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An Investigation of Groundwater Quality for Drinking Purposes using hydro-Chemical Parameters in and around Sandur Taluka, Bellary District, India

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ABSTRACT

The destruction of groundwater quantity and quality due to anthropogenic activities is increasing atdistressing rate in most portions of the northern Karnataka Sandur taluka. Limited research works have been carried out on the ground water quality and analysis. In the present paper highlighted on the ground water quality and compare the quality with respect to drinking and agricultural purposes in the Sandur region a northern part of Karnataka. In Sandur region most of the formers are depending upon the ground for drinking and agricultural practices also they are using pesticides and fertilizers. The summary of the analytical results and the statistical measures such as minimum, maximum, mean and standard deviation are also discussed for March 2015 and February 2017. Total fifty ground water samples were collected and analysed for all cations, anions and other physicochemical parameters. Analytical results are compared with the drinking and agricultural purposes. Results are indicated majority of the ground water samples were above the permissible limit of Indian standards. The groundwater of the Sandur region was very hard and the relative richness of major cations and anions. In the entire study period fluoride content was higher than permissible (1.0 mg/L) limit in 52 %. According to this study, the ground water in and around Sandur region all the water samples were supersaturated with respect to carbonate minerals, the present work concludes all most all the ground water samples were not suitable for drinking uses in the study area. Hence the authors are recommended to carry out continuous monitoring program and effective development management practices for utilization of most important a biotic natural resources.

Keywords : Hydro-Chemical, Ground Water, Total Hardness, TDS

I. INTRODUCTION

Water is a vital abiotic component in socio-economic life of community. In rural areas, during summer epically in villages face the scarcity of drinking water. The usage of ground water for unscientifically for agricultural and industrial purpose has further serious problem and the situation, impact on the quality and quantity of ground water. The communities are suffering from a critical scarcity of drinking water due to excessive prescription of trace metals, anion and cations (Annouara, et al., 2004). According to WHO, in India 50% of diseases are due to polluted water means water borne and every year about 35% of the people and children are die either by shortage of water and use of polluted water.

The environmental conditions and geographical conditions may highly impact on the quality of ground water. The ground water tables is also related to sources, regular withdrawal, overgrazing changes the quality of ground water some of the researches resets the quality of ground water (Damodarkumar, et al., 2008; Venkatesh, et al., 2010; Suresh, B, et al., 2011 and Tamailarasi, et al., (2015).

Day by day due to human activity urbanization and development in industrial activity throughout the world and lotic and lentic water availability is becoming scarce. Currently lack of lotic and lentic water availability are depending and exploiting to meet the demand of various purposes. Distribution and quality of ground wateris deteriorating becauseof the local geologic set-up and anthropogenic factors, including that for human consumption.

Groundwater contains numerous types of pollutants and several other constituents are dissolved in it. Concentration of which is useful for human body but in a specific limit. The study was conducted to know the anion, cation and other physico-chemical properties of ground water and in different seasons and its impact on human life.The present investigationwas carried to investigate the groundwater quality in and around Sandur region of Bellary district, Karnataka State.

II. METHODS AND MATERIAL

Study Area

The present study is carried out at Sandur area of Bellary district, Karnataka which is geographically bounded by 15° 10' and 15°50' north latitude and 76° 55' and 76° 61' east longitude covering an area of above 565 meters (Figure 1). Sandur and its surrounding village's places of natural beauty with lush green mountains, valleys, deep gorges and most of the villages are depending upon the ground water for their daily needs. The Sandur town located to the south of Hosapete. It located on the southern edge of the original Vijayanagara metropolitan area. Sanduru Taluka has deposits of manganese ore and hematite (iron ore), and is home to several mines and steel plants in and around the taluka. Study area receives 750mm of elevation but has seen more than 1000mm of rainfall. As per 2011 census the population of the study area is 37,431. The location map of the study area are given in Figure 1. The details longitude and latitude of the selected ground water locations are given in Table 1.

Methodology

To study the quality in and around the Sandur region, total number of 50 groundwater samples were collected inpreviously soaked in 10 % nitric acid (HNO3) for 24 hand rinsed with deionized water 5L colored polythene cans from different locations for the period of two years from March 2015 to February 2017. Before collecting the water samples, the ground water was pumpedoutfrom bore wells for about 15minutestoremove stagnant groundwater. All the ground water samples were transported to laboratory and kept for 40C until used for further analysis. The physical parameters measured and recorded in the field are colour, taste, odour, temperature (Thermometer), EC (using conductivity meter) and pH (using pH meter). Groundwater samples collected were colorless, odorless but were very spiteful to taste. As far as water temperature is concerned there was not much difference between the groundwater and that of air temperature in a limited samples wherein the temperature varied between 10C and 20C. The physicochemical parameters have been analyzed by volumetric like total hardness, calcium and chloride (APHA, 2005). Sulphates were measured using spectrophotometer and sodium and potassium was measured using flame photometer.

