Drinking Water Quality Assessment of Commercial Areas in Shivamogga Town using Physico-Chemical Parameters, NSF-WQI Karnataka-India

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Abstract— The present study aimed at assessment of the drinking water quality of commercial areas of shivamogga town using NSF-WQI. The physico-chemical parameters such as pH, Temp, EC, Ca, Mg, TDS, Cl, Sulphate, Nitrate, Phosphate, Iron, DO, BOD, COD, Total hardness, Alkalinity, Turbidity values used to assess water quality. Few parameters pH, TDS, phosphate, nitrates, DO, BOD & turbidity were considered to compute water quality index based on national sanitation foundation (NSF-WQI). WQI is an excellent management & general administrative tool in communicating water quality information. NSF-WQI online calculator is used to calculate the water quality index. According to NSF-WQI ranking, water quality is good & suitable for drinking purpose.

Key words: Drinking water, Physico-chemical & biological parameters, NSF-WQI, regression equations Correlation, drinking water standard

I. INTRODUCTION

Water is a prime natural resource and a basic human need. Water is one of the three major Components of the environment; therefore, there exists a close linkage between the quality of water and the environment which bears an almost importance for eco-system. Natural bodies of water are not absolutely pure as various organic compounds and inorganic elements remain in dissolved form. Many kinds of macroscopic flora and fauna grow in different types of aquatic habitats. The physical and chemical quality of water vary according to the basin shape and size, depth, light penetration, precipitation, location, temperature, chemical nature of surrounding soil and dissolved minerals, pH, etc, and the biological components of the habitats depend upon them If all the physical, chemical and biological parameters are in optimum condition the balance between these is maintained. (Pratiksha Tambekar et al, 2012**)**

Almost 70% of the water in India has become polluted due to the discharge of domestic sewage, agricultural runoff and industrial effluents into natural water source, such as rivers, streams as well as lakes (Sangu and Sharma, 1987). According to WHO estimate about 80% of water pollution in developing country, like India is carried by domestic waste. The improper management of water systems may cause serious problems in availability and quality of water (Subba Rao and Subba Rao, 1995). In our country 70% of the water is seriously polluted and 75% of illness and 80% of the child mortality is attributed to water pollution (Zoeteman, 1980). Currently, about 20% of the world's population lacks access to safe drinking water, and more than 5 million people die annually from illness associated with safe drinking water or inadequate sanitation.

There is almost a global shortage of water and the world's most urgent and front rank problem today is supply and maintenance of clean drinking water.

Water quality index is one of the most effective tools to monitor the surface as well as ground water pollution and can be used effectively in the implementation of water quality upgrading programmes (Ramakrishnaiah, 2009). The water quality index (WQI) has been considered as one criteria for drinking water classification based on the use of standard parameters for water characterization. A commonly used WQI was developed by the National Sanitation Foundation (NSF) in 1970(Brown et. al. 1970). The WQI is one of the most widely used of all existing water quality procedures. WQI was the intent of providing data (Liou et al., 2003). The index ranges from 0 to 100, where 100 represent excellent water quality condition.

The present work mainly concentrated on water quality index of water used for drinking in commercial areas like Hotels, Hospitals, Schools & Collages of Shivamogga town.

II. MATERIAL & METHODS

A. Study area

Shivamogga city is located at 13^0 55^1 18^{11} N, 75^0 34^1 12^{11} E. The city has a total area of about $50km^2$ (19.31 square miles). The climate of Shivamogga is tropical wet & dry. Summer average temperature 20-35 degree centigrade. Shivamogga is apart of a region vernacularly known as Malnadu in Karnataka. Shivamogga city is divided into 35 Municipal wards/ Divisions. From the 35 wards in the city, 10 sites are selected for the study.

B. Sample collection

Water samples were collected from ten (10) various locations within study area during pre-monsoon, post monsoon & monsoon season. Samples were collected in polythene bottles to avoid unpredictable changes in characteristic as per standard procedure (APHA, 1998).

