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Assessment of Quality of Water Resources in Radhanagari

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***Abstract*— This paper contains the water quality evaluation of the water resources available in the town of Radhanagari. Assessment of water quality is the general method of assessing the physical, chemical and biological nature of water. In this research work, we surveyed the village of Radhanagari and selected 15 surface and groundwater sample sites. We calculate the water sample's physical, chemical and biological parameters as pre-monsoon and post-monsoon season and represent the seasonal variations of these parameters. It is vital to explore the consistency of water from time to time to ensure good water quality as environmental factors continue to change, thus affecting the quality of water. Based on this examination, we realized that the available water sources are appropriate for drinking purposes or not.**

Keywords — Water quality of water resources, drinking water water quality, ground water quality, water quality assessment.

I. INTRODUCTION

Water may be a profitable and limited asset on Soil. Water amount as well as quality are becoming dominant issues in numerous nations. Water could be a rare valuable source which is the essential prerequisite for presence of all living things. The operations included in water quality analysis are a lot of complicated. Water quality appraisal is the around the world handle of assessment of the physical, chemical and natural nature of the water, through water quality checking is the gathering of the significant data. Thus, numerous nations have significant problems concerning not as it were extreme water shortage but moreover destitute water quality.

Soil and surface water that are the most sources of new water for drinking purposes, water system and different other uses, speak to as little division of water burden on soil. It is pointed out that as it were 30% of the freshwater (3% of the full volume of water on Soil is groundwater). Yet, streams are the fundamental water hotspots for household, modern, and farming water system purposes. In a local, stream water quality is one among vital factors legitimately in regard to with soundness of mankind and living creatures. In this manner, it is essential just as fundamental to have trustworthy information on water quality attributes for practical defilement control and water resource organization.

I. STUDY AREA

Radhanagari would be a village and the central command of Radhanagari tehsil inside the radhanagari subdivision in the Indian Territory of Kolhapur of Maharashtra. The geocoordinate of the scope 16.40571 and the longitude 73.9662898 Radhanagari. It's placed on the bank of Bhogawati River, close to the Laxmi Talav Dam and the radhanagari forest. Radhanagari gets daily response from surrounding villages as Radhanagari is a taluka. Main attraction of Radhanagari is Laxmi Talav for the visitors as Radhanagari has a beauty of nature in all 3 seasons. So that thousands of visitors visits the village which has full of natural environment.

In 2011, Radhanagari village's literacy rate was 84.01 percent compared to Maharashtra's 82.34 percent. As By the constitution of India and the Panchayati Raaj Act, the village of Radhanagari's Sarpanch is administered (Village Head) who is chosen illustrative of the town.

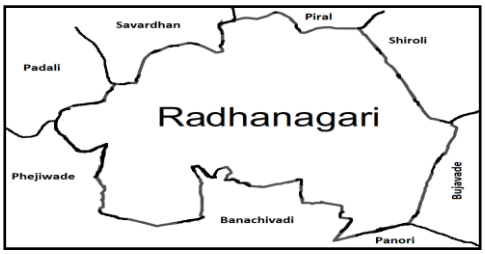

Fig.1- village map

RAINFALL:

The major portion of this persists in the rain shadow of the Sahyadri rangas. It gets rain from the south-east and from north-east monsoons. In this village the rain falls from May to November. However, main season is from June to October. Months of June, July, and August are of heavy rainfall. In this area the rainfall is very heavy and farming without irrigation is possible in rainy season. Following table gives us the annual rainfall information of Radhanagari.

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Year	Annual Rainfall in mm (1June To 31 May)
2007/08	5634.00
2008/09	4904.00
2009/10	4285.00
2010/11	4306.00
2011/12	3871.00
2012/13	5554.00
2013/14	4340.00
2014/15	4823.00
2015/16	2779.00
2016/17	4534.00
2018/19	5361.00

Table No.1- Annual Rainfall

In this village the ground water sources are total 03 bore wells and 10 open wells which are properly works in all seasons and the surface water sources are 01 brooklets and Bhogavati River which is the central belt of Radhanagari. Following table gives the sample location.