III. RESULTS AND DISCUSSION

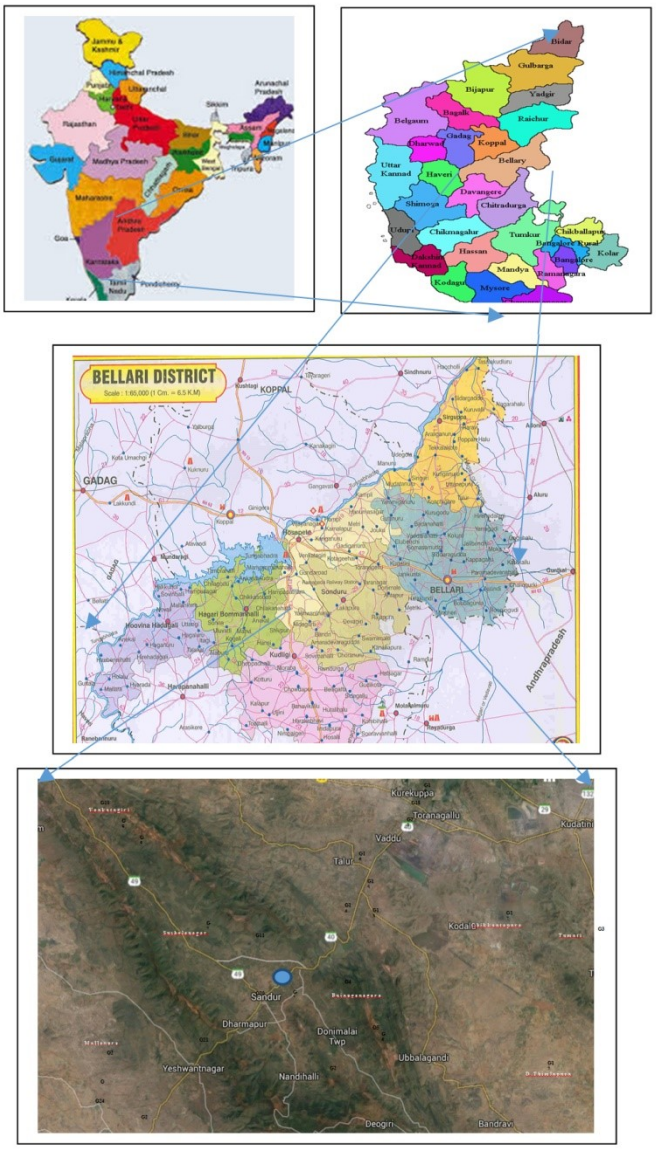

Figure 1. Location Map of the Study Area Showing Ground Water Sampling locations

Assessment of physical and chemical characteristics of ground water is essential for the suitability of water for drinking, agricultural, industrial and household uses. The summary of the analytical results and the statistical measures such as minimum, maximum, mean and standard deviation is given in Table 2 for March 2015 and February 2017. Standards have been laid down by various agencies such as a World health organization, U.S. Environmental protection agency, Bureau of Indian standard and ICMR for drinking water quality for various uses. The results of the physico-chemical analysis of water samples are shown in table 2. The temperature was measured at spot, the mean temperature of ground water samples ranged from 24 to 37ºC. The highest temperature was recorded in

the month of July (second year analysis) and the lowest temperature was recorded in the month of January (first year analysis). All the ground water samples were colourless, odourless and clear.

