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SPATIAL DISTRIBUTION OF GROUNDWATER QUALITY PARAMETERS IN AND AROUND NARAYANKHER, MEDAK DISTRICT, TELANGANA STATE

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ABSTRACT

Groundwater is the most important natural resource required for drinking to many people around the world, especially in rural areas. Groundwater now accounts for a major part of domestic and agricultural water supply, groundwater features geometry, natural recharge, storage, flow and discharge conditions, permeability characteristics and quality conditions. The resource cannot be optimally used and sustained unless the quality of groundwater is assessed. The study described here uses geographic information system (GIS) technology to map groundwater quality for drinking and construction, utilizing data generated from chemical analysis of water samples collected from the area under study. spatial distribution maps of pH, EC,TDS, Na^+ , $K^{+,}$ Ca^{2+} , Mg^{2+},TH , CO_3^{2-} HCO_3^- Cl, $NO_3^-$and SO_4^{2-} have been created. Form this map one can easily assess the quality of water present at various places of this area and also it helps in taking decision of what are the improvements that are to be made in the water usage and its quality. The physico-chemical results were compared to the standard guideline values as recommended by the World Health Organization (WHO) for drinking and public health in order to have an overview of the present groundwater quality.

KEY WORDS: GIS, Chemical analysis, Quality maps, pH, Sulfate content, Chlorides content, Total hardness, Sodium content, Carbonate hardness, Calcium content.

1. INTRODUCTION

As an important element of earth groundwater is required for human health, socioeconomic development and most importantly for ecosystem. In last few decades, there has been a tremendous increase in the demand for the fresh water due to rapid growth of population and their accelerated pace of industrialization [1]. The important of using safe water has become an international issue with the ever increasing of world population which eventually accelerates the water demand. This scares and fragile resource is under the risk of degradation in both quality and quantity in many parts of the world [2]. Large quantities of human and industries waste disposals pose serious threat to this valuable resource. Excessive pumping and unscientific management of aquifers are also responsible for deterioration of water quality. According to the report of WHO 80% of all the diseases in human being are caused by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source, therefore it becomes very important to regulate monitor the quality of groundwater and to device ways and means to protect it [3].

Groundwater is a valuable natural resource that is essential for human health, socio-economic development, and functioning of ecosystems [4, 5&6]. In India severe water scarcity is becoming common in several parts of the country, especially in arid and semi-arid regions. The overdependence on groundwater to meet ever-increasing demands of domestic, agriculture, and industry sectors has resulted in overexploitation of groundwater resources in several states such as Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh, Tamil Nadu, among others [7, 8&9]. Geographic information system (GIS) has emerged as a powerful tool for storing, analyzing, and displaying spatial data and using these data for decision making in several areas including engineering and environmental fields [10,11, 12 &13].

Groundwater can be optimally used and sustained only when the quantity and quality is properly assessed [14]. GIS has been used in the map classification of groundwater quality, based on correlating total dissolved solids (TDS) values with some aquifer characteristics [15] or land use and land cover [16]. Other studies have used GIS as a database system in order to prepare maps of water quality according to concentration values of different chemical constituents [17&18]. In such studies, GIS is utilized to locate groundwater quality zones suitable for different usages such as irrigation and domestic [18].

2. LOCATION OF THE STUDY AREA

Study area situated at distance of 120 kms from the Telangana state, capital of Hyderabad. The study area (Figure 1) in Medak district lies between North latitudes 18^0 2′ and East longitudes 77^0 46′ and is included in Survey of India topo sheet 56F/12 and 56F/16(Figure 2). It has an average elevation of 610 meters above mean sea level. The total study area is covered 343.47 Sq.km. The area comprises of several villages and major town is Narayankher, which is on Hyderabad-Nagpur high pass through the district.