Sample No.	Location(geocoordinates)
Surface water-	
1.	(NL-16^0 25’25”; EL-73^0 59’45”)
2.	(NL-16^0 24’31”; EL-73^0 59’44”)
Open wells-	
3.	(NL-16^0 24’39”; EL-74^0 0’1”)
4.	(NL-16^0 24’38”; EL-74^0 0’1”)
5.	(NL-16^0 24’39”; EL-74^0 0’1”)
6.	(NL-16^0 24’28”; EL-73^0 59’52”)
7.	(NL-16^0 24’28”; EL-73^0 59’52”)
8.	(NL-16^0 24’26”; EL-73^0 59’53”)
9.	(NL-16^0 24’41”; EL-73^0 59’56”)
10.	(NL-16^0 24’40”; EL-73^0 59’56”)
11.	(NL-16^0 24’40”; EL-73^0 59’41”)
12.	(NL-16^0 24’41”; EL-73^0 59’56”)
Bore wells-	
13.	(NL-16^0 24’48”; EL-74^0 0’0”)
14.	(NL-16^0 24’39”; EL-74^0 0’1”)
15.	(NL-16^0 24’43”; EL-73^0 59’41”)

Table No.2-sample location

III. METHODOLOGY

Analysis of Physical, Chemical and Biological Parameters:
In this research work, the physical, and chemical parameters of water quality are studied. The parameters are temperature, turbidity, electrical conductivity, pH, and total dissolved solids, (TDS), hardness, alkalinity, chloride, nitrate, sulphate, calcium, magnesium, sodium, potassium, nitrogen, and phosphate. The outcomes of the site of each sample is presented as post monsoon and pre monsoon and discussed seasonal variation for each parameter.
Biological parameters are significant factors that determine water quality as a drinking intent. It's more crucial throughout the immediate impact of human health than physical and chemical parameters. It is seemed to define the presence of microbiological organisms and water-borne pathogens. When eaten by humans and livestock, many organisms can cause disease. Either naturally or through the release of untreated or partially handled waste material, microorganisms and waterborne pathogens enter the water resources as river, brooklets, wells etc. Polluted with Escherichia coli and coliform bacteria, drinking and bathing water can readily trigger diseases.
Water samples were collected in pre monsoon and post monsoon seasons. The samples were collected in one litre plastic cans. Above mentioned parameters were analyzed and tabulated in following tables. The seasonal variation of each parameter is shown below by graphically.

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sample	temp(^{0}C)	pH	Turbidity(NTU)	EC(µmhos/cm)	TDS(mg/L)
1	21	8.40	2.0	74	38
2	20	7.21	1.5	85	162
3	20.5	7.52	1.4	359	135
4	21	6.51	1.1	237	140
5	20	7.22	1.2	174	81
6	21	6.97	1.3	345	212
7	21	7.02	1.5	246	168
8	20	7.33	1.3	346	180
9	21	7.64	1.2	236	155
10	21	8.04	1.0	347	120
11	21.5	8.42	1.3	248	118
12	20	8.15	1.0	278	121
13	21	7.11	0.9	332	115
14	20.5	7.29	0.8	306	165
15	20	7.52	1.0	269	122

Table No.3- Post Monsoon Physical Parameters

sample	Temp(^{0}C)	pH	Turbidity(NTU)	EC(µmhos/cm)	TDS(mg/L)
1	22	8.21	0.8	72	36
2	22	6.84	0.7	80	165
3	20	6.92	1.2	389	137
4	20.5	7.26	1.3	273	145
5	21	7.80	1.1	168	85
6	22	6.75	1.5	355	210
7	21.5	7.79	1.2	256	173
8	22	6.20	1.4	326	184
9	20	7.38	1.3	216	157
10	22	7.68	1.1	367	118
11	22.5	8.40	1.0	268	115
12	21.5	8.24	1.2	298	119
13	22	8.05	0.8	352	110
14	20	7.32	0.7	336	168
15	21	7.56	0.8	289	126

Table No.4- Pre Monsoon Physical Parameters

sample	TH	Alkalinity	Cl	NO_3	SO_4	Ca	Mg	Na	K	Phosphate	N
1	92	75	3	6.23	64.75	24.30	25	5.6	2.6	2.32	16
2	74	77	8	7.18	92.36	22.0	23	5.2	4.3	2.59	19
3	97	81	19	18.48	85.40	14.4	18	5.3	4.9	1.52	20
4	123	91	8	13.74	84.47	19.8	16	6.5	4.7	1.85	22
5	62	78	6	12.64	85.49	12.3	24	7.0	2.8	1.92	20
6	103	87	19	21.89	80.41	16.4	12	6.0	5.9	1.61	16
7	114	90	16	16.69	86.49	21.4	21	5.9	7.6	1.11	20
8	132	132	57	26.71	92.75	18.7	18	7.6	7.8	2.58	23
9	178	84	41	16.91	79.41	16.2	17	8.0	5.8	2.02	17
10	128	92	13	8.63	72.89	22.2	22	3.8	7.3	1.34	14
11	74	85	16	7.86	67.95	15.8	15	7.0	6.7	1.25	21
12	103	80	7	8.48	82.0.2	12.1	11	8.8	5.9	1.02	19
13	112	65	13	19.05	47.92	32.5	32	2.5	2.5	1.60	13
14	158	74	9	2.34	50.98	24.9	25	4.5	4.5	2.05	15
15	118	70	11	5.43	54.18	23.8	23	2.7	4.7	2.42	16

Table No.5- Post Monsoon Chemical Parameters

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sample	TH	Alkalinity	Cl	NO_3	SO_4	Ca	Mg	Na	K	Phosphate	N
1	90	71	2	6.75	67.64	24.0	20	6.0	2.8	2.36	15
2	70	70	7	7.05	94.56	23.2	22	4.3	4.4	2.65	18
3	95	76	20	19.75	86.44	15.6	15	6.8	5.0	1.56	21
4	125	90	7	13.56	88.44	18.2	14	7.0	4.8	1.89	24
5	60	72	5	11.44	84.50	11.2	21	7.6	2.4	1.98	19
6	105	82	18	21.05	82.14	16.8	14	5.4	5.8	1.65	15
7	111	70	15	17.89	88.42	23.3	23	7.2	6.7	1.09	19
8	135	120	58	27.05	90.50	19.9	20	8.2	7.2	2.60	25
9	180	88	42	15.68	84.45	17.4	19	8.4	4.9	2.01	16
10	130	76	12	8.08	76.46	23.8	23	4.5	7.1	1.36	13
11	70	80	15	6.82	69.68	12.6	12	6.2	5.7	1.22	22
12	105	78	6	9.85	84.05	11.8	13	8.5	4.8	1.08	20
13	110	60	12	18.71	48.54	32	28	2.8	2.7	1.62	12
14	160	72	8	2.88	51.24	25.6	23	3.9	3.6	2.23	18
15	120	74	10	5.75	56.80	24.7	24	2.1	4.3	2.20	14

Table No.6- Pre Monsoon Chemical Parameters

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total coliform (MPN/100mL)	11	07	12	13	10	19	15	19	10	15	08	10	07	10	09

Table No.7- Post Monsoon Biological Parameters

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total coliform (MPN/100mL)	10	08	11	15	12	21	13	13	12	16	07	11	06	09	10

Table No.8- Pre Monsoon Biological Parameters

Graphically the seasonal variation of all parameters is shown below:

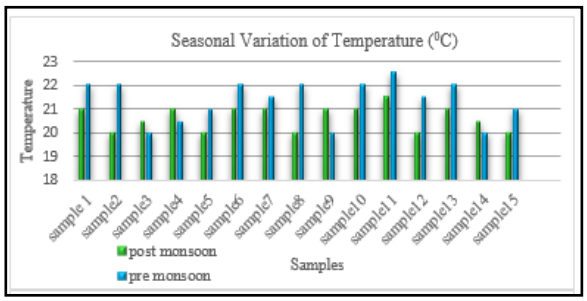

Fig.2-Graph- Seasonal Variation of Temperature

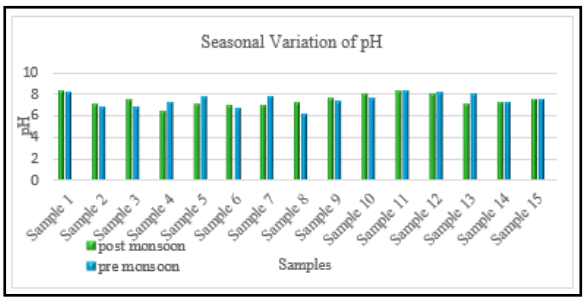

Fig.3-Graph- Seasonal Variation of pH

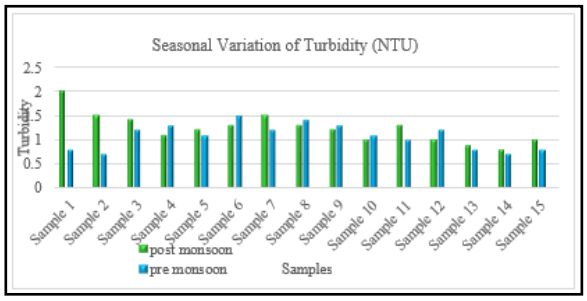

Fig.4-Graph- Seasonal Variation of Turbidity

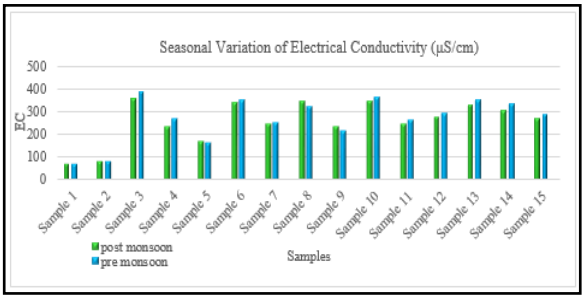

Fig.5-Graph- Seasonal Variation of EC

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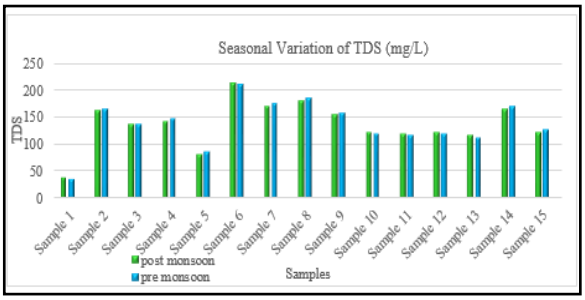


Fig.6-Graph- Seasonal Variation of TDS

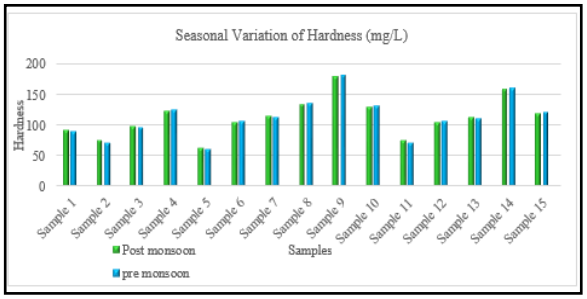
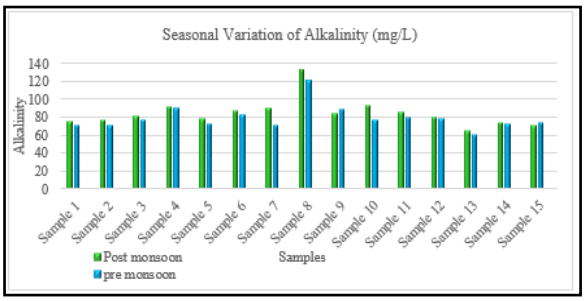


Fig.7-Graph- Seasonal Variation of Hardness



\Fig.8-Graph- Seasonal Variation of Alkalinity

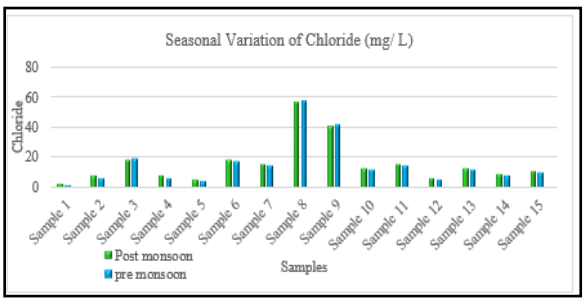


Fig.9-Graph- Seasonal Variation of Chloride

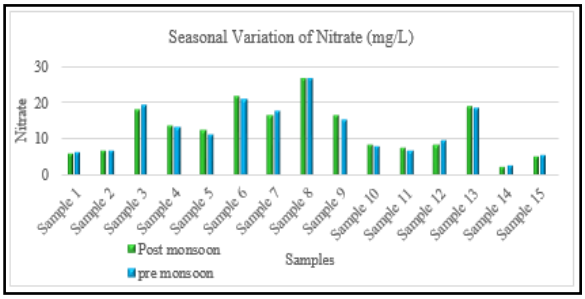


Fig.10-Graph- Seasonal Variation of Nitrate

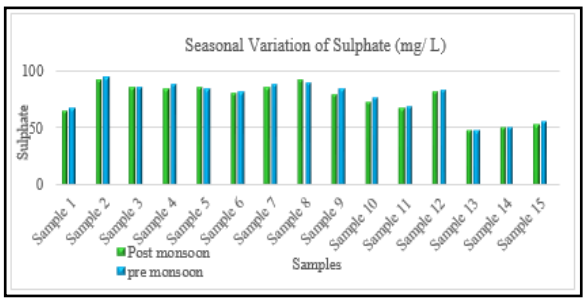


Fig.11-Graph- Seasonal Variation of Sulphate

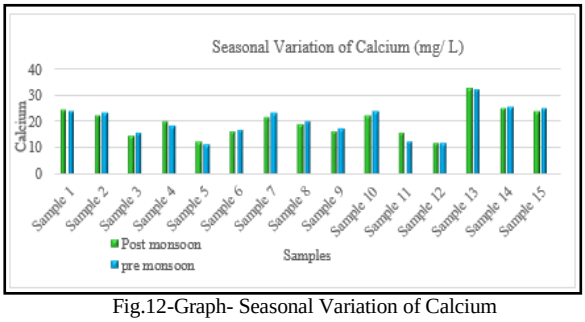


Fig.12-Graph- Seasonal Variation of Calcium

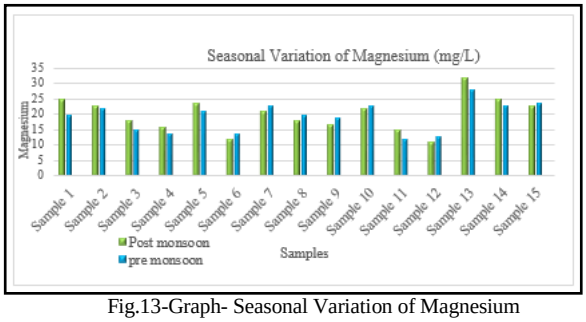


Fig.13-Graph- Seasonal Variation of Magnesium

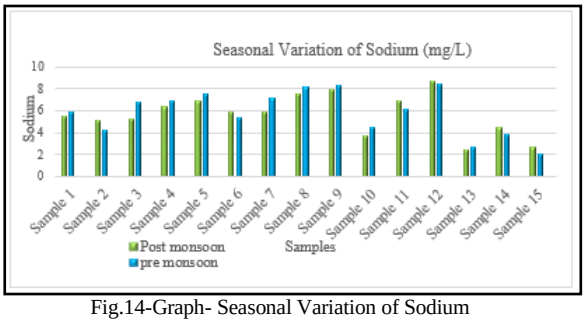


Fig.14-Graph- Seasonal Variation of Sodium

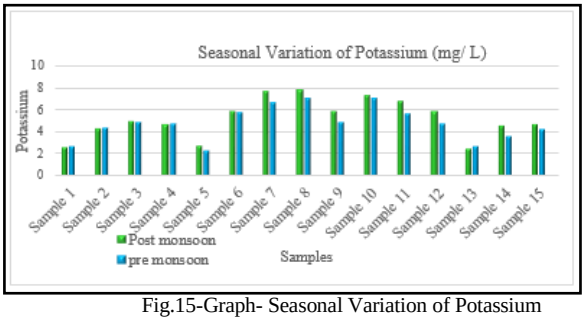


Fig.15-Graph- Seasonal Variation of Potassium

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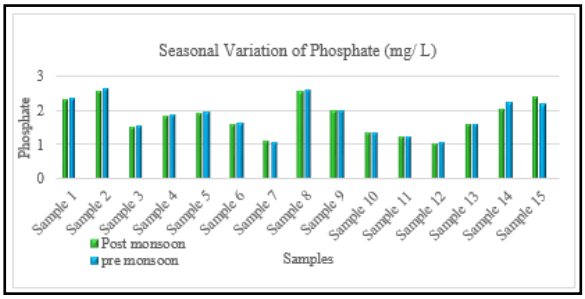

Fig.16-Graph- Seasonal Variation of Phosphate

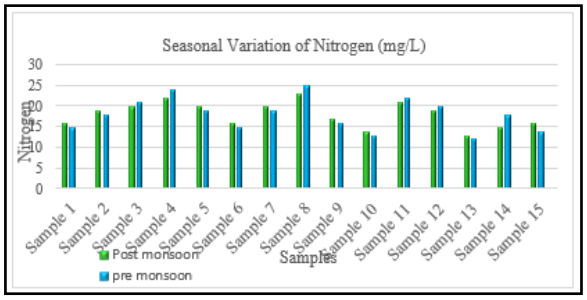

Fig.17-Graph- Seasonal Variation of Nitrogen

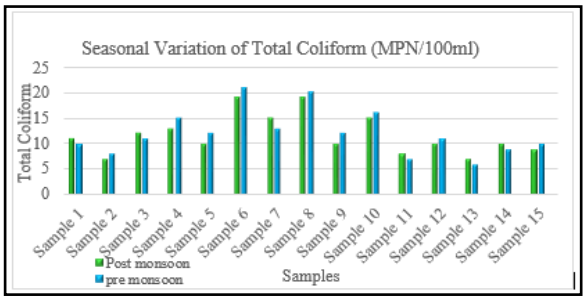

Fig.18-Graph- Seasonal Variation of Total Coliform

IV. RESULT AND DISCUSSION

Temperature:

Temperature acts as a significant chemical and biological role reactions of organisms in water. The reactions are speeded up at higher temperatures along with reduction in solubility of gases and changes in taste and odour. The best temperature range for pleasantly tasting and refreshing water is between 7^0C and 11^0C. Temperature also controls other parameters like pH, conductivity and solubility of gases and hence plays a significant part role in their determinations [1]. The oscillations of seasons in water temperature at the 15 different Sampling place shown in Table No.3&4 and it is graphically in Fig.2. There is not much temperature variation in sampling as the morning sample was gathered, the general range of temperature for this 15 samples is varies between 20^0C to 22.5^0C which is within desirable limit (below 40^0C).

pH:

pH is a hydrogen ions indicator in water, reflecting the acidic or alkaline condition of water. Natural water has pH of 7.0, any disturbance from this value leads to water being acidic (pH<7.0) or alkaline (pH>7.0) due to imbalance in H+ and OH- ions concentration. Generally most fresh waters are alkaline because of the appearance of carbonates in large amount. Affects in pH occur due to biological activity, disposal of waste etc. as such pH has no direct adverse effect on health of living systems. The pH of all the 15 locations of study area varied in a range of 6.20 to 8.40 which are in desirable limit prescribed by WHO (6.0 to 8.5). The seasonal variation of pH values is shown in Table No.3&4 and graphically given in Fig.3.

Turbidity:

Turbidity is due to the presence of particles which having sizes bigger than the true particles i.e., sizes greater than 10-9m, like clay, silt, organic matter and microscopic organisms. The seasonal change (post and pre monsoon) in the turbidity level of water which is collected from 15 different location of water resources in Radhanagari Village is seen in Table No.3&4 and graphically presented in Fig.4. In the recent work it is seen that, an average turbidity is slightly more for post monsoon Compared with pre monsoon and yet it is within the desired limit (5NTU) as WHO prescribed.

Electrical Conductivity:

Water conductivity shows the availability in water of ionic salts. It also offers recognition of the concentration of TDS and industrial discharges in it. The connection between TDS and conductivity relies on the type and character of the dissolved ions in water. [2].Conductivity is heavily temperature-dependent. Water can be categorized based on electrical conductivity values as,

Type	Range of Electrical Conductivity
Excellent	250 µS/cm
Good	250-750 µS/cm
Permissible	750-2000 µS/cm
Doubtful	2000-3000 µS/cm
Unsuitable	>3000 µS/cm

In the current research, Table No.3&4 shows the seasonal variation in electrical conductivity and graphically in Fig. 5.After the analyzing samples, generally EC range varied from 72 µS/cm to 389 µS/cm which is excellent as well as good range of EC and within desirable limit.

Total Dissolved Solids:

Concentration of dissolved solids is a significant thing parameter to assess water quality. Natural water contains carbonates, bicarbonates, sulphates, nitrates, phosphates and chlorides of calcium, magnesium, sodium and potassium dissolved solids. Seasonal variation of TDS in table No.3&4

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and graphically seen in Fig.6. The values of the TDS varied from 36 mg/L to 212 mg/L for all 15 sample locations. The TDS value below 100 mg/L is categorized as non-saline water [3]. Sample No.1 and 5 are non-saline in this investigation.

Hardness:
Hardness=calcium + magnesium.
Water can be categorized on the criteria of hardness,

Type	Range of Hardness
Soft water	0-60 mg/L
Moderately hard	60 – 120 mg/L
Hard	120- 180 mg/L
Very hard	> 300 mg / L

The Table No.5&6 shows the seasonal variation of total hardness and graphically depicted in the Fig.7. The present research work indicates that water hardness in the region of research ranges from 60 mg/L to 180 mg/L which is below desirable limit. According to above classification the water's hardness ranges from moderately hard to hard.

Alkalinity:
Water alkalinity is because of carbonate salts, bicarbonates, phosphates, nitrates, and silicates along with free hydroxyl ions. The seasonal variation of alkalinity is compiled in the table No.5&6 and graphically displayed in Fig.8. The alkalinity of this research ranged from 60 mg/L to 132 mg/L, which is in desirable limit as recommended by WHO (200 mg/L).

Chlorides:
The rise in chloride concentration improves water's electrical conductivity. Chloride does not have a negative health effect, but it gives poor taste to drinking water. Chlorides are present normally in all kinds of waters, with fresh water having low concentrations. It is harmless up to 1500 mg/L but imparts a salty taste at 250 – 500 mg/L [1]. The seasonal change of chlorides depicted in Table No.5&6 and graphically described in Fig.9. Chloride ranges from 2 mg/L to 58 mg/L. The chloride content for water samples of all 15 locations displayed well below the acceptable limit [250 mg/L (WHO)].

Nitrate:
Nitrate normally arise in trace quantities in surface water. It can induce methemoglobinemia in infants which destroys RBC's oxygen transportation ability. Nitrates are obtained as the final oxidation product of ammonia and also due to oxidation of nitrites by micro bacteria. It's very essential nutrient in an ecosystem. However, if present in large amounts it could prove toxic even leading to death. The seasonal nitrate variation is listed in table No.5&6 and graphically described in Fig.10. In this research nitrate ranges from 2.34 mg/L to 27.05 mg/L.

Sulphate:
Presence of sulphate in water has does not adversely effect on health. Sulphate is a significant anion discovered water minerals like gypsum, pyrite etc. The allowable limit of (SO_4^{2-}) sulphate as per the WHO is 500 mg/ L. Low level of Sulphate ions do not change the taste of water [4]. It is a gastro intestinal irritant if present in high concentration. The seasonal sulphate changes in concentration is depicted in Table No.5&6 and also depicted graphically in Fig.12. In this research, the concentration of sulphate is discovered well below 500 mg/L and its value varies between 47.92 mg/L to 94.56 mg/L.

Calcium:
Calcium is, of course, found in water. It is dissolved from rocks and soils attributing hardness to water. The existence of calcium in water promotes to the creation of a scale. The primary sources of calcium in groundwater are silicate minerals, igneous and metamorphic rocks, calcareous and sedimentary rocks. The permissible calcium limit in water is 75–200 mg/L, as per the WHO. The current research shows the seasonal variation of calcium in Table No.5&6 and graphically summarized in Fig.13. The calcium is present within the allowable limits, which is ranged from 11.8 mg/L to 32.5 mg/L.

Magnesium:
Magnesium also adds to water hardness. It is sourced from minerals like dolomite, magnetite etc. Magnesium forms the other important component of hardness of water along with calcium. In water the magnesium limit is approximately 100mg / L (WHO). The seasonal magnesium variation is illustrated in the table No.5&6 and graphically in Fig.14. Generally, the magnesium content ranges from 11 mg/L to 32 mg/L, which is well within the boundaries allowed in this research.