Table 1: Physico-chemical parameters of bore well (BW) and hand pump (HP) of Sandur taluk, Bellary district

Sample No	Village	Location	Water
S1	Laxmipura	Outside village	15.10 Lati, 76.48 Longi
S2	Nandihalli	near school	15.11 Lati, 76.48 Longi
S3	Tumati	Down the village	15.10 Lati, 76.48 Longi
S4	Bujanganagara	Near bus station	15.11 Lati, 76.48 Longi
S5	Narasingapura	bus stop circle	15.10 Lati, 76.48 Longi
S6	RanaJIthpura	near school	15.12 Lati, 76.48 Longi
S7	Susheelanagara	Hospet road side	15.10 Lati, 76.47 Longi
S8	Siddapura	near devi temple	15.12 Lati, 76.48 Longi
S9	Jaisingpura	outside	15.12 Lati, 76.48 Longi
S10	Venkatagiri	near Anjaiani temple	15.12 Lati, 76.48 Longi
S11	Dowlatpura	near masjid	15.10 Lati, 76.50 Longi
S12	D.Thimmalapura	Outside village	15.04 Lati, 76.49 Longi
S13	Taranagara	near halla	15.12 Lati, 76.50 Longi
S14	Muraripura	Near Doni	15.11 Lati, 76.50 Longi
S15	V-Nagalpura	Behind the Govt. school	15.11 Lati, 76.50 Longi
S16	Taluru	Govtschcool	15.11 Lati, 76.51 Longi
S17	Chikkantapura	road side irrigation land	15.12 Lati, 76.53 Longi
S18	S-Basapura	near bus stand	15.11 Lati, 76.52 Longi
S19	Kurekuppa	Road side	15.11 Lati, 76.52 Longi
S20	Dharmapura	Ashryaya colony	15.11 Lati, 76.52 Longi
S21	Yashavantanagara	kudligi road side	15.04 Lati, 76.49 Longi
S22	Nidagurthi	beside the pond	15.03 Lati, 76.48 Longi
S23	72-Mallapura	near Govt. school	15.03 Lati, 76.48 Longi
S24	Katinakamba	near bus stand	15.02 Lati, 76.47 Longi
S25	Bandri	inside vasavi temple	15.02 Lati, 76.47 Longi
S26	Ankamnal	mallapur road	15.30 Lati, 76.55Longi
S27	D-Mallapura	Near tank	15.21 Lati, 76.58 Longi
S28	Hiralu	near pakkiradevru temple	15.20 Lati, 76.61Longi
S29	Thippanamaradi	Near angannavadi	15.31 Lati, 76.60Longi
S30	Tyagadalu	village entrance	15.30 Lati, 76.42Longi
S31	Kalingeri	Choranur Roadside	15.42 Lati, 76.49Longi
S32	Sovenahalli	near gramapanchyati	15.40 Lati, 76.51Longi
S33	Agrahara	near water tank	15.48Lati, 76.54Longi
S34	Sulthanpura	Road side water tank	15.50Lati, 76.38Longi
S35	Mallarahalli	road side	15.31 Lati, 76.39Longi
S36	S.Lakkalahalli	Roadside arriculture land	15.28Lati, 76.40 Longi
S37	Genethikatte	chornur road side	15.24 Lati, 76.39 Longi
S38	Nallabande	near minwater tank	15.20Lati, 76.30 Longi
S39	Hosavaddanakatte	road side	15.18Lati, 76.32Longi
S40	Choranuru	near water tank	15.12Lati, 76.20Longi
S41	Bommagatta	near hulikunteshwara temple	15.18Lati, 76.29Longi
S42	Bannihatti	near anganavadi	15.22Lati, 76.33 Longi
S43	Lingadahalli	ubbalgundi road side	15.26Lati, 76.42 Longi
S44	Ubbalagundi	outside village	15.31 Lati, 76.32 Longi
S45	Rajapura	near chappardahalli	15.36Lati, 76.50Longi
S46	Metriki	near bus stand	15.44 Lati, 76.39 Longi
S47	Vittalapura	beside govt. school	15.42Lati, 76.38 Longi
S48	Anthapura	Havinamadagu road	15.46Lati, 76.42Longi
S49	Sandur	Shanbogar street	15.37Lati, 76.44Longi
S50	Kodalu	outside village	15.29Lati, 76.51Longi

Mean Ca concentration found in our study were higher than those reported previously in Muktsar groundwater by Kumar et al. (2009) while mean Mg concentration were found to be lower in this study. Total alkalinity in water is mainly caused due to OH, CO_3, HCO_3 ions. Bicarbonates represent prevailing anion during the study period followed by sulfates and chloride. A similar observations were made by Thakur et al. (2016) in parts of Punjab which showed that HCO_3 as the dominant anion in the region.

