ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Evaluation Of Water Quality Index For Assessment Of Water Quality Of The Garud Chatti Waterfall At Rishikesh, Uttarakhand, India.

Sonu Dwivedi*.

Department Of Chemistry, D.B.S. (PG) College, Dehradun- Uttarakhand, India.

ABSTRACT

Surface water is the water that flows along the surface of the earth and is the second largest source of fresh water, the first being ground water. Precipitation, springs, melting of glaciers etc. are the major sources of surface water. The modern civilization, over exploitation, rapid industrialization and increased population has lead to fast degradation of our environment. In this study, Water Quality Index (WQI) of Garud Chatti Waterfall, Rishikesh was analyzed with the help of ten physicochemical parameters such as Alkalinity, Calcium, Chloride, Electrical Conductivity, Magnesium, Nitrate, pH, Sulfate, Total Dissolved Solid, Total Hardness to know the suitability for drinking purpose during pre and post monsoon seasons of the year 2022.The value of Calcium and Sulfate which exceeded the permissible limit during pre monsoon seasons and during post monsoon season are average. The calculated Water Quality Index values are 86.589 during pre monsoon season and 77.028 during post monsoon season. This water quality rating study clearly shows that, the status of the water body is not suitable for drinking. Which according to Standard Rating of Water Quality is Unsuitable for Drinking Purpose in both monsoon season.

Keywords: Civilization, Environment, Glaciers, Industrialization, Population.

https://doi.org/10.33887/rjpbcs/2023.14.5.13

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The availability of water both in terms of quality and quantity is essential for the very existence of mankind. Water, though indispensable and plays a pivotal role in our lives, is one of the most badly abused resources [1, 2]. Lack of awareness and civic sense, use of inefficient methods and technology lead to more than 50% of water wastage in the domestic, agriculture & industrial sectors. Water pollution is rendering much of the available water unsafe for consumption [3]. The quality of surface water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water [4]. In many parts of the country available water is rendered non-potable because of the presence of heavy metal in excess. The situation gets worsened during the summer season due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems [5, 6]. The demand for potable water is rising due to population increase in developing countries. Such areas are expected to experience imbalances of potable water demand and supply due to climate change [7]. The chemical constituents of groundwater is known to cause some health risks, so supply cannot be said to be safe if specific information on water quality which is needed for sustainable resource development and management is lacking [8]**.** The sources of fresh water in Uttarakhand state are glaciers, rivers and lakes but due to the shortage of rains and snowfall and also because of pollution, in summer Uttarakhand state is suffering from water shortage. To overcome this situation, presently water is the most abundantly (>70 %) consumed natural resource for various human activities [9, 10]. Poor water quality is responsible for the deaths of an estimated five billion children annually in the developing countries. According to World Health Organization (WHO) survey 80% of all human diseases in developing countries are waterborne [11]. Water quality indices are tools to determine conditions of water quality and like any other tool require knowledge about principles and basic concepts of water and related issues [12]. It is a well-known method of expressing water quality that offers a stable and reproducible unit of measure which responds to changes in the principal characteristics of water. WQI is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality [13]. In other words, WQI summarizes large amounts of water quality data into simple terms e.g., excellent, good, bad, etc. for reporting to management and the public in a consistent manner [14]. The analysis of the water is extremely important as it contains a large number of impurities which are necessary to be checked before the water is used for any Specific purpose. In municipal water, which is used for drinking purpose, it is most essential to determine Alkalinity, Calcium, Chloride, Electrical Conductivity, Magnesium, Nitrate, pH, Sulfate, Total Dissolved Solid, Total Hardness etc. However, none of these studies give a comprehensive picture for major drinking water source of Garud Chatti Waterfall, Rishikesh, Uttarakhand, India about suitability of their water quality for drinking purpose.

MATERIALS AND METHODS

Study Area

Garud Chatti waterfall is one of the most famous waterfalls in not only Rishikesh but also in Uttarakhand. Garud Chatti Waterfall from Rishikesh involves an approximately 4.2 km or 55 minute walk from the Laxman Jhula bridge in Tapovan and at a distance of 11 km from Rishikesh Railway Station. It is nearly 1339 meters above sea level at 78.3546^{o}'East longitude and 30.1244^{o}'North latitude. It is renowned because of its natural beauty as it is located quite close to Lakshman Jhoola and Neelkanth Mahadev temple. The waterfall is not one of the highest falls in Uttarakhand but the force and ferocity of the water are quite high in this fall [15].

Collection And Analysis Of Water Sample

The water sample were collected in the pre and post monsoon season 2022 and analyzed for 10 physicochemical parameters by following the established procedure. The parameters pH and electrical conductivity were monitored at the sampling site and other parameters like TDS, alkalinity, total hardness, calcium, magnesium, chloride, nitrate and sulfate were analyzed in the laboratory as per the slandered methods of APHA [16]. During study period WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian Standards [17].

ISSN: 0975-8585

Figure: View of Study area

Calculation Of Water Quality Index

WQI is defined as a rating technique that demonstrates the composite influence of individual water-quality parameters on the overall quality of water for human consumption [18]. For this study, 10 water-quality parameters were selected. The parameters used to develop a WQI depend on the purpose for which the water is used. Parameters were selected according to the availability of data as well as their relative importance in defining water quality for human consumption. The parameters for this purpose follow the WHO guidelines. WQI is calculated by assigning weights to the measured parameters based on their relative importance. WQI tool is used successfully to state the quality of water for water bodies. The calculation of the WQI is well explained [19] and the same formula was applied to calculate the WQI The weighted arithmetic index method [20] has been used for the calculation of WQI in this research .

