RESEARCH ARTICLE OPEN ACCESS

A Study on Physico-Chemical Characteristics of Borewell Water In Sugar Town, Mandya City, Karnataka State, India

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Abstract

Groundwater is a natural resource for drinking water .In addition to the population growth, urbanization and industrialization also extend the demand of water. Providing safe drinking water supply to the ever growing urban and sub-urban population is going to be a challenge to the civil authorities, city planners, policy makers and environmentalists.

Groundwater is a major source of drinking water in both urban and rural areas of Mandya. Mandya city is rapidly raising population, changing lifestyle and intense competition among users- agriculture, industry and domestic sectors is driving the groundwater table lower. Besides, discharge of untreated wastewater through bores and leachate from unscientific disposal of solid wastes also contaminate groundwater, thereby reducing quality of fresh water resources.

The present work is aimed at assessing the water quality index for the ground water samples of Sugar town, Mandya city. The groundwater samples of about 40 samples were collected and subjected for a comprehensive physicochemical analysis. The purposes of this investigation are to provide an overview of present ground water quality for the following 12 parameters such as pH, total hardness, calcium, magnesium, chloride, nitrate, sulphate, total dissolved solids, iron, fluoride, alkalinity are to be considered for calculating the WQI. The results are analyzed by WQI method for predicting water quality. Water Quality Index (WQI) is a very useful and effective way for assessing the quality of water. WQI is a very useful tool for communicating the information on overall quality of water.

Keywords: Groundwater, Water quality standards, Water quality characteristics, Water quality index.

I. Introduction

Groundwater is used for domestic, industrial, water supply and irrigation all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. Human health is threatened by unsanitary conditions through open drain carrying and disposing wastewater into natural water bodies. Rapid urbanization, especially in developing countries like India, has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, especially in urban areas. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. WQI is defined as a rating, reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of groundwater for human consumption. The objective of the present work is to discuss the suitability of groundwater for human consumption based on computed, groundwater characteristics, quality assessment and water quality index values.

II. Materials and Methods

2.1 Description of the study area

Mandya district is lies between North latitude $12^0$13’ to $13^0$04’ and East longitudes $76^0$19’ to $77^0$20’ and is bounded on northwest by Hassan district, on the north and northeast by Tumkur district, on the east by Ramanagar district and south by Mysore and Chamarajnagar district. Total geographical area of the district is 4961 Sqkms. The city is situated at an elevation of 669.47 m above MSL.The district is divided into seven taluks coming under two subdivisions (Mandya and Pandavapura). The Mandya subdivision comprises Mandya, Maddur and Malavalli taluks. The Pandavapura subdivision comprises of Pandavapura, Srirangapattana, Nagamangala and K.R.Pet taluks.

2.2 Population growth and density

As per provisional reports of Census India, population of Mandya in 2011 is 1,37,735; of which male and female are 68,748 and 68,987 respectively. The sex ratio of Mandya city is 1003 per 1000 males. In education section, total literates in Mandya city are 105,938 of which 55,442 are males while 50,496 are females. Average literacy rate of Mandya city is 85.11 percent of which male and female literacy was 89.54 and 80.74 percent. Total children (0-6) in Mandya city are 13,269 as per figure from Census India report on 2011. There were 6,826 boys while 6,443 are girls. Child sex ratio of girls is 944 per 1000 boys. In Mandya city more than 99% of the population speaks Kannada.

Mandya City Municipality Council (CMC) is spread up to 17.03 Sq.km in which 1, 37,735 persons reside. The population density on an average in 8,629 per Sq.km which is thickly populated and the city is developing steadily; the projected population growth in the CMC is given in the Table2.1. Since the city is the district head quarter the floating population is moderate and works out to be 15000 per day. Table3.2 shows details of ward wise population distribution and there components, these details will be use full to design solid waste management system.

2.3 Geomorphology

The district is located in the southern maiden region of the state. The surface topography is in the form of undulating plain situated at an average elevation of 750- 900m above MSL. There are few sporadic out crops of rocks as hills and few fertile shallow valleys. In the south-eastern part of the district the Biligirirangana hill ranges extending from Mysore District tapers off here. In this portion Cauvery river breaks through the hill ranges and forms the famous Gaganachukki and Barachukki waterfalls. The Melukote range of hills fallen a broken series of conspicuous peaks, which reach the altitude of 1159m above MSL, 1064m above MSL, 1050m above MSL and 1046m above MSL.The Hulikere-Kartigatta hill range near S.R.Patna and bold rugged low peaks near Sindhugatta are also conspicuous. The general slope in the district is in southeast direction.

2.4 Groundwater sampling in the Study area

Careful planning and preparation of a groundwater- sampling trip was made to save time and help reduce the number of difficulties that commonly occur with fieldwork. Correct sampling procedure begins with thorough preparation in the office and laboratory before sample collection. Each sample bottle is to be thoroughly cleaned and protected from any contamination during sample collection, preservation, and shipment to assure a high quality sample. Filtering equipment is to be rinsed thoroughly to remove any mineral deposits in hoses or support container vessels. The sample containers and hoses for organic analyses are to be acid-washed and rinsed several times with deionised water. Grab sampling has been adopted to collect groundwater samples. 40 groundwater samples were collected in polythene containers of 2 litres capacity for chemical analysis after pumping out sufficient quantity of water from the source such that, the sample collected served as a representative sample. The samples thus collected were transported to the laboratory condition.

2.5 Analysis of Groundwater Samples

The groundwater quality was assessed by the analysis of chemical parameters such as pH, Electrical Conductivity, Total Dissolved Solids, Alkalinity, Chlorides, Total Hardness, Calcium Hardness, Nitrates, Sulphates, Iron and Fluorides. The Bureau of Indian Standards (BIS) for drinking water quality for various parameters is presented in the table 2.The analytical methods used to measure chemical parameters of groundwater samples collected from all the sampling stations are listed in the table 1.The water samples were analysed adopting standard methods in the Environmental Laboratory.