In the present study, among the studied parameters total hardness and alkalinity was found to be much higher than the permissible limits as prescribed by BIS and WHO standard. Especially, hardness of ground water mainly depends upon the amount of calcium or magnesium along with their carbonates, sulfates and chlorides. Based on Total hardness classification of groundwater almost all the ground water samples were found to be very hard and unfit for drinking purposes. Analytical results, revealed that the total hardness reported in our study was higher as compared to their studies (Sharma 2012). The soil texture in the region was predominantly calcareous which may be the possible reason of hardness in water. The order of abundance of the major cations and anions in both the seasons are indicated in the study area (Kumar et al., 2007). In the present study, with reference to sodium and potassium does not have any prescribed limits for drinking water but the high levels of sodium in drinking water makes it salty in nature. During the study period, 100 % of ground water samples were found to exceed the desirable limit of Ca^{2+} for drinking water (75 mg/L). In the entire study, the average value of calcium ion was 198.26 mg/L in 2016-17 in S26 location, with maximum value of 1172.23 mg/L observed in sample S18 during 2015-16. The average value of magnesium was 176.75 mg/L during 2016-17 at S30 ground water sample which was more as compared to the mean value (146.01 mg/L) in 2015-16.
Nearly about 60% of ground water samples are indicating Chloride content above the permissible limits with some 38.6 % samples in 2015-16 and 42.5 % samples during 2016-17 showed higher concentration of chloride than desirable limit (250 mg/L) set by BIS for drinking water which may be due to the use of inorganic fertilizers and irrigation drainage.

As far as nitrate contamination is concerned, except S47 all the ground water samples phosphate in entire study was note more than 0.26 mg/L. Presence of phosphates in groundwater may be attributed to natural minerals or through pollution by application of fertilizer, sewage and industrial waste (Alemu, et al. 2015). In the present study 0.25 in S24 ground water this may be due to interpretation of sewage and other agricultural activity.

Table 2. Statistical summary of the physico-chemical parameters of underground water samples collected from the Sandur Region

Ground water Quality Parameters	WHO standards (2004)		Indian Standards (BIS-1991)		Range (March 2015- February 2016)				Number of Samples above the desirable limits (BIS)	Number of Samples above the permissible limits (BIS)	Range (March 2016 - February 2017)				Number of Samples above the desirable limits (BIS)	Number of Samples above the permissible limits (BIS)
	Max desirable Limit	Max permissible limit	Max desirable Limit	Max permissible limit	Max	Min	Mean	Std. Dev			Max	Min	Mean	Std. Dev		
pH	7.0 – 8.5	6.2 – 9.2	6.5 – 8.5	-	7.47	6.68	7.09	0.16	-	-	7.45	6.66	7.07	0.16	-	-
EC	-	400	-	-	4871.98	754.13	1984.11	942.87	23	27	4611.39	629.28	1818.71	911.79	26	24
TDS	100	500	300	600	2224.34	154.09	758.07	417.31	23	27	1478.93	198.26	576.39	303.16	26	24
TA	75	200	75	200	1172.23	93.71	394.61	417.31	40	10	932.82	124.69	363.53	190.71	38	22
TH	30	150	30	100	176.75	122.68	394.61	219.62	12	38	146.01	192.32	56.89	29.60	10	40
Ca^{2+}	200	600	250	1000	995.60	39.82	218.14	204.37	10	40	1109.97	44.40	243.21	227.85	12	38
Mg^{2+}	-	-	200	600	299.53	86.53	166.78	37.10	12	38	296.39	83.39	163.64	37.10	12	38
Cl^-	200	600	2500	1000	995.60	39.82	218.14	204.37	50	-	1100.00	44.40	243.21	227.85	38	12
F^-	1.0	1.5	1.0	1.9	1.61	0.78	1.02	0.19	42	08	1.49	0.69	0.92	0.18	50	-
SO_4^{2-}	200	400	200	400	174.88	50.69	82.77	23.63	50	-	170.36	49.38	80.63	23.02	50	-
NO_3^-	45	-	45	-	45.72	7.41	21.05	8.56	48	02	50.68	8.21	23.33	9.48	46	04
PO_4^{2-}	-	-	-	-	0.90	0.02	0.11	0.17	-	-	0.26	0.01	0.03	0.05	-	-
Na^+	-	200	-	200	331.12	27.21	105.56	76.58	41	09	300.85	24.72	95.91	69.58	40	10
K^+	-	12	-	-	12.15	1.01	2.39	1.70	48	02	11.78	0.92	2.26	1.66	50	-
Fe	0.3	1.0	-	-	1.66	0.34	0.81	0.24	41	09	1.81	0.23	0.73	0.30	40	10

Note: All parameters are expressed in mg/L except pH, EC: Micro/simen and Turbidity: NTU