Sodium:
Sodium is a massive component of potable water with an average presence of greater than 100mg/L [15]. High concentration of sodium leads to difficulty in boiler operations. It also affects health. The allowable sodium threshold in water is 200 mg / L (WHO). The seasonal changes is represented in Table No.5&6 and graphically shown in Fig.14. The variation in sodium content is between 2.1 mg/L to 8.8 mg/L that is well within the permitted limit.

Potassium:
The potassium concentration in potable water relies on the sort of therapy used. Water that passes through permanganate has reduced potassium concentrations than water that utilizes mostly softener derived potassium. The potassium concentrations discovered in drinking water are small enough not to be a good person problem, states the WHO. The seasonal change of potassium is depicted in Table No.5&6 and graphically in Fig.15. In this work potassium values varies from 2.5 mg/L to 7.8 mg/L, which is under the desired limit. (WHO 250 mg/L).

Phosphate:
Phosphate can occur both as soluble and insoluble forms. It naturally happens in water from leaching of phosphorous rich rocks, and also from sources anthropogenic [6]. The phosphate limit permitted in water by the WHO is 5 mg / L.

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The seasonal phosphate variation is viewed in Table No.5&6 and graphically shown in Fig.16. Phosphate values vary from 1.02 mg / L to 2.65 mg / L which is under the desirable limit in the current research. (WHO 5 mg / L).The phosphate ion is either absent or present in both seasons below the permissible threshold for samples of water from the 15 places.

Nitrogen:

Probably the most frequently used nitrogen fertilizers are- $NaNO_3$ (sodium nitrate) &NH_4NO_3 (ammonium nitrate).Too much nitrogen as nitrate will harm young babies or young animals in drinking water. Total Kjeldhal Nitrogen's seasonal variation is computed in Table No.5&6 and revealed graphically in Fig.17. The value of TKN ranges from 12 mg / L to 25 mg / L in this research.

Total coliform:

The existence of only a few fecal coliform microorganisms would show that there's no disease infecting organisms in a water in all probability, whereas massive quantities of fecal coliform microorganisms would imply a very elevated likelihood that's water could contain disease producing organisms producing unsafe water for intake. Table No. 22 tabulates the seasonal changes of complete coliform and its graphical representation given in fig. 35 in this research, the complete coliform value varies from 6 MPN/100ml to 20 MPN/100ml.

V. CONCLUSION AND SUGGESTIONS

*Conclusion***:**

It can be concluded from the study of 15 distinct water specimens gained from Radhanagari village surface and groundwater sources that the physical, chemical and biological parameters current in water do not harm the living environment. Physical and chemical parameters are within permissible boundaries in this work of research, but an average turbidity is slightly higher for post-monsoon compared to pre-monsoon. Minimum value of MPN is detectable in few water samples during biological parameter assessment, so that surface water sources and bore well water sources are secure for drinking and household use after some bacteria removal treatments along with some excessive parameters such as phosphate, nitrate, potassium, etc. Mostly open wells due to dirtiness are unworkable for drinking purposes.

Suggestions:

Annual average precipitation intensity in the village of Radhanagari is about 4581 mm, so farming without irrigation is feasible in rainy season. There is no absence of water availability for drinking, national and agricultural use in the post-monsoon season. But people in the pre-monsoon are now facing issues of scarcity access to water. Some suggestions for sustaining water quality and amount are provided below through this research work.

- By educating the people about the harmful effects of disposing domestic, agricultural and biomedical wastage into the river without treatment.
- By educating the people to use filtered water at home for drinking and cooking purposes.
- By giving awareness to the people about importance of government involvement to avoid pollution from Ganpati Visarjan in Bhogavati River and brooklet.
- By restricting the people to wash clothes, vehicles, animals and disposal of crematorium ash in surface water sources.
- By training the farmers to use chemicals and pesticides proportionally and to change the crop pattern seasonally.
- By increasing people's awareness of rainwater harvesting to decrease groundwater pollution and enhance groundwater quality through distillation when refilled to groundwater, thereby offering high-quality water, soft and low in minerals, such as meeting the self-sufficiency of their water supply and promoting domestic water demands throughout the summer and drought.

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