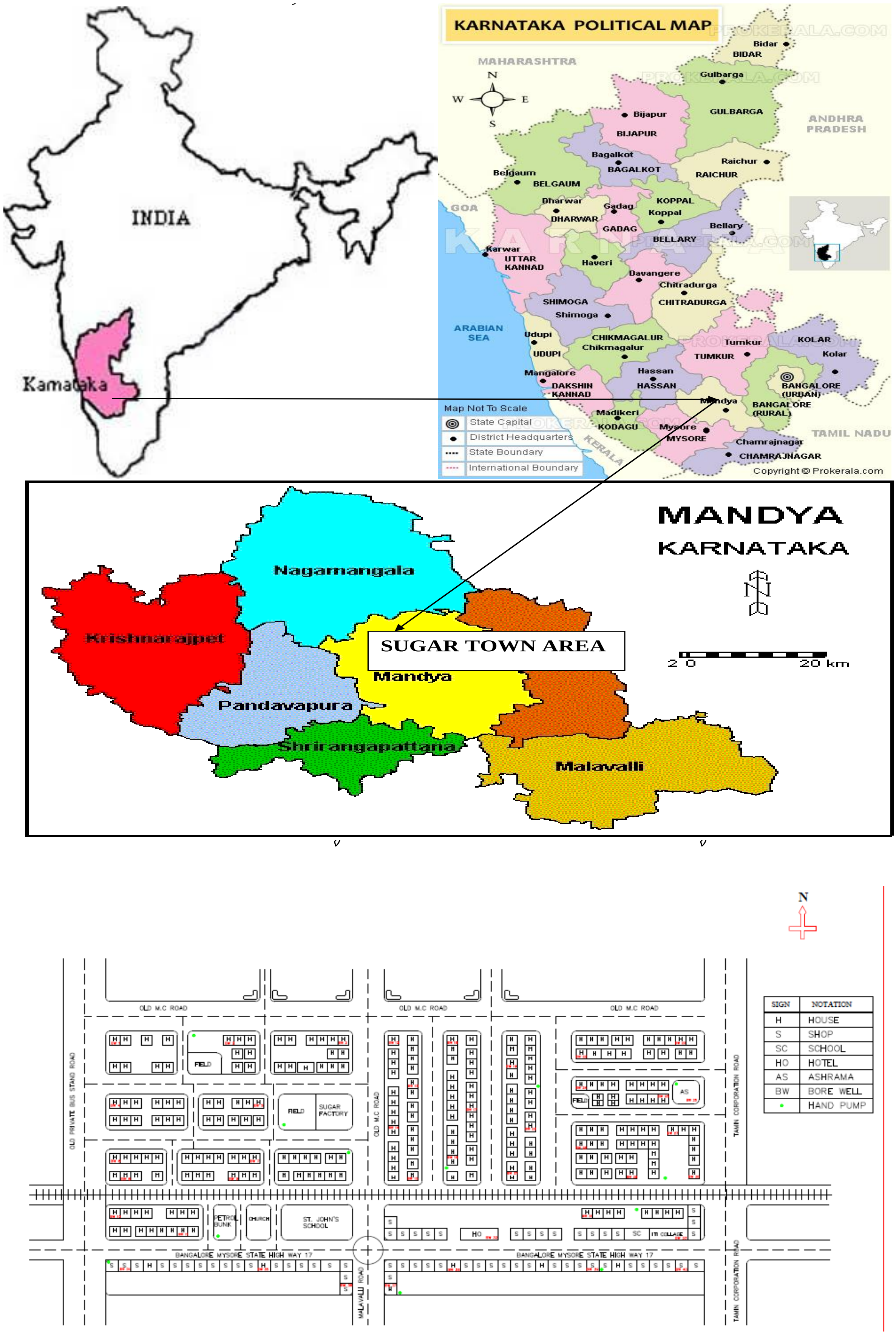

Figure 2.1: Layout of Sugar town area, Mandya city.

2.6 Physico-Chemical analysis of groundwater samples:

All the reagents used were of analytical grade and solutions were made of distilled water. Various water quality parameters such as alkalinity, hardness, chlorides etc., were determined using standard analytical methods and procedures (table-1). The instruments used were calibrated before use for observing readings. The repeated measurements were made to ensure precision and accuracy of results

Table 1: Methods Used for Groundwater analysis (Laboratory analytical methods)

Sl.N	Physico-chemical Parameters	Methods
1	pH	Potentiometry (pH meter)
2	Conductivity	Conductivity probe
3	Alkalinity	Argentometry (Titration)
4	Chloride	Argentometry (Titration)
5	Total Hardness	Complexometry by EDTA titration
6	Calcium	Argentometry (Titration)
7	Magnesium	Argentometry (Titration)
8	Total Dissolved Sol	TDS Probe
9	Fluoride	Ion Analyser
10	Iron	Spectrophotometry
11	Nitrate	Spectrophotometry
12	Sulphate	Spectrophotometry

Table 2: Bureau of Indian Standards (BIS) for drinking water (IS 10500: 2003)