Table 3. Classification of Groundwater samples of the study area on the basis of Total hardness and TDS

Parameters	Range	Water Class	No of Samples	
			2015 – 2016	2016 - 2017
Total Hardness (TH) mg/L	Soft	0 – 60	Nil	Nil
	Moderate hard	61 – 120	Nil	Nil
	Hard	120 – 180	Nil	Nil
	Very Hard	>180	50	50
Total Dissolved Solids, mg/L	< 1000	No saline	30	27
	1000 – 3000	Slightly Saline	20	23
	3000 – 10000	Moderately Saline	Nil	Nil
	> 10000	Very saline	Nil	Nil

Table 4 Correlation matrix of Physico-chemical parameters of Ground water during (March 2015 – February 2016)

Parameters	pH	EC	TDS	TA	TH	Ca^{2+}	Mg^{2+}	Cl^-	F^-	SO_4^{2-}	NO_3^-	PO_4^{2-}	Na^+	K^+	Fe
pH	1.000	-0.603(**)	-0.591(**)	-0.195	-0.613(**)	-0.588(**)	-0.645(**)	-0.570(**)	0.058	-0.037	0.073	-0.048	-0.151	-0.190	-0.202
EC	-0.603(**)	1.000	0.962(**)	0.417(**)	0.941(**)	0.941(**)	0.910(**)	0.951(**)	0.094	0.108	-0.034	-0.029	0.593(**)	0.350(*)	0.072
TDS	-0.591(**)	0.962(**)	1.000	0.369(**)	0.990(**)	0.992(**)	0.897(**)	0.951(**)	0.132	0.127	-0.079	0.009	0.596(**)	0.323(*)	0.152
TA	-0.195	0.417(**)	0.369(**)	1.000	0.381(**)	0.371(**)	0.482(**)	0.253	0.239	0.179	0.028	-0.252	0.088	0.055	0.094
TH	-0.613(**)	0.941(**)	0.990(**)	0.381(**)	1.000	0.990(**)	0.909(**)	0.938(**)	0.163	0.130	-0.103	0.003	0.540(**)	0.273	0.186
Ca^{2+}	-0.588(**)	0.941(**)	0.992(**)	0.371(**)	0.990(**)	1.000	0.877(**)	0.941(**)	0.156	0.136	-0.112	0.033	0.567(**)	0.272	0.173
Mg^{2+}	-0.645(**)	0.910(**)	0.897(**)	0.482(**)	0.909(**)	0.877(**)	1.000	0.871(**)	0.093	0.030	-0.185	-0.091	0.423(**)	0.260	0.080
Cl^-	-0.045	0.233	0.221	0.074	0.200	0.221	0.162	0.272	0.160	-0.070	-0.011	-0.107	0.218	0.234	0.041
F^-	0.112	0.043	0.056	0.096	0.067	0.043	0.099	0.046	0.299(*)	0.127	0.133	0.050	-0.008	0.079	0.004
SO_4^{2-}	-0.079	0.380(**)	0.327(*)	0.496(**)	0.320(*)	0.320(*)	0.293(*)	0.297(*)	0.156	0.261	0.116	-0.061	0.208	0.219	-0.110
NO_3^-	-0.570(**)	0.951(**)	0.951(**)	0.253	0.938(**)	0.941(**)	0.871(**)	1.000	0.140	0.081	-0.069	0.055	0.583(**)	0.271	0.129
PO_4^{2-}	0.058	0.094	0.132	0.239	0.163	0.156	0.093	0.140	1.000	0.002	-0.156	-0.005	-0.010	-0.103	-0.035
Na^+	-0.037	0.108	0.127	0.179	0.130	0.136	0.030	0.081	0.002	1.000	0.275	0.039	0.153	0.207	0.408(**)
K^+	0.073	-0.034	-0.079	0.028	-0.103	-0.112	-0.185	-0.069	-0.156	0.275	1.000	-0.131	0.042	0.247	0.079
Fe	-0.048	-0.029	0.009	-0.252	0.003	0.033	-0.091	0.055	-0.005	0.039	-0.131	1.000	-0.086	-0.026	-0.116

Table 5 Correlation matrix of Physico-chemical parameters of Ground water during (March 2016 – February 2017)