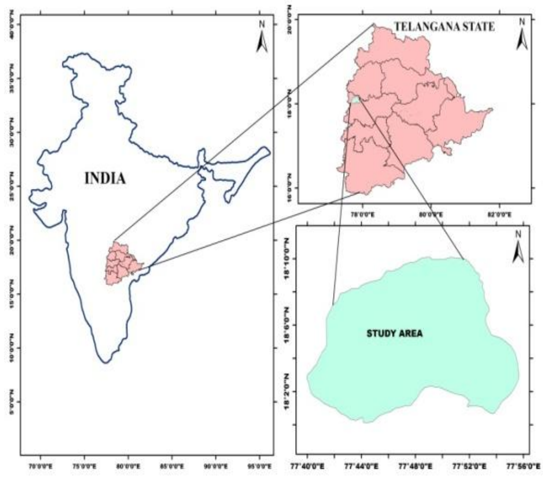

Figure 1. Location map of the study area

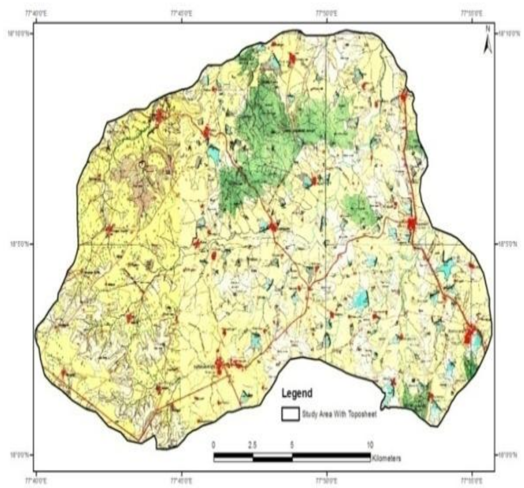

Figure2. Topographic map of the study area

3. SAMPLING AND ANALYTICAL METHODS

The proposed Narayankher, Medak of Telangana is taken as the area of interest in order to perform this water analysis as this is the developing area. One has very use by knowing the quality of water one requires the quality of water at that area. The area consists of places in and around Narayankher which is central part. Dependency on groundwater is currently very high and it is preferred for drinking purpose by large number of the population. Because of the inadequacy and concern over quality of tap water, ground water will continue to be a significant source of domestic water supply for this , so it is very important to know about the quality of water at this region as it is the very essential to survive. Forty-four groundwater samples were collected from bore wells, dug wells and hand pumps of the following villages Malkapur, Baddaram, Shankarampet, Kamalapuram, Venkatapura, Kamalapur ‘X’road, Tenkati, Nizampet, Bachupalli, Mirkampet, Raparthi, Ankampalle, Krishnapurm, Kanapur, Narayankher, Thimmapur villages are in Granitic terrain. Kajapur, Kadpol and Sirgapur villages are in Granites-Basalts contact Rakal, Thurkapalle, Kondapur, Mansurpur and Gadidi Hukran Villages are having Basalts. Abendda and Sheligera ‘X’ road villages are having Intratrappeans (Figure 2)**.** Using pre-cleaned sterilized poly propylene plastic bottles with necessary precautions, among which twenty two sample, are from granitic aquifer and twenty two samples are from basaltic aquifers (2 Lit. Capacity) and numbered sequentially.

Groundwater was collected after pumping the wells for 5–10 min and rinsing the bottles for two to three times with water to be sampled. For sample collection, preservation, and analysis, standard methods [19] were followed. The chemical analyses carried out for pH, electrical conductivity (EC), total dissolved salts (TDS), total hardness (TH) as well as sodium (Na+), calcium (Ca2+), potassium (K+), chloride (Cl-), sulphate (SO42-), nitrate (NO3-) and fluoride (F-) according to the standard methods (APHA, 2005). All the experiments were carried in triplicate. Using pH/EC/TDS meter (Hanna HI 9811-5), the EC and pH of water samples were measured in the field immediately after the collection of the samples. Total hardness (TH) as CaCO3 and Calcium (Ca2+) were analyzed titrimetrically, using standard EDTA. TDS were computed from EC multiplied by a factor (0.55–0.75), depending on relative concentrations of ions. Magnesium (Mg2+) was computed, talking the difference between TH and Ca2+ values. Carbonate (CO32-) and Bicarbonate (HCO3-) were estimated by titrating with H2SO4. Sodium (Na+) and Potassium (K+) were measured by flame photometer (Model-Mediflame 127). Chloride (Cl-) was estimated by standard AgNO3 titration. Sulphate (SO42-) was measured by Spectrophotometer (Model Spectronic 21). Nitrate (NO3-) and Fluoride were analyzed, using an Ion selective electrodes (Model-Orion 4 star). This method is applicable to the measurement of fluoride in drinking water in the concentration range of 0.01–1,000 mg/L. The electrode used was an Orion fluoride electrode, coupled to an Orion electrometer. The spatial distribution for groundwater quality parameters such as, pH, EC, TDS, TH, CO32-, HCO3-, SO42-, NO3-, Ca2+, Mg2+, Cl- and F- were done with the help of spatial analyst modules in Arc GIS 9.2 software.

4. RESULTS AND DISCUSSION

The analytical results for the water samples collected from the study area were shown in (Table 1). The minimum and maximum along with the averages are given in (Table 1a). Range in values of geochemical parameters in groundwater and WHO (2006) and Indian Standards (IS-10500; BIS 1991) for drinking water are shown in (Table 1b). Classification of groundwater for drinking based on EC (Table 2). Groundwater classifications of all groundwater on the basis of TDS and TH are presented in (Table 2a &2b). Sample locations of groundwater in the different aquifers are presented in (Figure 2) and topographic map of the study area is shown in (Figure 3). Spatial distribution maps of all physico-chemical concentration of groundwater are illustrated in (Figure 4 to 5).