Sl. No.	Characteristics	Desirable limit	Permissible limit
1	Colour, (Hazen units)	5	25
2	Odour	Unobjectionable	Unobjectionable
3	Taste	Agreeable	Agreeable
4	pH value	6.5-8.5	No relaxation
5	Total hardness (mg/l as $CaCO_3$)	300	600
6	Iron (Fe), mg/l	0.3	1.0
7	Manganese (Mn), mg/l	0.1	0.3
8	Chloride, mg/l	250	1000
9	Total dissolved solids, mg/l	500	2000
10	Calcium, mg/l	100	200
11	Sulphate, mg/l	200	400
12	Nitrate, mg/l	45	100
13	Fluoride, mg/l	-	1.5
14	Alkalinity, mg/l	200	600
15	Mercury, mg/l	0.001	-
16	Cadmium, mg/l	0.01	-
17	Lead, mg/l	0.05	-
18	Zinc, mg/l	5	15

III. Results and Discussions

In this chapter for the purpose of revealing the water quality of 40 bore wells of covering the study area have been established by determining the physical and chemical characteristics as per standard methods[4]. They have been listed systematically and represented in table2. The parameters viz., pH, total dissolved solids and Electrical conductivity know the physical characteristics of the ground water under the study area. The chemical characteristics of the ground water under the study area are known by the parameters viz., total hardness, calcium hardness, magnesium hardness, iron, fluoride, nitrate, chloride, sulfate, and alkalinity.

The **pH** of the groundwater samples are neutral or close to it as they all range from 6.45 to 7.89 which are within the permissible limits 6.5- 8.5 given by Indian Standards, also complies with standard 0f 7.0-8.0 given by WHO[17]. One of the main objectives in controlling pH is to produce water that minimizes corrosion or incrustation. These processes, which can cause considerable damage to the water supply systems, result from complex interactions between pH and other parameters, such as dissolved solids, dissolved gases, hardness, alkalinity, and temperature. The variation of pH in the study period is shown figure 3.1

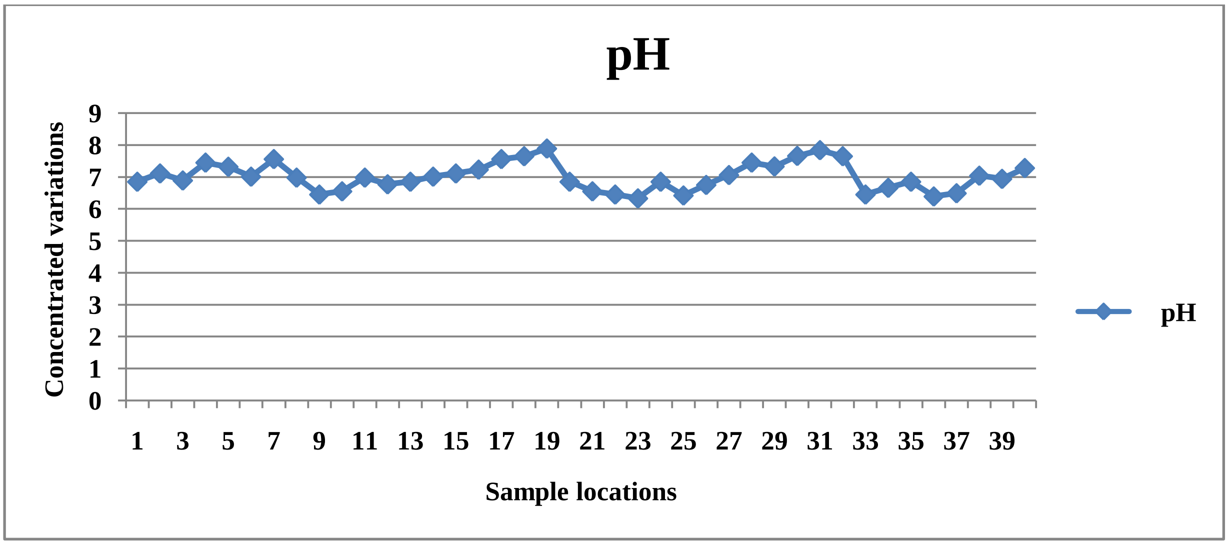

Figure 3.1: pH- Hydrogen ion concentration variations during the study period

The **Conductivity** of the groundwater in Sugar town, Mandya city ranges from 585-1109µs/cm. Conductivity itself is not a human or aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problems. Water with high mineral content tends to have higher conductivity, which is a general indication of high dissolved solid concentration of the water[10]. Therefore, conductivity measurements can be used as a quick way to locate potential water quality problems. The variation of Electrical conductivity in the study period is shown figure 3.

Total dissolved solids level in ground water is 359-665 mg/L which exceeds the permissible limit of 500 mg/L as per Indian standards and 1000 mg/l as per WHO Standards. The term total dissolved solids refer mainly to the inorganic substances that are dissolved in water. The effects of TDS on drinking water quality depend on the levels of its individual components; excessive hardness, taste, mineral depositions and corrosion are common properties of highly mineralized water.

The variation of total dissolved solids in the study period is shown figure 3.2.