SL NO	NAME OF THE SITES	SOURCE	APPARENT WATER QUALITY	USES OF WATER
1	Annapoorna Hostel (Kote Road)	Both Under Ground & Tunga Water	Colour Less, Odour Less	Drinking & Washing & Bathing
2	Govt School (Bapooji nagar)	Both Under Ground & Tunga Water	Colour Less, Odour Less	Drinking & Cooking Purpose
3	Megan Govt Hospital	Both Under Ground & Tunga Water	Colour Less, Odour Less	Drinking
4	Ganga Hospital (B.H.Road)	Both Under Ground & Tunga Water	Colour Less, Odour Less	Drinking & Washing & Bathing
5	Guthi Nursing Home	Tunga River Water	Colour Less, Odour Less	Drinking
6	A T N C Collage	Tunga River Water	Colour Less, Odour Less	Drinking
7	Ashoka Hotel (B.H.Road)	Tunga River Water	Colour Less, Odour Less	Drinking
8	Panchatara (Gopi circle)	Tunga River Water	Colour Less, Odour Less	Drinking
9	Hotel Sankranthi	Tunga River Water	Colour Less, Odour Less	Drinking
10	G F G C	Both Under Ground & Tunga Water	Colour Less, Odour Less	Drinking

Table 1: Details of sampling sites

C. Methodology

For Physico chemical and biological analysis the following standard methods & instruments used.

PARAMETERS	INTRUMENTS & METHODS USED FOLLOWED
pH	pH pen-pH ep®
TDS & Conductivity	Water analyzer kit 371 (Systronics)
Alkalinity, Hardness,D.O, Chloride, Calcium	Titrimetric method
Nitrate, Iron & Sulphate	UV-VIS spectrophotometer 119 (Systronics)

D. Results and Discussion

Table 2, 3 & 4 shows physico chemical values of the sampling points.

The pH value of drinking water is an important index of acidity, alkalinity and resulting value of the acidic-basic interaction of a number of its mineral and organic components. pH below 6.5 starts corrosion in pipes. (Pandya et al., 2013). In the study pH value ranges between 7.1 to 7.4 in pre & post monsoon season. And 7.1 to 7.7 in monsoon season. It is with in the prescribed limit of BIS. TDS is sum of the cations and anions concentration. A high contents of dissolve solids elevates the density of water, influences solubility of gases (like oxygen) reduces utility of water for drinking irrigation and industrial purpose. (Pandya et al., 2013) .In the present study Total Dissolved Solid ranges from 25.8 to 157 mg/L, in pre monsoon season &21.7 to 208mg/L in post monsoon season, 22.7 to 108mg/l in monsoon season TDS is due to high dissolved salts of Ca, Mg & Fe it requires specific cation & anion analysis (Sandeep et al 2009). All the values of Total Dissolved Solids are in the prescribed limit of BIS. Electrical conductivity depends on the function of dissolved mineral matter content. If the TDS is high then EC will be high (Ananthakrishnan et al, 2012). In the present study conductivity ranges from 52.4 to 314 µs/cm, in pre monsoon season & 48 to 428 µs/cm, in post monsoon season, & 53 to 219 µs/cm in monsoon season.Alkalinity ranges from 12 to 86 mg/L; in pre monsoon season & 8 to 102 mg/L, in post monsoon season; & 8 to 76 mg/l in monsoon season it is in the prescribed limit of BIS. Alkalinity is the cause of carbonate and bicarbonate ion and its salts (Sandeep et al 2009).The hydroxide, carbonates and bicarbonates probably released from limestone sedimentary rocks, carbonate rich soils, cleaning agents contributes to the alkalinity. Chlorides are common constituents of all natural water. Higher value of it impacts a salty taste of water, making it unacceptable for human consumption (Ananthakrishnan et al, 2012). The chlorides contents in the samples between 5.7 to 51.1 mg/L, in pre monsoon season, & 1.42 to 69.5 in post monsoon season; & 5.67 to 35.45 mg/l in monsoon season. Cl content is with in the limit of BIS. The total hardness is due to the presence of divalent cations of which Ca and Mg are the most abundant in ground water. (Jadhav et al, 2012). In the present study total hardness ranges from 40 to 92 mg/L; in pre monsoon season & 16 to 126 mg/L; in post monsoon season & 22 to 106mg/l in monsoon season. Magnesium ranges from 4.17 to 10.66 mg/L, in pre monsoon season & 0.5 to 21.6 mg/L in post monsoon season & 1.27 to 9.69 mg/l in monsoon season. All the samples shows with in the prescribed limit of BIS for both hardness & magnesium .Calcium ranges from 6.41 to 22.4 mg/L, in pre monsoon season & 3.21 to 22.44 mg/L in post monsoon season , & 6.41 to 25.65 mg/l in monsoon season. Which is in the prescribed limit of BIS and Dissolved oxygen ranges from 3.64 to 5.27mg/L in pre monsoon season &4 to 5.67 mg/L, in post monsoon season, 4 to 6.1 in monsoon season. D.O indicating the nearly pure symptoms of good water quality. Iron ranges from 0.008 to 0.06 mg/L in pre monsoon & 0.04 to 0.004 mg/L in post monsoon season, 0.01 to 0.04 mg/L in monsoon season. & Sulphate ranges from 0.8 to 4.86 mg/L, in pre monsoon season & 0.5 to 4.08 in post monsoon season, 0.8 to 5.64 mg/L, in monsoon season. Which are all in prescribed limit of BIS. Phosphate ranges from 0.0012 to 0.009 in pre monsoon, 0.001 to 0.004 mg/L in post monsoon & 0.0015 to 0.005 mg/L in monsoon season. Which are all in prescribed limit of BIS.