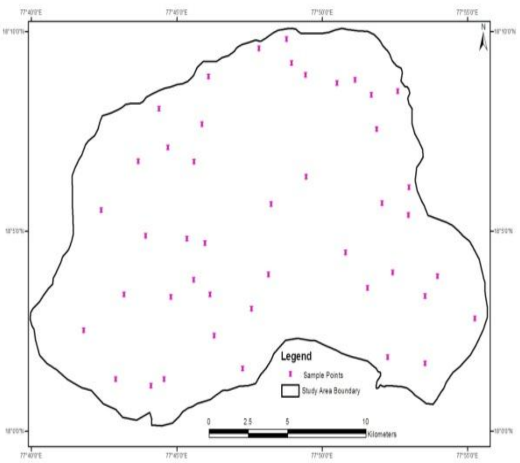

Figure 3. Groundwater sample location map of the Study Area

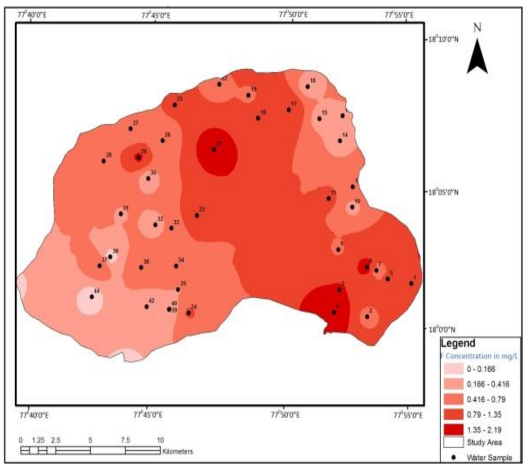

Figure 4. Spatial distribution of Fluoride (mg/L) in groundwater

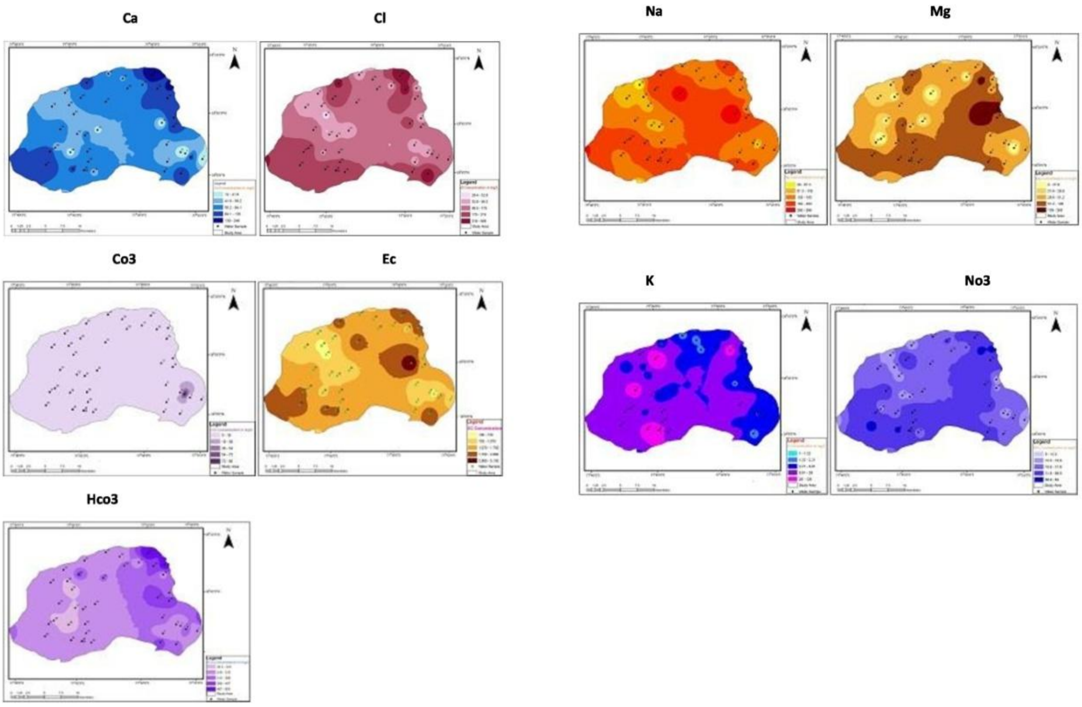

Figure 5. Ground water quality maps of Narayankher region

In the present investigation an attempt was made to evaluate and to map ground water quality of Narayankher region (Figure 5). Spatial distribution of ground water parameters was carried out through GIS. These groundwater quality maps are useful in assessing the usability of the water for different purposes. Moreover the maps are made in easily understood format using the GIS. It is shown that the majority of the samples presented .The pH of the groundwater in the granitic aquifers ranges from 6.79 to 7.87 with an average of 7.87 and the basaltic aquifers the pH ranges from 6.69 to 7.15 with an average of 7.58, which show that the groundwater quality is slightly acidic to slightly alkaline in nature, in majority of the samples, it is within the desirable limits of the WHO standards and Bureau of Indian Standards. EC of the groundwater is varying from 100 to 5100 µS/cm at 25ºC with an average value 938 µS/cm. The study area minimum value is observed granitic terrain is at Venkatapuram village with a value 300 µS/cm and a maximum value is observed at 5100 µS/cm at Nizampet village.

The range of TDS values in granitic and basaltic aquifers was found to be in the range of 186-3162 mg/L with an average of 974 mg/L and 62-2170 mg/L with an average of 1263 mg/L respectively (Table 1a). The lowest value is observed at Narayankher town and the highest concentration is observed at Nizampet. The concentration of TH was relatively high in eastern and north-eastern parts of the study area such as Nizampet (610 mg/L), Nizampet crossroad (660 mg/L), Raparthi (525 mg/L), Mirkampet (520 mg/L) and Sheliger (520 mg/L). Sodium, potassium, magnesium, Sulphate and calcium are within the permissible limit except few sampling locations. In excess of Cl^- in the water is usually taken as an index of pollution and considered as tracer for groundwater contamination. About 18% (Raparhi 568 mg/L; Malkapur 444 mg/L; Mirkampet 440 mg/L and Baddaram 369 mg/L) granitic aquifer and 26% (Narayankher 405 mg/L; Kajapur 369 mg/L; Kadpol 351 mg/L and Sheligera 266 mg/L) basaltic aquifer samples have chloride more than desirable limit. Nitrate concentration of groundwater samples varied from 8 to 80 mg/L with an average value of 34 mg/L in the granitic aquifer and from 8 to 84 mg/L with an average value of 33 mg/L in the basaltic aquifer. The high nitrate concentration (Sheligera 82 mg/L; Narayankher 84 mg/L; Mirkampet 80 mg/L; Baddaram 79 mg/L; Nizampet 75 mg/L; Kadpol 74 mg/ L; Timmapur 79 mg/L; Kodapur 73 mg/L and Mansurpur 46 mg/L) may occur due to leaching of NO_3^- from fertilizers and pesticides during the irrigation of agriculture land. From the above maps it is easily understood the quality scenario of the ground water distribution in our area. One can easily access the properties of water. It is seen that some of parameters are exceed in some of the regions in such regions the remedial measures may be taken in order to reduce the effect of the water.

5. CONCLUSIONS

The present study has been carried out to evaluate hydro chemical characteristics of groundwater of Narayankher area. To visualize the spatial distribution of groundwater quality in the study area, GIS has been applied. 44 samples were collected and analyzed for various physicochemical parameters. The chemical analysis were carried out for pH, electrical conductivity (EC), total dissolved salts (TDS), total hardness (TH) as well as sodium (Na+), calcium (Ca2+), potassium (K+), chloride (Cl-), sulphate (SO4-), nitrate (NO3-) and fluoride (F-) according to the standard methods (APHA, 2005). GIS has been applied to visualize the spatial distribution of groundwater quality in the study area. The pH of the groundwater in the granitic aquifers ranges from 6.79 to 7.87 with an average of 7.87 and the basaltic aquifers the pH ranges from 6.69 to 7.15 with an average of 7.58, which show that the groundwater quality is slightly acidic to slightly alkaline in nature, in majority of the samples, it is within the desirable limits of the WHO standards and Bureau of Indian Standards. EC of the groundwater is varying from 100 to 5100 μS/cm at 25ºC with an average value 938 μS/cm. The study area minimum value is observed granitic terrain is at Venkatapuram village with a value 300 μS/cm and a maximum value is observed at 5100 μS/cm at Nizampet village. This study shows the use of GIS integrated with analytical data and WQI to assess the groundwater quality. WQI helps us to understand the status of groundwater in the study area. It also helps us to understand whether the overall quality of groundwater body poses a potential threat to various uses of water. Regions of low groundwater quality should be targeted for more detailed investigation and to take immediate remedial measure. To safe grade the groundwater.

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Table 1. Major ion concentrations of water samples in the Narayankher, Medak District, Telangana State

