.3	7.8	1	428	174.7	27.8	1.6	229.4
7	6.5	848	647.4	86.4	1	96	12	2	456.4	108.6	27.5	1.8	311
8	6.1	593	546.5	87.5	0.86	93.6	10.4	0	376.8	247.3	27	1.7	351.4
9	7.6	1128	959.2	65.5	12.3	77	22.4	3	568.3	135.6	113	1.5	427.6
10	7.7	1059	771.6	115.6	3.6	65.8	59.7	0	210	75.5	84.6	1.6	306.3
11	6.4	1412	929.4	63.4	2.7	58.3	54.6	1	249.2	86	92.4	1.8	239.2
12	6.5	1319	898	77.3	8.8	67.4	47.4	2	372.6	82.6	37.5	1.6	264.2
13	7.7	1239	866.3	102.1	12.6	70.6	12.7	1	337.6	62.4	167.6	1.7	279.4
14	6.5	1398	570.1	61.6	2.12	67.4	16.4	2	331.5	171.5	106.5	1.6	242.3
15	6.3	1207	839.7	94.4	11.2	65.4	27.6	0	342.7	221.2	87.1	1.6	167.5
16	6.7	1349	654.2	65.8	21.5	83.3	33.7	1	337.2	116.4	47.6	1.5	269.6
17	6.3	1203	729.3	126.2	18.5	127.3	22.8	0	518.6	124.6	34.8	1.6	324.4
18	6.6	1139	687	147	23	117.4	82.2	0	213	47.8	26	1.5	166.5
19	6.2	1319	723.4	63.2	21.2	47.2	57.8	2	290.2	73.6	34	1.4	319.4
20	6.4	1242	782.6	125	29.8	47	44.7	2	416.3	113.2	135.6	1.5	240
21	6.2	1589	833.3	182	34	137.3	21.8	0	379.4	121.4	73.2	1.2	247.3
22	6.6	1417	807.2	171.2	34.2	101.2	32.1	3	342.6	214	44	1.5	224.4
23	6.2	1045	707.6	130	27	53.1	36.4	6	196.4	132.4	54	1.5	184.4
24	6.4	966	683.4	125	37	105.2	35.5	6	331.2	137.4	38	1.5	187.8
25	6.6	978	704.5	126	48	47.5	35	8	238.4	94.6	24.4	1.6	263.6
26	6.4	829	608.2	126	45	101.4	72.4	1	419.4	98.2	71.4	1.6	304.4
27	6.3	747	775.6	103	54	45.6	85.2	1	312	196	64	1.5	214.8
28	6.6	822	717.4	86	34	46.4	16.8	0	430.5	82.6	92.5	1.4	232.5
29	6.4	938	612.4	101	35	70.6	21.8	0	249.4	164	45	1.6	202.4
30	6.4	860	627.6	101.4	46	43.4	11.2	0	375.5	103.8	58.6	2.2	314.8
31	6.2	940	834.4	97	48	129.3	15.5	0	336.5	108.7	57	1.5	430.2
32	6.5	851	598.8	77	46	129.3	11.6	0	385.6	246	57	1.4	205.4
33	6.4	732	895	66	22	85.5	22.3	3	431.5	62.3	63.4	1.4	416.4
34	6.2	650	801.5	42.5	22.8	91.3	35	2	535.6	106.4	112.8	1.5	617.3
35	6.4	728	865.4	111.4	18	75.6	47.1	2	376.2	198.5	102.4	1.5	346.8
Min	**6.1**	**593**	**445.3**	**27**	**0.84**	**43.4**	**7.8**	**0**	**196.4**	**47.8**	**24.4**	**1.2**	**166.5**
Max	**7.7**	**1589.0**	**959.2**	**182.0**	**54.0**	**137.3**	**85.2**	**8.0**	**568.3**	**298.8**	**184.4**	**2.2**	**617.3**
Avg	**6.5**	**1028.9**	**720.7**	**95.0**	**21.0**	**76.8**	**31.9**	**1.6**	**379.5**	**142.9**	**69.8**	**1.5**	**276.0**

Table 3 Quality of groundwater samples from Nalgonda study area for drinking purpose (BIS, 2012 standards)

Parameter	Desirable limit	Pre monsoon		Post monsoon	
		Within limits	Exceed limits	Within limits	Exceed limits
pH	6.5–8.5	16	19	13	22
EC	300 (lmhos/cm)		35		35
TDS	500 (mg/L)	1	34	1	34
Total hardness	200 (mg/L)	6	29	5	30
So_4	200 (mg/L)	35	0	35	0
F	1.0 (mg/L)	1	34	0	35
Ca	75 (mg/L)	19	16	35	0
Mg	30 (mg/L)	20	15	20	15
Na	200 (mg/L)	34	1	35	0

Conclusion

The major ion concentration of the ground water samples are within the permissible limits of BIS and WHO standards during the pre monsoon and post monsoon for the drinking purposes. 15 samples fall in the C1S1 range, indicating the low conductivity and low salinity, 16 samples fall in the C2S2 category, showing the medium conductivity and medium salinity, 3 samples belongs to the C2S3 category, 1 sample fall in the C2S4 category which is medium conductivity and high salinity. Only one sample is exceeded the permissible limit of fluoride in the research area. All the samples were within the limits. The data is concluded that the Kattangur watershed ground water is maximum suitable for drinking and irrigation purposes.