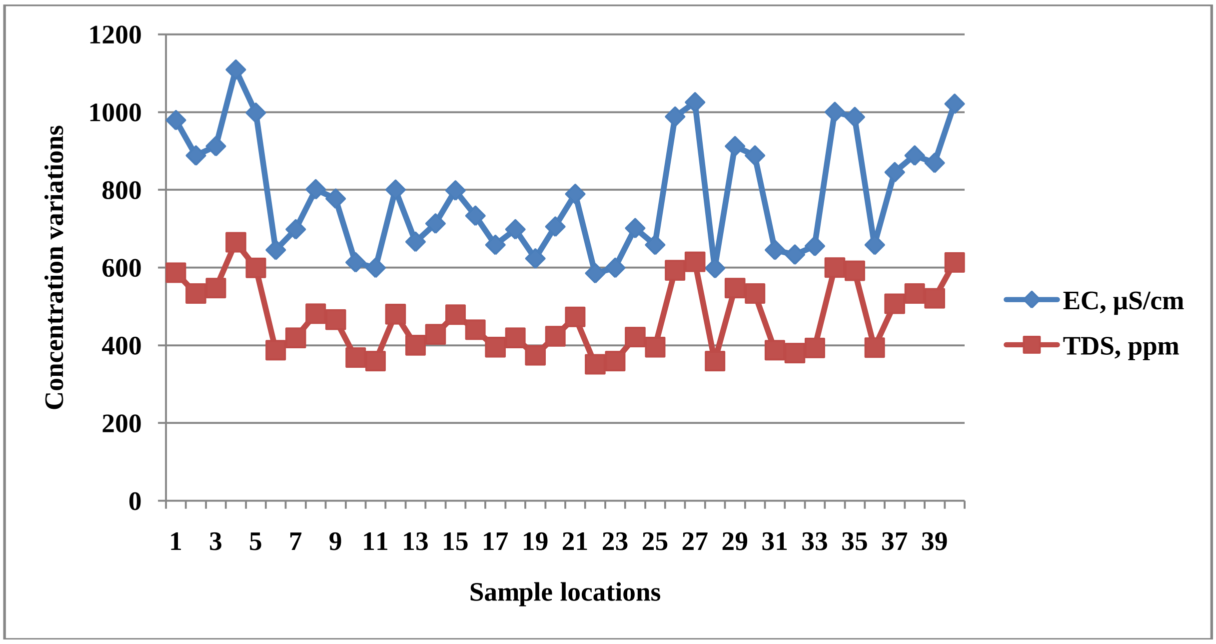

Figure 3.2: EC- Electrical conductivity, TDS- Total dissolved solids concentration variations during the study period

Total Hardness varies from 255-410 mg/l as $CaCO_3$. The hardness values for the study area are found to be hard for almost all locations and determined to fall higher edge of the desirable limit of WHO specification and Indian standards. According to Sawyer and McCarty's classification for hardness, water samples collected from study area are falls under the hard class 28.21%. The variation of total alkalinity and total hardness in the study period is shown figure 3.3. Hardness is caused by polyvalent metallic ions dissolved in water, which in natural water are principally magnesium and calcium. So the adverse effects of such hard water are i. Soap consumption by hard water cause economic loss to water, ii. MgSO4 has laxative effects in person unaccustomed to it, iii. precipitation by hard water adhere to the surface of tubs and sinks and may stain clothing, dishes and other items[1]

Table-3: Classification of water based on hardness by Sawyer and McCarthy

Hardness as $CaCO_3$ (mg/l)	Water quality	Percent
0-75	Soft	10.26
75-150	Moderately hard	33.33
150-300	Hard	28.21
Above 300	Very hard	28.21

Alkalinity of the samples are in the range of 352-465 mg/L. The alkalinity levels of all the water samples are high thus, resisting acidification of the groundwater samples. The variation of total alkalinity and total hardness in the study period is shown figure 4

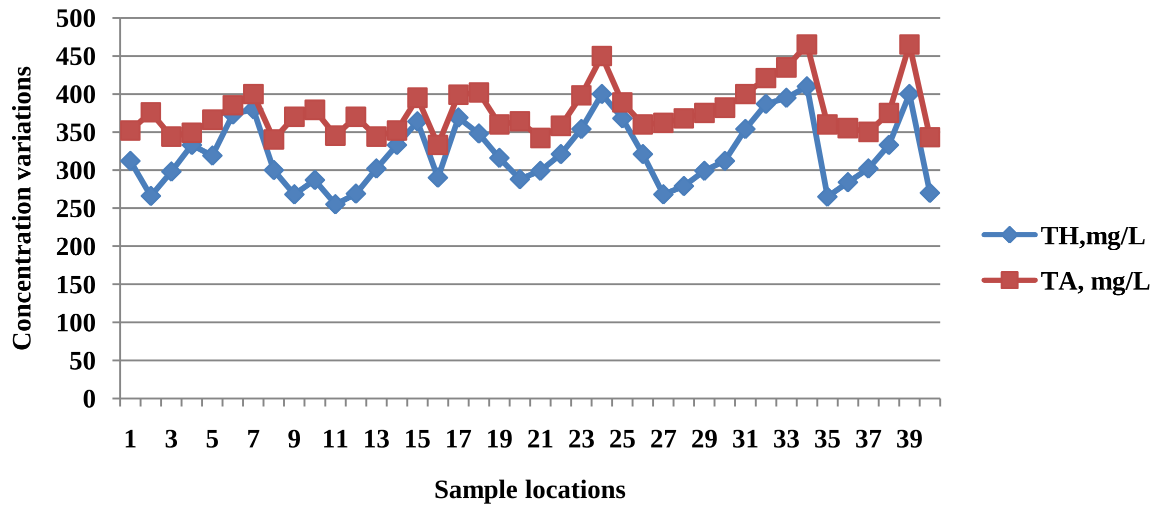

Figure 4: TH- Total Hardness, TA- Total Alkalinity variations during the study period

The presence of calcium in water results from its passage through the deposits of limestone, dolomite, gypsum and other calcium bearing rocks. Calcium contributes to the total hardness of water and is an important micro nutrient in aquatic environment. Small concentrations of calcium carbonate prevent corrosion of metal pipes by laying down a protective coating. But increased concentration of calcium precipitates on heating to form harmful scales in boilers, pipes and utensils. As per BIS and WHO standards, the permissible limit for calcium is 200 mg/l. In the present study, the groundwater samples have calcium concentration varying from 48-84.8 mg/l. Variation of calcium in the study area is shown in the figure 5

Magnesium is one of the abundant elements in the earth's crust, It is found in all natural waters and its source lies in rocks. It is an important element contributing to hardness and a necessary constituent of chlorophyll. High concentrations of magnesium reduce utility of water for domestic use, while a concentration above 500mg/l imparts an unpleasant taste to water and renders it unfit for drinking. As per IS 10500: (2003), the desirable limit of magnesium is 30 mg/l and permissible limit is 100 mg/l. In the present study, the groundwater samples have magnesium concentration varying from 32.80-52.08 mg/l. Variations of Magnesium in the study area is shown in the figure 5.