Parameters	pH	EC	TDS	TA	TH	Ca^{2+}	Mg^{2+}	Cl^-	F^-	SO_4^{2-}	NO_3^-	PO_4^{2-}	Na^+	K^+	Fe
pH	1.000	-0.608(**)	-0.608(**)	-0.192	-0.605(**)	-0.606(**)	-0.607(**)	-0.576(**)	0.058	-0.033	0.075	-0.079	-0.158	-0.191	-0.198
EC	-0.608(**)	1.000	1.000(**)	0.417(**)	0.994(**)	0.995(**)	0.998(**)	0.951(**)	0.092	0.108	-0.034	-0.005	0.593(**)	0.350(*)	0.073
TDS	-0.608(**)	1.000(**)	1.000	0.417(**)	0.994(**)	0.995(**)	0.998(**)	0.951(**)	0.092	0.108	-0.034	-0.005	0.593(**)	0.350(*)	0.073
TA	-0.192	0.417(**)	0.417(**)	1.000	0.405(**)	0.406(**)	0.410(**)	0.253	0.237	0.179	0.028	-0.239	0.088	0.054	0.088
TH	-0.605(**)	0.994(**)	0.994(**)	0.405(**)	1.000	1.000(**)	0.999(**)	0.959(**)	0.110	0.117	-0.054	0.010	0.597(**)	0.339(*)	0.105
Ca^{2+}	-0.606(**)	0.995(**)	0.995(**)	0.406(**)	1.000(**)	1.000	1.000(**)	0.959(**)	0.109	0.116	-0.053	0.009	0.597(**)	0.340(*)	0.103
Mg^{2+}	-0.607(**)	0.998(**)	0.998(**)	0.410(**)	0.999(**)	1.000(**)	1.000	0.958(**)	0.104	0.114	-0.047	0.005	0.596(**)	0.343(*)	0.094
Cl^-	-0.046	0.234	0.234	0.075	0.233	0.233	0.233	0.272	0.159	-0.071	-0.011	-0.135	0.218	0.234	0.041
F^-	-0.027	0.227	0.227	0.143	0.226	0.226	0.227	0.267	0.248	-0.080	-0.048	-0.151	0.202	0.176	0.065
SO_4^{2-}	-0.068	0.310(*)	0.310(*)	0.219	0.306(*)	0.306(*)	0.308(*)	0.335(*)	0.226	-0.011	0.008	-0.153	0.254	0.240	0.044
NO_3^-	-0.576(**)	0.951(**)	0.951(**)	0.253	0.959(**)	0.959(**)	0.958(**)	1.000	0.139	0.081	-0.069	0.070	0.582(**)	0.271	0.135
PO_4^{2-}	0.058	0.092	0.092	0.237	0.110	0.109	0.104	0.139	1.000	0.002	-0.159	-0.008	-0.011	-0.104	-0.036
Na^+	-0.033	0.108	0.108	0.179	0.117	0.116	0.114	0.081	0.002	1.000	0.275	0.053	0.153	0.207	0.417(**)
K^+	0.075	-0.034	-0.034	0.028	-0.054	-0.053	-0.047	-0.069	-0.159	0.275	1.000	-0.148	0.042	0.247	0.077
Fe	-0.079	-0.005	-0.005	-0.239	0.010	0.009	0.005	0.070	-0.008	0.053	-0.148	1.000	-0.070	-0.041	-0.070

Note: ** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

IV. Correlation Analysis

In the present study total 15 different physic-chemical parameters were selected for descriptive statsics and correlation study. The correlation results are varies from year to year but most of the parameters are showing same trends of correlation relationship in the study area. In 2015-16, a strong correlation between EC–TDS (r = 0.962), EC–NO3- (r = 0.951), EC–TH & Ca2+ (r = 0.941), EC–TA (r = 0.417), EC– Mg2+ (r = 0.910), TDS– Mg2+ (r = 0.897), TDS– NO3 (r = 0.951). In the present study there is no significant correlation with Chloride and other parameters. From the present study during 2015-16 suggested that presence of TH, calcium, magnesium, nitrate and Total hardness greatly influence the TDS and EC.

V. CONCLUSION

The observation of physic-chemical parameters in ground water samples of the study area in parts of Sandur region, Bellary district Karnataka State (India) reveals that the groundwater is highly contaminated except for a few locations. The majority of ground water samples were found to be beyond desirable limits as prescribed by WHO standards and Indian standards for drinking water. Samples from almost all the locations were classified as hard and contained high TDS which indicate its unsuitability for drinking. A wide variation in EC and TDS is observed in samples during both the seasons indicating the influence of climatic factors including rock water interaction as well as anthropogenic activities, such as increase in pumping, excessive use of fertilizers, and discharge of industrial effluents on the water chemistry of the study area.

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