References

Alagbe SA (2006) Preliminary evaluation of hydrochemistry of the Kalambain Formation, Sokoto Basin, Nigeria. Environ Geol 51:39–45

Anjaneyulu M, K. Nagaraju, and I. Panduranga Reddy (2019) Petrological and Gochemical studies of Precambrian granitoids from Kattangur area, Nalgonda District Telangana State India Journal of Applied Geochemistry Vol. 21, No 3 (2019). pp. 311-316.

Anjaneyulu M, M. Narsimha Reddy and I. Panduranga Reddy (2017) Petrological And Geochemical Studies Of Precambrian Granitoids From Kattangur and Nakrekal area of Nalgonda District, Telangana, India. Journal of Applied Geochemistry Vol. 19, No. 3 (2017). pp. 263-269.

Anjaneyulu M, M. Narsimha Reddy and I. Panduranga Reddy (2018) Petrological and Geochemical Studies of Mafic Rocks from the Kattangur- Nakrekal Area of the Nalgonda District Telangana State India Journal of Applied Geochemistry Vol. 20, No. 3 (2018). pp. 275-286.

APHA (1995) Standard methods for the examination of water and waste water, 19th edn. APHA, Washington DC

Appelo CAJ, Postma D (2005) Geochemistry, groundwater and pollution, 2nd edn. Balkema publishers, Leiden, p 404

BIS (2012) Specifications for drinking water IS: 10500:1991, Bureau of Indian Standards, New Delhi. In the soils of Tallinn (Estonia). Environ Geoche Health 22:173–193

Brown E, Skougstand MW, Fishman MJ (1970) Methods for collection and analyses of water samples for dissolved minerals and gases. In: Techniques of Water Resources Investigation of the US Geological Survey 5

Carpenter SR, Caraco NF, Correll DL, Howarth RW, Sharpley AN, Smith VH (1998) Non point of surface waters with phosphorous and nitrogen. Ecol Appl 8(3):559–568

CGWB 2013 Central Ground Water Board Ministry of Water Resources Government of India Ground Water Brochure Nalgonda District, Andhra Pradesh (CGWB 2013).

Domenico PA, Schwartz FW (1990) Physical and chemical hydrology. Wiley, New York

Doneen LD (1964) Notes on water quality in agriculture. Published as a water science and engineering paper 4001, Department of Water Science and Engineering, University of California

Eaton FM (1950) Significance of carbonates in irrigation waters. Soil Sci 69:123–133

Gibbs RJ (1970) Mechanism controlling world water chemistry. Science 170:795–840

Handa BK (1969) Description and classification of media for hydrogeochemical investigations. In: Symposium on groundwater studies in arid and semi-arid region. Roorkee

Jalali M (2005) Nitrates leaching from agricultural land in Hamadan, western Iran. Agric Ecosyst Environ 110:210–218

Jac van der Gun, in Global Groundwater, 2021

Jarvie HP, Whitton BA, Neal C (1998) Nitrogen and phosphorous in east coast British rivers: Speciation, sources and biological significant. Science Total Environ pp 210–211, 79–109. (World Acad Sci Eng Technol 52 2009 482)

Karanth KR (1987) Ground water assessment, development and management. Tata McGraw Hill Publishing Company Ltd., New Delhi, p 720

Kolahchi Z, Jalali M (2006) Effect of water quality on the leaching of potassium from sandy soil. J Arid Environ 68:624–639

Naik PK, Awasthi AK, Anand AVSS, Behera PN (2009) Hydrogeochemistry of the Koyna River basin, India. Environ Earth Sci 59(3):613–629

Piper AM (1944) A graphical procedure in the geochemical interpretation of water analysis. Trans Am Geophys Union 25:914–9

Purushotham D, Prakash MR, Rao AN (2011) Groundwater depletion and quality deterioration due to environmental impacts in Maheshwaram watershed of R.R. District, AP (India). Environ Earth Sci 62(8):1707–1721

Rao PM, Sekhar P, Yadav YS (2004) Water Quality Studies on Kolleru Lake and Its Infalling Drains of A.P., India. In: Kumar Arvind (ed) Water pollution. APH Publishing Corporation, New Delhi, p 171

Richards LA (ed) (1954) Diagnosis and improvement of saline and alkali soils. In: USDA Handbook no. 60, Washington, pp 160

Shivran HS, Dinesh Kumar D, Singh RV (2006) Improvement of water quality though biological denitrification. J Environ Sci Eng 48(1):57–60

Simeonov V, Stratis JA, Samara C, Zachariadis G, Voutsa D, Anthemidis A, Sofoniou M, Kouimtzis TH (2003) Assessment of the surface water quality in Northern Greece. Water Res 37:4119–4124

Todd DK (1980) Groundwater Hydrology, 2nd edn. Wiley, New York, p 535

Todd DK (2001) Groundwater hydrology. Wiley, Canada, pp 280–281

USDA (1954) Diagnosis and improvement of saline and alkali soils. U.S. Salinity Laboratory Staff, Government Printing Office, Washington, DC.

V. Satish Kumar B. Amarender Ratnakar Dhakate S. Sankaran K. Raj Kumar (2016) Assessment of groundwater quality for drinking and irrigation use in shallow hard rock aquifer of Pudunagaram, Palakkad District Kerala DOI 10.1007/s13201-014-0214-6 Appl Water Sci (2016) 6:149–167

Walton WC (1970) Groundwater resources evaluation. McGraw-Hill Book Co., New York

WHO (2011) Guidelines to drinking water quality. World Health Organisation, Geneva 186

Wilcox LV (1955) Classification and use of irrigation waters. US Department of Agriculture Circular 969, Washington, DC, p 19