SL NO	PARAMETERS	S I	S II	S III	S IV	SV	S VI	S VII	S VIII	S IX	S X	BIS Standard
1	pH	7.3	7.7	7.6	7.3	7.2	7.2	7.1	7.2	7.3	7.4	6.5-8.5
2	Temperature ◦ C	22	22	22	23	23	22	23	22	22	22	-
3	Conductivity (µs/cm)	168	219	215	56.2	53	65.3	58.9	76.8	68.4	140	-

4	T D S (ppm)	84	108	102	25.6	22.7	33.8	26.45	38.4	34.2	68.2	500
5	Alkalinity (ppm)	36	60	34	54	16	16	10	48	8	76	200
6	Chloride (ppm)	25.5	28.36	35.45	8.51	7.1	15.6	9.93	24.11	5.67	24.11	250
7	T H S (ppm)	44	88	106	40	24	22	38	42	46	44	300
8	Calcium (ppm)	9.62	18.43	25.65	7.21	6.41	6.41	8.01	8.82	8.01	9.62	75
9	Magnesium (ppm)	4.59	9.69	9.47	5.15	1.76	1.27	4.15	4.61	4.64	4.58	30
10	Sulphate (ppm)	2.14	4.98	5.64	2	0.9	0.8	0.9	2.18	2	2	200
11	Phosphate (ppm)	0.005	0.004	0.002	0.0018	0.002	0.0015	0.005	0.003	0.0016	0.002	-
12	Iron (ppm)	0.04	0.04	0.07	0.03	0.01	0.01	0.03	0.03	0.01	0.01	0.3
13	Nitrate (ppm)	0.006	0.008	0.005	0.002	0.002	0.002	0.004	0.003	0.006	0.008	45
14	D O (ppm)	5.67	6.1	4.9	5.67	4.46	4.9	5.3	4.0	5.67	5.3	4 – 6
15	B O D (ppm)	0.77	0.43	0.85	0.4	0.82	0.85	0.84	0.76	0.37	0.84	2 - 3
16	C O D (ppm)	1	1	3	2	2	2	1	1	2	2	10
17	Turbidity (NTU)	0.1	1.2	0.4	0.7	0.5	0.6	2.4	0.7	9.6	0.3	5 – 25

Table 2: Physico - chemical & biological parameters at different sampling sites recorded during monsoon season (June to August, 2011)

PARAMETERS	STANDARD DEVIATION	MEAN	MODE	MEDIAN	STANDARD ERROR
pH	0.188856	7.33	7.3	7.3	0.059722
Temperature C	0.483046	22.3	22	22	0.152753
Conductivity (us/cm)	67.25829	112.06	-	72.6	21.26894
T D S	33.18167	54.335	-	36.3	10.49297
Alkalinity	23.35142	35.8	16	35	7.384368
Chloride	10.39576	18.434	24.11	19.855	3.287428
Total hardness	26.73408	49.4	44	43	8.454059

Ca	6.257808	10.819	9.62	8.415	1.978893
Mg	2.743839	4.991	-	4.6	0.867678
Sulphate	1.659613	2.354	2	2	0.524816
Phosphate	0.001622	0.0026	0.002	0.002	0.000513
Iron	0.019322	0.028	0.01	0.03	0.00611
Nitrate	0.002366	0.0046	0.002	0.0045	0.000748
D O	0.637723	5.197	5.67	5.3	0.201666
B O D	0.20505	0.693	0.85	0.795	0.064843
C O D	0.674949	1.7	2	2	0.213437
Turbidity	2.867151	1.65	0.7	0.65	0.906673

Table 3: Statistical data showing SD, Mean, Mode, Median & SE for table 2

SL NO	PARAMETERS	S I	S II	S III	S IV	S V	S VI	S VII	S VIII	S IX	S X	BIS
1	pH	7.2	7.2	7.3	7.3	7.2	7.1	7.3	7.4	7.2	7.2	6.5_8.5
2	Temperature ◦ C	22	23	22	22	21	21	21	21	22		-
3	Conductivity (µs/cm)	177	428	54	218	72	64	67	48	48	148	-
4	T D S (ppm)	84.6	208	27	106	36	28.6	33.5	21.7	25.4	72.6	500
5	Alkalinity (ppm)	38	102	10	34	16	16	18	8	10	24	200
6	Chloride (ppm)	29.8	69.5	8.51	24.1	12.76	7.1	8.51	1.42	2.8	15.6	250
7	T H S (ppm)	48	126	18	60	50	24	28	18	16	42	300
8	Calcium (ppm)	10.42	22.44	5.61	11.22	8.82	8.01	7.21	4.01	3.21	9.62	75
9	Magnesium (ppm)	5.1	16.4	0.81	7.46	6.56	0.73	2.21	1.83	1.85	4.1	30
10	Sulphate (ppm)	4.08	21.6	2.01	12.1	2.26	0.9	0.8	0.5	0.5	1.2	200

11	Phosphate (ppm)	0.001	0.009	0.002	0.0015	0.002	0.0018	0.003	0.0016	0.002	0.004	-
12	Iron (ppm)	0.04	0.007	0.03	0.008	0.03	0.04	0.03	0.03	0.02	0.004	0.3
13	Nitrate (ppm)	0.007	0.009	0.006	0.006	0.002	0.002	0.004	0.005	0.002	0.008	45
14	D O (ppm)	5.3	4.0	4.46	4.9	4.0	4.9	5.67	5.67	4.46	4.46	4 - 6
15	B O D (ppm)	0.84	0.76	0.46	0.9	0.76	0.44	0.4	0.4	0.46	0.82	2 - 3
16	C O D (ppm)	1	3	2	2	1	3	2	2	1	1	10
17	Turbidity (NTU)	0.3	0.2	0.6	0.7	0.7	0.5	0.3	0.6	0.6	0.3	5 - 25

Table 4 : Physico - chemical & biological parameters at different sampling sites recorded during winter season (November to December, 2011)

Table 5: Simple statistics applied for table 3

PARAMETERS	STANDORD DEVIATIN	MEAN	MODE	MEDIAN	STANDASDANARD ERROR
pH	0.084327	7.24	7.2	7.2	0.026667
Temperature C	0.674949	21.7	22	22	0.213437
Conductivity (us/cm)	120.1556	132.4	48	69.5	37.99655
T D S	58.32174	64.34	-	34.75	18.44295
Alkalinity	28.0127	27.6	10	17	8.858392
Chloride	20.18466	18.01	8.51	10.635	6.382949
Total hardness	33.02861	4.31	18	35	10.44456
Ca	5.396122	9.057	-	8.415	1.706404
Mg	4.736847	4.705	-	3.155	1.497922
Sulphate	6.920291	4.595	0.5	1.605	2.188388
Phosphate	0.002338	0.0028	0.002	0.002	0.000739
Iron	0.013404	0.0239	0.03	0.03	0.004239
Nitrate	0.002558	0.0051	0.002	0.0055	0.000809

D O	0.615301	4.782	4.46	4.68	0.194575
B O D	0.207161	0.624	0.76	0.61	0.06551
C O D	0.788811	1.8	1	2	0.249444
Turbidity	0.18738	0.48	0.3	0.55	0.059255

SL NO	**PARAMETERS**	**S I**	**S II**	**S III**	**S IV**	**S V**	**S VI**	**SVII**	**S VIII**	**S IX**	**S X**	**BIS Standard**
1	pH	7.4	7.1	7.4	7.4	7.2	7.2	7.1	7.3	7.3	7.4	6.5_8.5
2	Temperature ◦ C	26	26	26	26	26	26	26	26	26	26	_
3	Conductivity (µs/cm)	174	246	58.2	314	67.6	52.4	78.7	56.2	69.2	78.6	_
4	T D S (ppm)	86	121	28.8	157	33.6	25.8	37.9	27.7	34.5	39.1	500
5	Alkalinity (ppm)	32	82	12	86	20	16	24	18	22	24	200
6	Chloride (ppm)	26.9	29.8	9.9	51.1	11.3	8.5	12.76	5.7	8.5	14.2	250
7	T H S (ppm)	42	92	46	102	40	36	42	38	44	48	300
8	Calcium (ppm)	8.82	18.44	9.62	22.4	8.02	7.21	8.82	6.41	8.82	9.6	75
9	Magnesium (ppm)	4.61	10.66	5.07	10.54	4.64	4.17	4.61	5.17	5.09	5.56	30
10	Sulphate (ppm)	2.08	2.46	2	4.86	2.01	0.9	0.9	0.8	1.09	0.9	200
11	Phosphate (ppm)	0.005	0.008	0.005	0.009	0.0012	0.002	0.0018	0.002	0.002	0.002	-
12	Iron (ppm)	0.03	0.009	0.008	0.03	0.02	0.06	0.03	0.04	0.04	0.04	0.3
13	Nitrate (ppm)	0.008	0.008	0.004	0.002	0.001	0.001	0.002	0.003	0.002	0.009	45
14	D O (ppm)	4.0	4.9	4.9	4.0	5.27	5.27	4.9	4.0	4.0	4.0	4 - 6
15	B O D (ppm)	0.76	0.4	0.4	0.76	0.37	0.81	0.85	0.76	0.36	0.76	2 - 3

16	C O D (ppm)	1	3	1	1	1	2	1	1	2	2	10
17	Turbidity (NTU)	0.1	0.2	0.6	0.6	0.6	0.7	0.8	0.4	0.5	0.3	5 - 25

Table 6: Physico - chemical & biological parameters at different sampling sites recorded during summer season (March to May, 2012)

Table7: Simple statistic applied for table 4

PARAMETERS	STANDORD DEVIATIN	MEAN	MODE	MEDIAN	STANDASDANARD ERROR
pH	0.122927	7.28	7.4	7.3	0.038873
Temperature C	0	26	26	26	0
Conductivity (us/cm)	92.8744	119.49	-	73.9	29.36946
T D S	46.25702	59.14	-	36.2	14.62775
Alkalinity	27.10965	33.6	24	23	8.572825
Chloride	14.13454	17.866	8.5	12.03	4.469735
Total hardness	23.57494	53	42	43	7.45505
Ca	5.243083	10.816	8.82	8.82	1.658008
Mg	2.448672	6.012	4.61	5.08	0.774338
Sulphate	1.242569	1.8	0.9	1.545	0.392935
Phosphate	0.002814	0.0038	0.002	0.002	0.00089
Iron	0.015706	0.0307	0.03	0.03	0.004967
Nitrate	0.003127	0.004	0.002	0.0025	0.000989
D O	0.692342	4.416	3.64	4.45	0.218938
B O D	0.218696	0.635	0.8	0.78	0.069158
C O D	0.707107	1.5	1	1	0.223607
Turbidity	0.225093	0.48	0.6	0.55	0.071181

Karl Pearson's correlation coefficient r is used taking conductivity as dependent variable for all the ten data points of drinking water at shivamogga city, Karnataka, India, in all the three seasons.

$$r = \frac{\sum XY - \frac{\sum X \sum y}{n}}{(\sqrt{\sum x^2 - \sum (x)^2})(\sum y^2 - \sum (y)^2)}$$

Here, n = number of data points

x = values of x-variable

y = values of y – variables;

Parameters	Conductivity (µs/cm)
pH	0.89
T D S (ppm)	1.00
Alkalinity (ppm)	0.48
Chloride (ppm)	0.88
T H S (ppm)	0.85
Calcium (ppm)	0.86
Magnesium (ppm)	0.82
Sulphate (ppm)	0.87
Phosphate (ppm)	0.29
Iron (ppm)	0.70
Nitrate (ppm)	0.72
D O (ppm)	0.37
B O D (ppm)	0.02
C O D (ppm)	0.07
Turbidity (NTU)	-0.28

Table 8: correlation coefficient applied to table 2 of rainy season

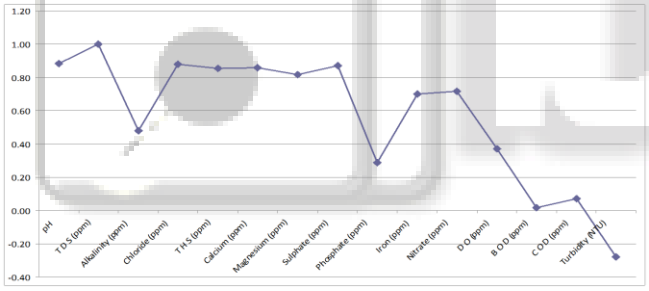

Fig 1: correlation coefficient (r) -value compared with conductivity of table 2

TDS are highly correlated where cl, THS, Ca, Mg, sulphate, nitrate, and iron shows moderate degree of correlation. Therefore all the parameters positively correlated with conductivity except turbidity which is negatively correlated.

Parameters	Conductivity (µs/cm)
pH	-0.17
T D S (ppm)	1.00
Alkalinity (ppm)	0.98
Chloride (ppm)	0.98
T H S (ppm)	0.96
Calcium (ppm)	0.96
Magnesium (ppm)	0.94
Sulphate (ppm)	0.95
Phosphate (ppm)	0.79
Iron (ppm)	-0.59
Nitrate (ppm)	0.73
D O (ppm)	-0.37
B O D (ppm)	0.63
C O D (ppm)	0.37
Turbidity (NTU)	-0.53

Table 9: correlation coefficient applied to table 4 of winter season

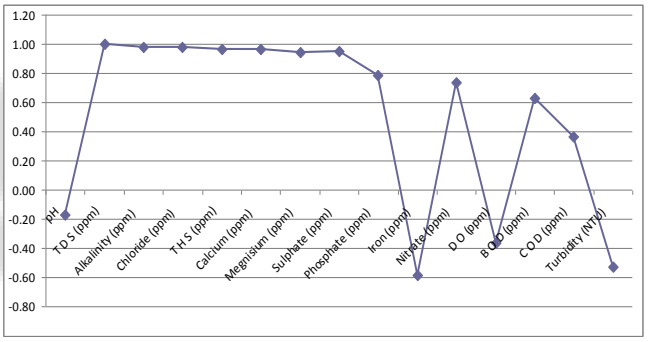

Fig 2: correlation coefficient (r) -value compared with conductivity of table 3

TDS, alkalinity, Cl, THS, Ca, Mg & sulphate are highly correlated where phosphate, nitrate, BOD, COD shows moderate degree of correlation. Therefore these parameters are positively correlated with conductivity where turbidity, iron, pH, DO which are negatively correlated.

Parameters	Conductivity (µs/cm)
pH	0.09
T D S (ppm)	1.00
Alkalinity (ppm)	0.96
Chloride (ppm)	0.98
T H S (ppm)	0.92
Calcium (ppm)	0.93
Magnesium (ppm)	0.89
Sulphate (ppm)	0.87
Phosphate (ppm)	0.91
Iron (ppm)	-0.33
Nitrate (ppm)	0.28
D O (ppm)	-0.19
B O D (ppm)	0.04
C O D (ppm)	0.16
Turbidity (NTU)	-0.33

Table 10: correlation coefficient applied to table 6 of summer season

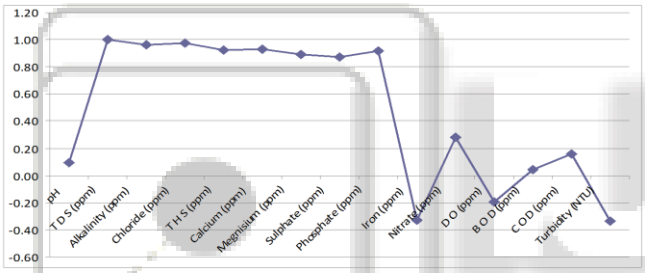

Fig. 3: correlation coefficient (r) -value compared with conductivity of table 4

TDS, alkalinity, Cl, THS, Ca, Mg & sulphate are highly correlated where nitrate, BOD, COD shows low degree of correlation. Therefore these parameters are positively correlated with conductivity where turbidity, iron, DO which are negatively correlated.

E. National sanitation foundation water quality index (NSF WQI)

NSF-WQI is an excellent management and general administrative tool in communicating water quality information. This index has been widely field tested and applied to data from a number of different geographical areas all over the world in order to calculate water quality index(WQI) of various water bodies critical pollution parameters were considered (Samantray,2009). The mathematical expression for NSF WQI is given by-

$$\text{NSF WQI} = \sum_{i=1}^{P} W_i I_i$$

Where,

I_i is the sub-index for i^{th} water quality parameters

W_i is the weight associated with i^{th} water quality parameter

P is the number of water quality parameters

The water quality index was calculated using NSF information software (Ramakrishnaiah 2009) and compared with standard water quality ranking (Table 12).

Parameters	Sit1	Sit2	Sit3	Sit4	Sit5	Sit6	Sit7	Sit8	Sit9	Sit10
pH	7.3	7.7	7.6	7.3	7.2	7.2	7.1	7.2	7.3	7.4
TDS	84	108	102	25.6	22.7	33.8	26.5	38.4	34.2	68.2
DO mg/l	5.67	6.1	4.9	5.67	4.46	4.9	5.3	4.0	5.67	5.3
BOD mg/l	0.77	0.43	0.85	0.4	0.82	0.85	0.84	0.76	0.37	0.84
Turbidity(NTU)	0.1	1.2	0.4	0.7	0.5	0.6	2.4	0.7	9.6	0.3
Phosphate mg/l	0.005	0.004	0.002	0.0018	0.002	0.004	0.003	0.003	0.006	0.008
Nitrate mg/l	0.006	0.008	0.005	0.002	0.002	0.002	0.004	0.003	0.006	0.008
WQI	88	90	85	89	84	85	86	82	87	87
Ranking	G	G	G	G	G	G	G	G	G	G