Calculation of Quality rating (Q_i)

Quality rating scales have been chosen so that each characteristics is assigned as a value depending on observed concentration. A survey of literature revealed that there are following six different methods of combining water quality rating curves and associated weightings: Unweighted arithmetic index, Weighted arithmetic index, Unweighted Solway index, Weighted Solway index, Unweighted geometric index, Weighted geometric index.

In this study, weighted arithmetic index is used to formulate rating curve. Permissible limits of variables is taken as the minimum and maximum values of the rating scale (varying from 0 to 100). When water quality rating (Q_i) is proportional to zero, it indicates the absence of such parameter for the rating. However, when Q_i rating is 100, it means that respective parameter is within the prescribed limit and if rating is more than 100, it signifies the parameter is above the standard limit.

Quality rating for each parameter was calculated by using the following equation

$$Q_i = \frac{(V_{actual} - V_{ideal})}{(V_{standard} - V_{ideal})} \text{ X } 100$$

Where,

Q_i = Quality rating of i^{th} parameter for a total of n water quality parameters.
V_{actual} = Actual value of the water quality parameter obtained from laboratory analysis
V_{ideal} = ideal value of that quality parameter can be obtained from the standard tables.
V_{ideal} for pH = 7 and for other parameters it is equating to zero and V_{ideal} DO = 14.6 mg / L
$V_{standard}$ = Recommended WHO standard of the water quality parameter.

ISSN: 0975-8585

Calculation of Unit weight (W_i)

The specific weight, also known as the unit weight, is the weight per unit volume of a material. The unit weight of water is one such property. It can be expressed in a variety of ways, depending on the particular units chosen. Results of total unit weight (W_i) of all the parameters used to find out Water Quality Index (WQI).

Unit weight is calculated by a value inversely proportional to the recommended standard (SI) for the corresponding parameter using the following expression

$$W_i = \frac{K}{S_i}$$

Where,
W_i = Unit weight for n^{th} parameter
S_i = Standard permissible value for n^{th} parameter
K = proportionality constant, For the sake of simplicity, K is assumed as 1,

The overall WQI is calculated by aggregating the quality rating with unit weight linearly using the following equation

$$WQI = \frac{\Sigma W_i Q_i}{\Sigma W_i}$$

Where,

W_iQ_i = Weighted value
W_i = Unit weight

RESULTS AND DISCUSSION

The analysis of the water is extremely important as it contains a large number of impurities which are necessary to be checked before the water is used for any Specific purpose. In municipal water, which is used for drinking purpose, it is most essential to determine Alkalinity, Calcium, Chloride, Electrical Conductivity, Magnesium, Nitrate, pH, Sulfate, Total Dissolved Solid, Total Hardness. The data of physicochemical parameters water of Garud Chatti Waterfall, Rishikesh obtained from pre and post monsoon season 2022 and standard permissible value WHO and ISI was presented in Table 1 and Table 2.

Table 1: Water quality parameters and there WHO & ISI standards in Pre-monsoon season-2022

S. No.	Parameters	Method	WHO Standards	ISI Standards	Sample
1.	Alkalinity	Titration Method	120	200	87
2.	Calcium	EDTA titration	75	75	79
3.	Chloride	Argentometric titration method	250	250	102
4.	Electrical Conductivity	Conductometry	400	300	134
5.	Magnesium	EDTA titration	150	30	28
6.	Nitrate	UV Spectrophoto-metric method	50	45	35
7.	pH	pH metery	8.0	8.5	7.5
8.	Sulfate	Turbidimetric method	250	200	261
9.	Total Dissolved Solid	Filtration Method	1000	500	478
10.	Total Hardness	EDTA titration	100	300	88

ISSN: 0975-8585

Table 2: Water quality parameters and there WHO & ISI standards in Post-monsoon season-2022

S. No.	Parameters	Method	WHO Standards	ISI Standards	Sample
1.	Alkalinity	Titration Method	120	200	33
2.	Calcium	EDTA titration	75	75	65
3.	Chloride	Argentometric titration method	250	250	101
4.	Electrical Conductivity	Conductometry	400	300	98
5.	Magnesium	EDTA titration	150	30	25
6.	Nitrate	UV Spectrophoto-metric method	50	45	21
7.	pH	pH metery	8.0	8.5	7.2
8.	Sulfate	Turbidimetric method	250	200	172
9.	Total Dissolved Solid	Filtration Method	1000	500	358
10.	Total Hardness	EDTA titration	100	300	74

The values of various physicochemical parameters of Garud Chatti water source for drinking purpose is discussed here under in detail:

Alkalinity

Alkalinity is the capacity of water to neutralize the acids. The presence of bicarbonates, carbonates and hydroxides causes alkalinity in the water. These salts in water are due to the dissolution of minerals from rocks, soils, plant and microbial activities. The alkalinity that was reported in the present study was found to be 87 mg/L during pre-monsoon season and 33 mg/L during post-monsoon season. Which according to WHO /ISI standards is average.

Calcium

Calcium is an essential nutrient for aquatic organisms and regulates physiological functions. It is very common in all water bodies Many organism use calcium as a structural or skeletal material. The presence of Calcium ions was found to be 79 mg/L, