Assessment of Water Quality Index (WQI) Of Groundwater in Udupi District, Karnataka, India

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***Abstract*: In the present study, water quality of groundwater has been assessed in terms of water quality index (WQI) in Udupi District of Karnataka. Data of 80 groundwater samples each of open well and bore well was taken for computingthe Water Quality Index using ten parameters is. pH, Total Dissolved Solids, Total Hardness, Calcium, Bicarbonate,Fluoride, Chloride, Nitrate, Iron and Sulphate. The WQI results show that the overall water quality class is 'fair' and water needs treatment.**

Index Terms: Water Quality Index, Physico-Chemical Parameters, Ground water, Udupi, Karnataka.

I. INTRODUCTION

Ground water is one of the Nation's most important natural resources. It provides about 40 percent of the Nation's public water supply. In addition, more than 40 million people, including most of the rural population, supply their own drinking water from domestic wells. As a result ground water is an important source of drinking water in every state. Ground water is also the source of much of water used for irrigation. Ground water is major contributor to flow in many streams and rivers and has strong influence on river and wetland habits for plants and animals. The quality of drinking water is a powerful environmental determinant of health. Assurance of drinking water safety is a foundation for the prevention and control of waterborne diseases. Water and sanitation are at the very core of sustainable development, critical for thriving people, planet and prosperity.Groundwater is water that exists in the pore spaces and fractures in rock and sediment beneath the Earth's surface. It originates as rainfall or snow, and then moves through the soil into the Groundwater system, where it eventually makes its way back to surface streams, lakes, or oceans. It is naturally replenished from above, as surface water from precipitation, streams and rivers infiltrates into the ground. Groundwater is a long-term reservoir of the natural water cycle, as opposed to short-term water reservoirs like the atmosphere and fresh surface water. Groundwater makes up about twenty percent of the world's fresh water supply, which is about 0.61% of the entire world's water, including oceans and permanent ice. Global groundwater storage is roughly equal to the total amount of freshwater stored in the snow and ice park, including the north and south poles. This makes it an important resource which can act as a natural storage that can buffer against shortages of surface water, as in during times of drought.

II. OBJECTIVES

- To analyse the physico-chemical characteristics of ground water.
- To determine the water quality index.
- To prioritize the area based on water quality index.

III. LITERATURE REVIEW

C R Ramakrishnanaiah, C Sadashivaiah and G Ranganna carried out work to study assessment of Water Quality Index for the ground water in TumkurTaluk, Karnataka state, India. Groundwater samples were collected from 269 locations during pre-monsoon period (February2006). The WQI for 269 samples ranges from 89.21 to 660.56. Almost ninety nine percent of the samples exceeded 100, the upper limit for drinking water. About 63.5% of water samples are poor in quality.

Gopal Krishnan and Surjeetsingh and SumanGurjar carried out to study about the water quality assessment in terms of WQI in Ballia District, Uttar Pradesh, India. WQI was computed using 11 water quality parameters. The WQI shows that over all ground water samples qualify in the 'fair' category and are not fit as such for drinking. The water needs 'filtration and disinfection' treatment and then can be used for the drinking purpose.

Rizwan Reza and Gurdeep Singh (2010) have assessed groundwater quality through Water Quality Index method in Orissa, India. Result indicates that water quality is poor during post monsoons as compared to summer season due to more seepage and movement of groundwater during post monsoon.

IV. STUDY AREA

We selected Udupi district as our study area. Udupi district lies between 13°04' and 13° 59' North latitude and 74°35' and 75° 12' East longitude. District measures 3575km^2.The western portion of Udupi district has Arabian Sea.Udupi district is surrounded by Dakshina Kannada in the south, Kundapur and Karkala in the north and east directions.

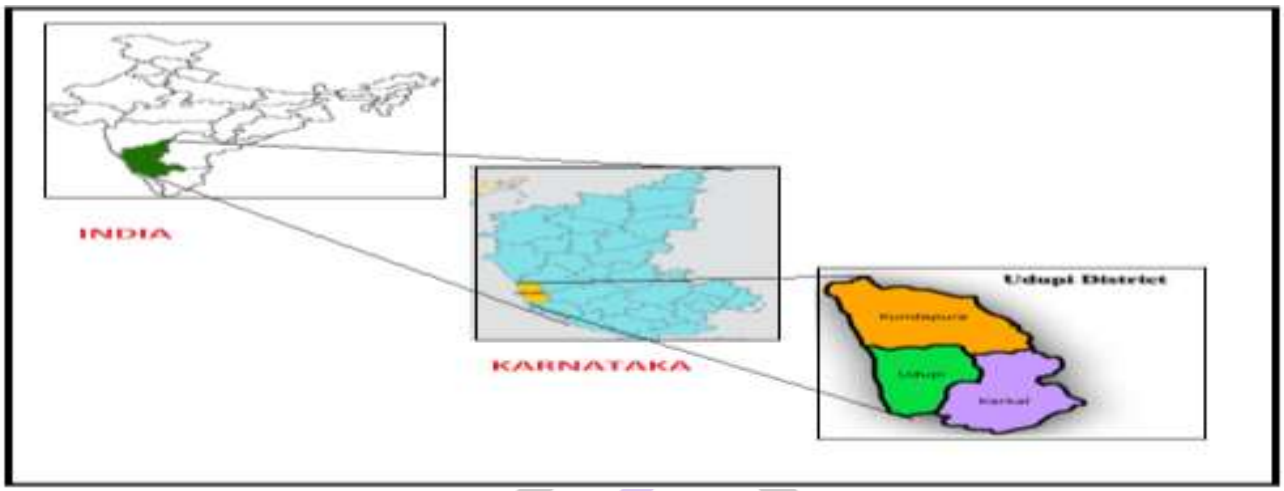

Fig 1: Study area of udupi district

V. METHODOLOGY

We selected Udupi district as our study area. Water sample were collected from selected locations. The Water Quality Index (WQI) was computed using 10 water quality parameters such as pH, Total Dissolved Solids, Total Hardness, Fluoride, Chloride, Nitrate, Iron, Sulphate and Bicarbonate of 80 groundwater samples of open well and bore hole and prioritizing the area based on water. Samples for analysis were collected in polyethylene bottles. The analysis of various physico – chemical parameters namely pH, total solids, hardness, calcium, sulphate, nitrate, iron, chloride, bicarbonates, fluoride were carried out – as per the methods. All the chemicals and reagents used were of analytical grade.

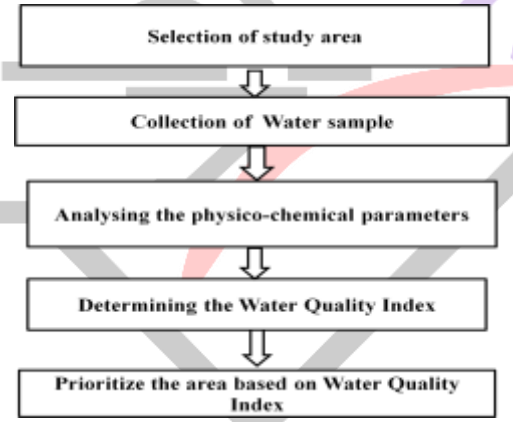

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Fig 2: Flowchart of Methodology

The first step involves the identification and selection of study area. The second step is collection of ground water samples from different locations of the study area. These ground water samples are analyzed using various laboratory procedures. Water Quality Index is calculated. Then the prioritizing of the area is done based on Water Quality Index.

VI. RESULT AND DISSCUSSION

The statistical summary of physico-chemical parameters and WQI variation of 11 samples each taken from open well and bore well

Table 1: Significance weight and water quality parameters

SL No	Parameter	Standards (BIS-10500) (1991)
1	pH	6.5-8.5
2	TDS	500-2000
3	Hardness	200-600
4	Calcium	75-200
5	Bicarbonate	200-600
6	Sulphate	200-400
7	Chloride	250-1000
8	Nitrate	<45
9	Fluoride	1-1.5
10	Iron	<0.3

[All the values are in mg/lt except pH and turbidity]

In Udupi district, Karnataka is given in Table 2and 3. The Hydrogen ion concentration (pH) values are one of the important factors of groundwater and in present study, the value of pH is found lower than the desired limit (8.5) prescribed by BIS in all the samples.

Total dissolved solids (TDS) in all the samples taken from open well varies from 40-276 mg/l while in the samples taken from bore well, TDS varies from 216-3444 mg/l. The higher values of TDS are attributed to application of agricultural fertilizer contributing the higher concentration of ions into the groundwater

The Hardness of water is a measure of dissolved Ca and Mg and is expressed as (CaCO3) and in the samples taken from open well it varies from 211 to 960 mg/lin the samples taken from bore well it varies from 462 to 2230 mg/l. Accordingly, the groundwater quality in study area is classified as hard water.

Fluorides concentration in groundwater is found to exceed thepermissible limit of 1.5 mg/l in most of the samples and the main sources of fluoride are geogenic/natural like minerals, rocks and sediments. The spatial distribution of fluoride is shown in Figure 3, which indicates fluoride concentration is evenly distributed in whole district. The chloride content in most of the samples taken from open well and few samples from bore well have high chloride concentration and some much higher the permissible limit of 200 mg/l. This may be due to its wide distribution in naturalenvironment. The average nitrate value is observed 2.0 mg/l and 1.9 mg/l, in the samples taken from open well and bore well, respectively which is well within the permissible limit of 45 mg/l.

The average concentrations of iron is found 2.09 mg/l and 1.04 mg/l, in the samples taken from hand pump and bore well, respectively exceeding the desirable limit of 0.3 mg/l. Excess iron in water is mostly accumulated through the weathering of rocks and industrial effluents discharge.

The computed WQI values and their spatial distribution for 80 bore wells and open well each in Udupi district, can be categorized into “fair” type. The water needs ‘Filtration and disinfection’ treatment. The reason of low values of WQI may be the higher values of TDS, total hardness, fluoride, chloride, bicarbonate, nitrate and sulphate.

Calculation of Water Quality Index

Suitable weights(**wi**) are assigned to the parametersRelative weights(**Wi**) are calculated using the following formula:

Wi={wi/∑wi}

Quality rating **(qi**) scale is calculated using:

qi=(ci/si)*100

Where **ci** is calculated concentration of each test parameter, **si** is the Indian limits for the respective parameterSubindex(**Si**) is calculated for each test parameter :

Si=Wi*qi

Water quality index, **WQI=∑Si,** where **Si** is the value of i^{th} parameter

Table 2: Physico-chemical parameters of Udupi District

Sl. No	pH	TDS	Chloride	Calcium	Bicarbonate	Sulphate	Hardness	Nitrate	Iron	Fluoride
1	6.86	216	23.82	84	16	AB	168	0.98	2	0.28
2	6.42	956	19.85	108	24	AB	148	0.93	1.8	0.13
3	6.74	1404	23.82	80	18	AB	156	0.91	1.83	0.7
4	6.46	3444	27.79	56	12	AB	152	0.78	0.4	0.22
5	6.8	620	19.85	104	26	AB	168	0.9	0.15	0.25
6	7.01	1924	23.82	80	22	AB	168	0.85	1.4	0.41
7	6.95	288	19.85	104	18	AB	224	0.9	0.25	0.43
8	6.91	1812	19.85	116	16	AB	136	0.86	0.25	0.39
9	6.82	1632	15.88	112	28	AB	176	0.78	0.49	0.36
10	6.81	2064	17.86	84	20	AB	168	0.89	0.15	0.16
11	6.19	1208	19.85	112	26	AB	160	0.86	0.28	0.21
12	7.56	268	29.77	168	18	AB	188	0.75	0.47	0.36
13	7.38	1768	27.79	72	14	AB	136	0.1	0.6	3
14	6.91	188	23.82	100	18	AB	152	0.36	0.53	0.2
15	7.42	4	33.77	64	24	AB	116	0.22	0.81	0.46
16	6.9	76	29.77	56	14	AB	80	0.11	0.72	0.53
17	6.85	104	23.82	104	22	AB	80	0.13	0.45	0.9
18	6.15	204	47.65	72	12	AB	92	0.13	0.18	0.24

Table 3: WQI of Udupi District

Sl no	pH	TDS	Chloride	Calcium	Bicarbonate	Sulphate	Hardness	Nitrates	Fluoride	Iron	WQI
1	12.35	5.836	7.718	3.024	0.648	AB	3.02	0.294	2.017	43.24	75.11
2	11.56	25.83	6.432	3.888	0.972	AB	2.66	0.279	0.936	38.91	88.79
3	12.14	37.93	7.718	2.88	0.729	AB	2.80	0.273	5.044	39.56	106.26
4	11.63	93.05	9.004	2.016	0.486	AB	2.73	0.234	1.585	8.648	126.67
5	12.24	16.75	6.432	3.744	1.053	AB	3.024	0.270	1.801	3.243	45.52
6	12.62	51.98	7.718	2.88	0.891	AB	3.02	0.255	2.954	30.26	109.54
7	12.51	7.78	6.432	3.744	0.729	AB	4.03	0.270	3.099	5.405	39.94
8	12.44	48.96	6.432	4.176	0.648	AB	2.44	0.258	2.810	5.405	81.11
9	12.28	44.09	5.145	4.032	1.134	AB	3.16	0.234	2.594	10.59	80.09
10	12.26	55.76	5.788	3.024	0.81	AB	3.02	0.267	1.153	3.243	82.30

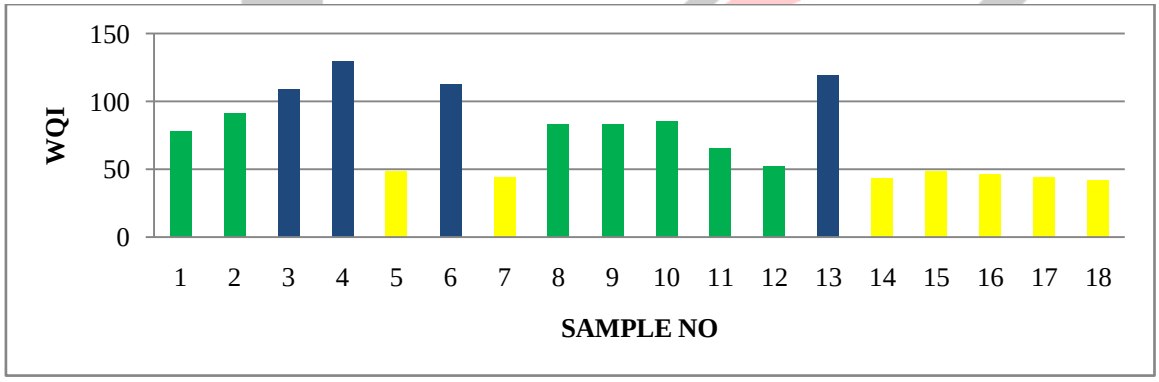
11	11.15	32.64	6.432	4.032	1.053	AB	2.88	0.258	1.513	6.053	62.12
12	13.61	1.81	9.64	6.04	0.72	AB	7.24	0.225	2.594	10.161	52.07
13	13.29	11.94	9.00	2.59	0.56	AB	47.77	0.030	21.62	12.97	119.79
14	12.44	1.26	7.71	3.6	0.72	AB	5.07	0.108	1.441	11.458	43.85
15	13.36	0.02	10.93	2.304	0.97	AB	0.18	0.066	3.315	17.512	48.60
16	12.42	0.51	9.64	2.01	0.56	AB	2.05	0.033	3.819	15.566	46.64
17	12.33	0.70	7.71	3.74	0.89	AB	2.81	0.039	6.486	9.729	44.45
18	11.07	1.37	15.43	2.59	0.48	AB	5.51	0.039	1.729	3.891	42.14

Prioritizing the area based on water quality index

Table 4: Standard value of WQI

WATER QUALITY INDEX	DESCRIPTION	Colour
<50	Excellent	Yellow
50-100	Good	Green
100-200	Poor	Blue
200-300	Very poor	Orange
>300	Unsuitable for drinking	Red

Graph 1: Value of WQI



VII. CONCLUSION

- Out of 37 collected samples from Kundapur 97% are excellent and 3% are good and it is fit for drinking. Out of 38 collected samples from Karkala, 68% are excellent, 8% are good and 11% are poor in quality, hence treatment should be provided for poor quality water before using.
- After the study of different water quality indices, it may be inferred that the aim of WQI is to give a single value to water quality of a source along with reducing higher number of parameters into a simple expression resulting into easy interpretation of water quality monitoring data.
- The analysis reveals that the ground water of an area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.

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