Village	pH	EC µS/cm	TDS mg/L	Na^+ mg/L	K^+ mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	TH mg/L	CO_3^{2-} mg/L	HCO_3^- mg/L	Cl^- mg/L	NO_3^- mg/L	SO_4^{2-} mg/L
Shankarampet	7.59	740	459	99	2	20	48	150	0	195	67	8	4
Malkapur	6.99	2500	1550	177	1	120	51	405	0	317	444	24	15
Baddaram	7.46	650	403	67	2	38	24	145	0	226	46	14	6
Baddaram vill	6.81	1700	1054	198	9	72	111	410	0	421	369	79	23
Shankarampet	7	1400	868	151	2	100	0	250	0	366	153	26	11
Kamalapuram	7.22	1200	744	159	2	36	27	145	0	476	131	16	7
Venkatapuram	7.87	300	186	54	2	14	22	80	90	305	124	11	5
Kamalapuram	7.39	900	558	125	2	32	39	160	0	201	32	13	10
Tenkati	7	400	248	154	37	48	41	205	0	366	53	41	16
Nizampet	6.96	1000	620	187	5	110	48	375	0	421	142	12	17
Nizampet	6.89	5100	3162	596	1	24	265	610	0	415	213	75	17
Nizampet	7.35	1030	639	92	2	148	140	660	0	311	50	8	7
Bachupalli	6.98	2500	1550	160	1	160	39	480	0	598	43	75	20
Bachupalli	7.14	1400	868	91	1	72	36	255	0	275	156	38	10
Mirkampet	6.79	800	496	160	53	90	142	520	0	366	440	80	23
Raparthi	6.88	3000	1860	191	2	246	36	525	0	653	568	71	25
Raparthi	7.22	1000	620	101	1	54	7	150	0	256	43	17	10
Ankampalli	7.06	1400	868	138	1	64	43	250	0	329	181	23	12
Kishnapura	7.19	1300	806	150	1	52	36	205	0	256	131	33	10
Kanapur.K	7.53	600	372	101	1	74	10	120	0	214	43	16	8
Kanapur	7.3	2300	1426	408	2	66	10	185	0	323	156	16	40
Kanapur Chrvuu	7.29	1100	682	109	1	54	39	215	0	275	53	27	13
Kajapur	7.25	900	558	151	2	38	14	125	0	275	67	16	8
Kajapur	7.3	1500	930	184	2	52	58	250	0	275	213	17	16
Kajapur Tank	7.07	2100	1302	294	1	102	82	425	0	305	369	9	18
Kadpol	6.8	700	434	306	94	88	63	350	0	397	351	74	21
Sirgapoor	7.46	700	434	50	2	50	24	175	0	214	36	8	6
Sirgapoor	7.21	700	434	72	1	40	24	150	0	214	67	15	8
Momya Tanda	7.22	600	372	80	2	44	12	75	0	207	50	12	10
Jamla Tanda	7.39	600	372	75	1	42	53	215	0	159	28	10	7
Rekhal Tanda	6.9	1300	806	114	54	68	17	135	0	293	117	44	8
Thurkpally	7.58	700	434	88	7	38	87	275	0	189	50	10	8
Thurkaplly	7.29	900	558	76	1	64	19	200	0	250	96	14	7
kondapur	7.17	1000	620	123	1	58	111	375	0	238	85	73	8
Mansurpur	7.03	1500	930	185	3	76	53	300	0	287	192	46	9
Gadidi Hukran	7.55	800	496	169	2	30	51	180	0	73	78	17	8
Abbanda	7.08	2100	1302	185	38	110	22	320	0	360	266	62	20
Abbanda Dargga	7.39	1100	682	246	4	40	0	100	0	146	209	8	13
Narayankher	6.83	3500	2170	360	126	96	101	450	0	378	405	84	21
Narayankher	6.69	100	62	26	3	20	0	50	0	31	64	20	3
Narayankher	7.02	2300	1426	318	21	88	80	385	0	342	337	10	16
Thimmapur	6.98	1900	1178	167	35	94	75	390	0	293	238	79	18
Sheligera	7.29	800	496	58	1	50	27	180	0	281	231	17	5
Sheligera	6.95	2000	1240	133	6	140	82	520	0	287	266	82	17

Table 1a. Drinking water specifications of the study area minimum, maximum, and mean and stranded deviation ion concentration in different aquifers