Table No.11: Physico-chemical parameters and WQI of all ten sites during rainy season

Parameters	Sit1	Sit2	Sit3	Sit4	Sit5	Sit6	Sit7	Sit8	Sit9	Sit10
pH	7.2	7.2	7.3	7.3	7.2	7.1	7.3	7.4	7.2	7.2
TDS	84.6	208	27	106	36	28.6	33.5	21.7	25.4	72.6
DO mg/l	5.3	4.0	4.46	4.9	4.0	4.9	5.67	5.67	4.46	4.46
BOD mg/l	0.84	0.76	0.46	0.9	0.76	0.44	0.4	0.4	0.46	0.82
Turbidity(NTU)	0.3	0.2	0.6	0.7	0.7	0.5	0.3	0.6	0.6	0.3
Phosphate mg/l	0.001	0.009	0.002	0.0015	0.002	0.0018	0.003	0.0016	0.002	0.004
Nitrate mg/l	0.007	0.009	0.006	0.006	0.002	0.002	0.004	0.005	0.002	0.008

WQI	87	81	84	85	81	85	88	88	83	83
Ranking	G	G	G	G	G	G	G	G	G	G

Table 12: Physico-chemical parameters & WQI of all the ten sites during winter season

Parameters	Sit1	Sit2	Sit3	Sit4	Sit5	Sit6	Sit7	Sit8	Sit9	Sit10
pH	7.4	7.1	7.4	7.4	7.2	7.2	7.1	7.3	7.3	7.4
TDS	86	121	28.8	157	33.6	25.8	37.9	27.7	34.5	39.1
DO mg/l	4.0	4.9	4.9	4.0	5.27	5.27	4.9	4.0	4.0	4.0
BOD mg/l	0.76	0.4	0.4	0.76	0.37	0.81	0.85	0.76	0.36	0.76
Turbidity(NTU)	0.1	0.2	0.6	0.6	0.6	0.7	0.8	0.4	0.5	0.3
Phosphate mg/l	0.005	0.008	0.005	0.009	0.0012	0.002	0.0018	0.002	0.002	0.002
Nitrate mg/l	0.008	0.008	0.004	0.002	0.001	0.001	0.002	0.003	0.002	0.009
WQI	83	86	87	82	88	88	86	83	83	83
Ranking	G	G	G	G	G	G	G	G	G	G

Table 13: Physico-chemical parameters & WQI of all the ten sites during summer season

The index values ranged from a minimum of 82 in site 8 & maximum 90 in site 2 during rainy season, minimum of 81 in site 2 & 5 and maximum 88 in site 7 & 8 during winter season and Minimum 82 in site 4 & maximum 88 in site 5 & 6 during summer season.

Factor	Weight
Dissolved oxygen	0.17
Fecal coli form	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.1
Total phosphate	0.1
Nitrates	0.1
Turbidity	0.08
T D S	0.07

Table-14: Water Quality Factors and parameters Weights in NSF WQI

Range	**Quality**
90-100	Excellent(E)
70-90	Good(G)
50-70	Medium(M)
25-50	Bad(B)
0-25	Very bad(VB)

Table-15: NSF water quality index ranking

III. CONCLUSION

The Drinking water samples collected from 10 different locations of commercial areas in shivamogga town is analyzed & studied. On the basis of these analytical findings, the following conclusion can be drawn.

Based on the data recorded Drinking water quality of commercial areas in shivamogga town is acceptable. According to WQI the quality of the water comes under G group. Present study may be treated as one step ahead towards the drinking water quality management.

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