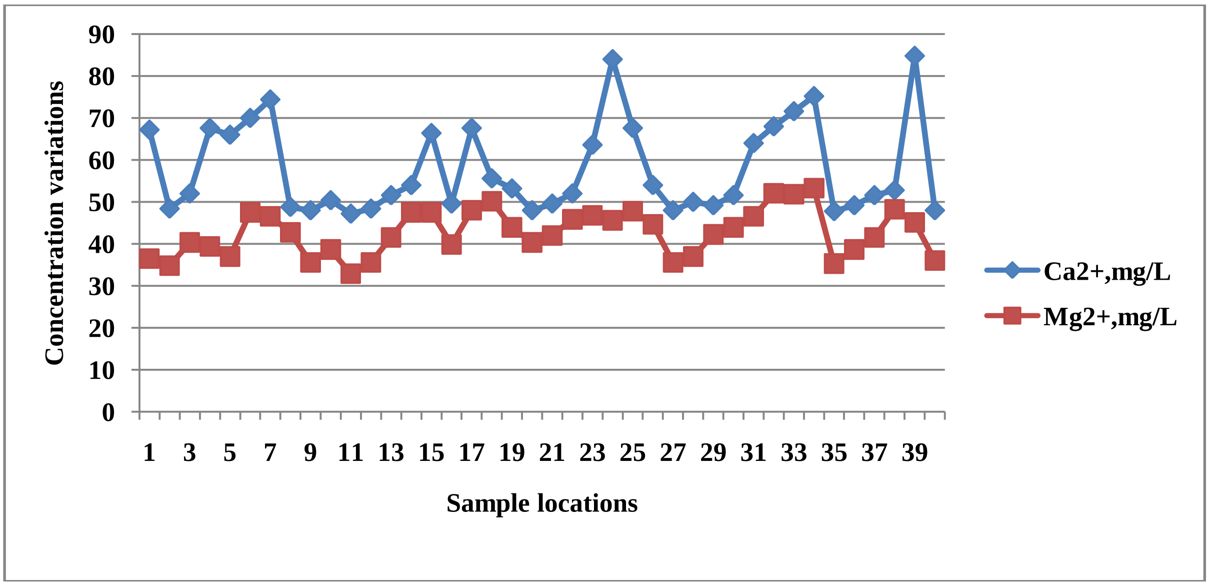

Figure 5: Ca- Calcium, Mg- Magnesium variations during the study period

Chloride present in ground water samples are in the range of 80.12-120.12 mg/l, which exceeds the permissible limit of 250 mg/l as per Indian standards as well as WHO Standards and this obviously affects the taste of the water. Similarly study of Chemical characteristics of groundwater in and around Sugar town, Mandya city chloride content is beyond the permissible limit[24]. This occurs may be due to saline water intrusion. Chloride is a widely distributed element in all types of rocks in one or the other form. Its affinity towards sodium is high. Therefore, its concentration is high in ground waters, where the temperature is high and rainfall is less. Soil porosity and permeability also has a key role in building up the chlorides concentration[17.] The variation of Chlorides in the study period is shown figure 6

Sulphate concentration in collected groundwater samples is ranged from 69.1-183 mg/l as in the permissible limit of 200mg/l as per Indian standards and 250mg/l as per WHO Standards. Health concerns regarding sulphate in drinking water have been raised because of reports that diarrhoea may be associated with the ingestion of water containing high levels of sulphate. The variation of Sulphate in the study period is shown figure 6

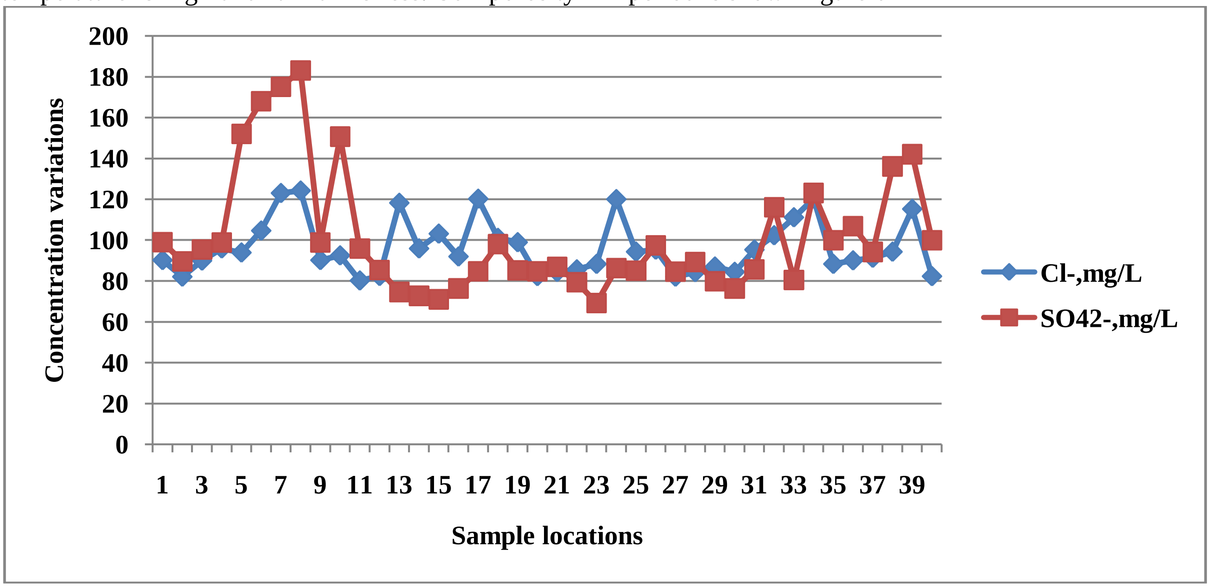

Figure 6: Cl- Chloride, SO_4- Sulphate variations during the study period

In the groundwater of Sugar town, Mandya City, **Nitrate** is varies from 6.20-8.45 mg/l which complies with the permissible limit of 45 mg/l as per Indian standards and 50 mg/L as per WHO Standards. Nitrates themselves are relatively non-toxic. Nitrogen essential component of amino acids, and therefore all proteins and nucleic acids, and therefore needed for all cell division and reproduction. The formation of nitrates is an integral part of the nitrogen cycle in our environment. Nitrate levels above 45 mg/l NO_3 may cause methemoglobinemia (Blue baby disease) in infants .Sources of nitrate contamination in Sugar town, Mandya city may include septic tanks and municipal sewage treatment systems. The ability of nitrate to enter well water depends on the type of soil and bedrock present, and on the depth and construction of the well[13].The variation of Nitrate in the study period is shown figure7

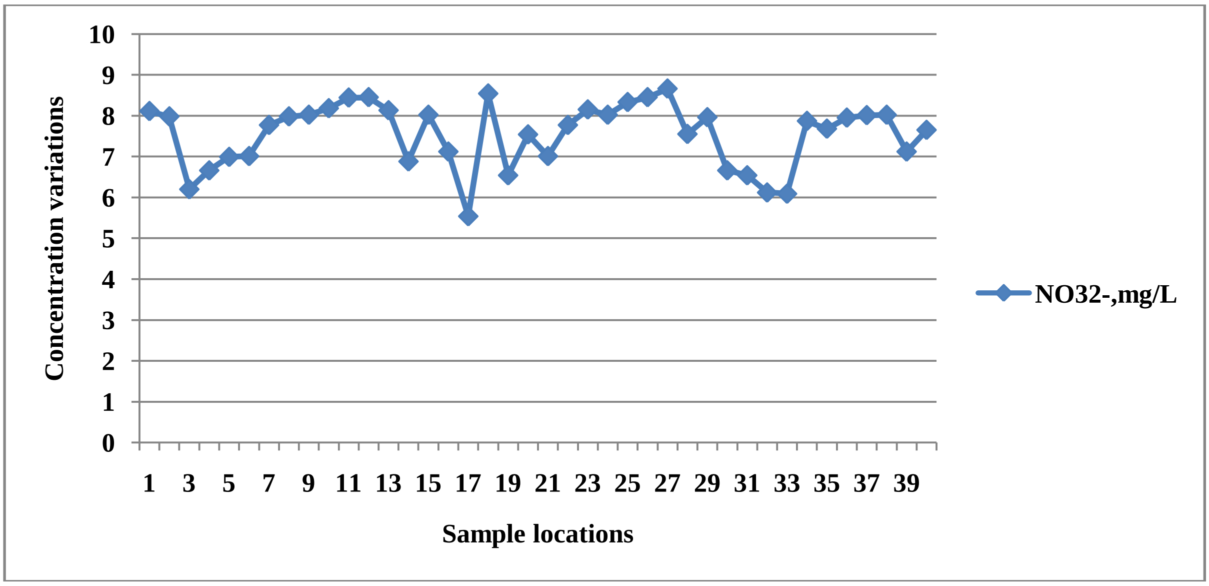

Figure 7: NO_3- Nitrate variations during the study period

The levels of **Flouride** in the groundwater samples ranged from 0.60-0.72 mg/l which are within the permissible limit of 1 mg/l as per Indian standards as well as WHO Standards.

The variation of fluoride is dependent on a variety of factors such as amount of soluble and insoluble fluoride in source rocks, the duration of contact of water with rocks and soil temperature, rainfall, oxidation- reduction process[12]. The presence of small quantities of fluoride in drinking water may prevent tooth decay. Fluoride is poisonous at high levels, and while dental fluorosis is easily recognized, skeletal damage may not be clinically obvious until advanced stages have occurred. Often, ground waters will contain more than 1.0 ppm, and in these cases, the water should probably be deflouridated for drinking. The variation of Fluoride in the study period is shown figure 8

Iron concentration of groundwater samples in the study area are varies from 0.32-0.56 mg/L and The Bureau of Indian Standards has recommended 0.3 mg/l as the desirable limit and 1.0 mg/L as the maximum permissible limit for iron in drinking water (BIS, 1991). Hence it is within the permissible limit. The ground water samples exhibited high Iron contamination which is an indication of the presence ferrous salts that precipitate as insoluble ferric hydroxide and settles out as rusty silt. High concentration of iron is may contributed by industrial estate located at the sampling site, Iron is an essential element in human nutrition**.** Toxic effects have resulted from the ingestion of large quantities of iron, but there is no evidence to indicate that concentrations of iron commonly present in food or drinking water constitute any hazard to human health. At concentrations above 0.3 mg/l, iron can stain laundry and plumbing fixtures and cause undesirable tastes. Iron may also promote the growth of certain microorganisms, leading to the deposition of a slimy coat in piping[14] .The variation of Iron in the study period is shown figure 8

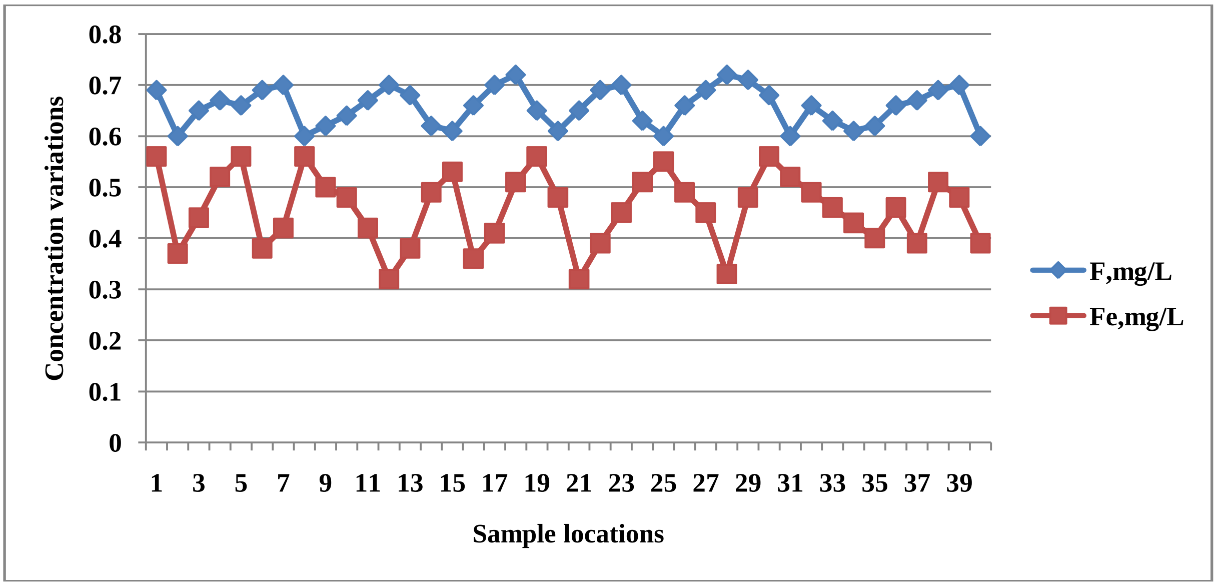

Figure 8: F- Fluoride, Fe- Iron variations during study period

Table-4: Comparison of groundwater quality with drinking water standards, Indian and WHO

Parameters	Indian Standard	Percentage compliance	WHO Standard
pH	6.5-8.5	100	7.0-8.0
TH, mg/L	300	100	100
Ca^{2+},mg/L	75	0	75
Mg^{2+},mg/L	30	100	30
Cl^{-}, mg/L	250	100	250
TDS, ppm	500	100	1000
Fe, mg/L	0.3	83	0.1
F, mg/L	1.0	100	1.0
NO_3^{2},mg/L	45	100	50
SO_4^{2},mg/L	200	100	250
TA, mg/L	200	100	-

Table 5 : Groundwater physico-chemical characteristics of Sugar town, Mandya city

Sample no	**pH**	**EC μs/cm**	**TDS ppm**	**TH mg/l**	**Ca^{2+} mg/l**	**Mg^{2+} mg/l**	**Cl mg/l**	**TA mg/l**	**F mg/l**	**Fe mg/l**	**NO_3^{2-} mg/l**	**SO_4^{2-} mg/l**
B1	6.85	979	587	312	67.2	36.48	90.12	352	0.69	0.56	8.11	98.9
B2	7.11	888	533	266	48.4	34.8	82.01	376	0.6	0.37	7.98	89.5
B3	6.89	912	547	298	52	40.32	89.87	344	0.65	0.44	6.2	95.3
B4	7.45	1109	665	333	67.6	39.36	95.85	349	0.67	0.52	6.66	98.7
B5	7.32	998	599	319	66	36.96	93.84	366	0.66	0.56	6.99	152
B6	7.01	645	387	373	70	47.52	104.58	385	0.69	0.38	7.01	168
B7	7.56	698	419	380	74.4	46.56	123	400	0.7	0.42	7.77	175
B8	6.98	801	481	300	48.8	42.72	124.2	340	0.6	0.56	7.98	183
B9	6.45	777	466	268	48	35.52	90.14	370	0.62	0.5	8.02	98.7
B10	6.55	613	368	287	50.4	38.64	92.42	379	0.64	0.48	8.18	150.6
B11	6.98	599	359	255	47.2	32.88	80.12	345	0.67	0.42	8.44	95.8
B12	6.77	800	480	269	48.4	35.52	82.32	370	0.7	0.32	8.45	85.2
B13	6.85	666	400	302	51.6	41.52	118.2	344	0.68	0.38	8.13	74.5