Parameters	Granitic aquifers				Basaltic aquifers			
	Min	Max	Average	Standard Deviation	Min	Max	Average	Standard Deviation
pH	6.8	7.9	7.2	0.3	6.7	7.6	7.2	0.2
EC µS/cm	300.0	5100.0	1469.1	1080.6	100.0	3500.0	1263.6	781.7
TDS mg/L	186.0	3162.0	910.8	669.9	62.0	2170.0	783.5	484.6
TH mg/L	80.0	660.0	295.5	172.4	50.0	520.0	255.7	131.9
Ca^{2+} mg/L	14.0	246.5	77.2	54.6	20.0	140.3	65.0	30.6
Mg^{+} mg/L	0.0	265.3	55.1	60.5	0.0	111.0	47.9	33.7
Na^{+} mg/L	54.0	596.0	166.7	119.2	26.0	360.0	157.3	95.6
K^{+} mg/L	1.0	53.0	6.0	13.0	1.0	126.0	18.5	33.3
CO_3^{-} mg/L	0.0	90.0	4.1	19.2	0.0	0.0	0.0	0.0
HCO_3^{-} mg/L	195.2	652.7	343.8	119.1	30.5	396.5	249.5	91.7
Cl^{-} mg/L	32.0	568.0	165.4	152.7	28.4	404.7	173.5	121.4
SO_4^{2-} mg/L	4.0	40.0	14.0	8.4	3.0	21.0	11.6	5.7
NO_3^{-} mg/L	8.0	80.0	32.9	25.6	8.0	84.0	33.0	28.7
F^{-} mg/L	0.2	2.2	0.9	0.6	0.1	2.3	0.6	0.5

Table 1b. Statistical summary along with different official limits of drinking water quality

Water Quality Parameters	Units	BIS (1991)		WHO (2006)		Concentration in the study area	Percentage of samples exceeding HDL	Percentage of samples exceeding MPL
		Highest Desirable Limit (HDL)	Maximum Permissible Limit (MPL)	Highest Desirable Limit (HDL)	Maximum Permissible Limit (MPL)			
pH		6.5	8.5	7	8.5	6.69 - 7.87	-	-
EC	µS/cm	-	-	-	1500	100 - 5100	12	32
TDS	mg/L	500	2000	500	1500	62 - 3162	5	39
TH	mg/L	100	500	100	500	50 - 660	5	39
Ca^{2+}	mg/L	75	200	75	200	14 - 246	1	43
Mg^{+}	mg/L	30	100	30	150	00 - 265	1	43
Na^{+}	mg/L	100	-	-	200	26 - 596	7	37
K^{+}	mg/L	10	-	12	-	01 - 126	8	36
CO_3^{-}	mg/L	10	-	10	-	00 - 90	1	43
HCO_3^{-}	mg/L	300	-	-	-	31 - 653	19	25
Cl^{-}	mg/L	250	1000	200	600	28 - 568	-	44
SO_4^{2-}	mg/L	200	400	200	400	3 t0 40	-	-
NO_3^{-}	mg/L	45	-	45	-	8 to 84	12	32
F^{-}	mg/L	0.6	1	1	1.5	00 - 2.30	5	39

Table 2. Classification of groundwater for drinking based on EC

EC (µS/cm)	Classification	No. of samples	Percentage of samples
<750	Desirable	12	27
750 - 1500	Permissible	20	45
1500 - 3000	Not Permissible	9	22
>3000	Hazardous	3	7

Table 2a. Groundwater classifications of all groundwater on the basis of TDS [20 &21]

TDS (mg/L)	Classification	Percentage of samples	
		Granitic region	Basaltic region
<500	Desirable for drinking	27	41
500 - 1000	Permissible for drinking	45	32
1000 - 3000	Useful for irrigation	23	27
>3000	Unfit for drinking and irrigation	5	Nil
Total		**100**	**100**
<1000	Fresh water	72	73
1000 -10,000	Brackish water	28	27
10,000 -100,000	Saline water	Nil	Nil
>100,000	Brine water	Nil	Nil
Total		**100**	**100**

Table 2b. Groundwater classification based on total hardness (TH) [22]

TH (mg/L)	Classification	Percentage of samples	
		Granitic region	Basaltic region
<75	Safe	Nil	5
75 - 150	Moderately high	22	23
150 - 300	Hard	32	37
>300	Very Hard	46	35
Total		**100**	**100**