B14	7.01	713	428	333	54	47.52	95.84	352	0.62	0.49	6.88	72.6
B15	7.11	798	479	364	66.4	47.52	103.1	395	0.61	0.53	8.02	70.9
B16	7.23	733	440	290	49.6	39.84	91.9	333	0.66	0.36	7.12	76.2
B17	7.56	658	395	369	67.6	48	120.2	399	0.7	0.41	5.54	84.6
B18	7.65	698	419	348	55.6	50.16	101	402	0.72	0.51	8.54	98
B19	7.89	623	374	316	53.2	43.92	98.89	360	0.65	0.56	6.54	85.1
B20	6.85	705	423	288	48	40.32	82.28	364	0.61	0.48	7.54	84.6
B21	6.55	789	473	299	49.6	42	84.32	342	0.65	0.32	7.01	86.8
B22	6.45	585	351	321	52	45.84	85.58	358	0.69	0.39	7.77	79.3
B23	6.33	599	359	354	63.6	46.8	88.25	398	0.7	0.45	8.15	69.1
B24	6.85	701	421	400	84	45.6	120	450	0.63	0.51	8.02	86.2
B25	6.42	658	395	368	67.6	47.76	94.25	389	0.6	0.55	8.33	84.9
B26	6.75	988	593	321	54	44.64	95.25	360	0.66	0.49	8.45	97.34
B27	7.06	1025	615	268	48	35.52	82.01	362	0.69	0.45	8.66	84.5
B28	7.45	598	359	279	50	36.96	84.23	368	0.72	0.33	7.55	89.2
B29	7.33	912	547	299	49.2	42.24	86.96	375	0.71	0.48	7.96	79.8
B30	7.66	888	533	312	51.6	43.92	84.36	382	0.68	0.56	6.66	76.2
B31	7.84	645	387	354	64	46.56	95.25	400	0.6	0.52	6.54	85.6
B32	7.65	633	380	387	68	52.08	102.3	421	0.66	0.49	6.12	116
B33	6.45	655	393	395	71.6	51.84	111.1	435	0.63	0.46	6.09	80.35
B34	6.66	1000	600	410	75.2	53.28	120.2	465	0.61	0.43	7.87	123
B35	6.85	987	592	265	47.8	35.28	88.25	360	0.62	0.4	7.68	99.8
B36	6.39	658	394	284	49.2	38.64	89.98	355	0.66	0.46	7.95	106.8
B37	6.49	845	507	302	51.6	41.52	91.25	350	0.67	0.39	8.01	94.12
B38	7.04	888	533	333	52.8	48.24	94.25	375	0.69	0.51	8.02	136
B39	6.94	869	521	400	84.8	45.12	115.2	465	0.7	0.48	7.12	142
B40	7.28	1021	613	270	48	36	82.25	343	0.6	0.39	7.65	99.89

Where **B** indicates borewell water

Estimation of Water Quality Index (WQI)

For computing WQI three steps are followed. In the first step, each of the all parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes (table-7). The maximum weight of 5 has been assigned to the parameter nitrate due to its major importance in water quality assessment. Magnesium which is given the minimum weight of 1 as magnesium by itself may not be harmful. In the second step, the relative weight (Wi) is computed from the following equation:

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \quad \text{..........................(1)}$$

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters.
Calculated relative weight (Wi) values of each parameter are also given in table-7

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration of each water sample by its respective standard according to the guideline laid down in the BIS 10500 and the result is multiplied by 100.

$$q_i = (C_i / S_i) * 100 \quad ....(2)$$

Where, qi is the quality rating,
Ci is the concentration of each chemical parameter of each water sample in mg/l,Si is the sta ndard value for each chemical parameter, mg/l according to the guidelines of BIS (BIS 10500-1991).
For computing the WQI, the sub index SI is first determined for each chemical parameter, which is then used to determine the WQI using the following equation

$$SI_i = W_i * q_i \quad ....(3)$$

$$WQI = \Sigma SI_i \quad ....(4)$$

Where, SI_i is the sub index of Ith parameter, q_i is the rating based on concentration of ith parameter and **n** is the number of parameter. The computed WQI values are classified into five types and are as shown in table no. 6

Table 6: Water quality classification based on WQI value [2, 1]

WQI Value	Water Quality
<50	Excellent
50-100	Good
100-200	Poor
200-300	Very poor
>300	Water Unsuitable for drinking

Table 7: Relative weight (Wi) of each parameters

Sl. Nos	Parameters	Indian Standards	Weightage (w_i)	Relative Weight (W_i)	Quantity Rating (q_i)	Sub Index (SI_i)
1	pH	6.5-8.5	4	0.0952	82.47	7.85
2	EC, µS/cm	2000	4	0.0952	39.19	3.73
3	TDS, ppm	500-1500	4	0.0952	23.51	2.23
4	TH, mg/l	300-600	3	0.071	53.7	3.81
5	Ca^{2+}, mg/l	75-200	2	0.0476	28.95	1.37
6	Mg^{2+}, mg/l	30-100	2	0.0476	42.6	2.02
7	Fe, mg/l	0.3-1.0	4	0.0952	45	4.28
8	TA, mg/l	200-600	3	0.071	62.8	4.45
9	Cl^-, mg/l	250-1000	3	0.071	9.63	0.68
10	F, mg/l	1-1.5	4	0.0952	43.33	4.12
11	NO_3^{2-}, mg/l	45-100	5	0.119	7.54	0.89
12	SO_4^{2-}, mg/l	200-400	4	0.0952	25.32	2.41
			$w_{i=42}$	$W_{i=0.998}$	$q_{i=464.04}$	WQI=37.84

Hence, WQI for the groundwater samples from the study area is 37.84

IV. Conclusions

After the careful study of analysis, interpretation and discussions of the numerical data following conclusions have been drawn for the ground water of Sugar town, Mandya city. The groundwater is crystal clear, odorless, and palatable. Most of the bore wells yield potable water with moderate mineral or dissolved salts. Water is soft in almost all the sampling points. As there is no considerable increase in chloride and sulphate, it shows that there is no possible contamination of groundwater due to percolation of polluted surface water. The concentration of nitrate and fluoride in the entire Sugar town, Mandya City is well within the permissible limit. The hardness is reported, it is by calcium itself, which is also little higher than the permissible limits. Scaling of utensils, household boilers have been reported by survey. It has been revealed by the analysis that industrial effluents have negative effect on the quality of ground water of Sugar town, Mandya City. The water quality index (WQI) falls in the Excellent Range and hence the ground water of Sugartown, Mandya city is as considered as **Excellent**. The analysis reveals that the groundwater of the area, needs certain degree of treatment before consumption (at least disinfection), and it also needs to be protected from the perils of contamination.

V. Acknowledgement

Thanks to the principals, HOD's,and guide of UBDT's davanagere, for encouragement and support.

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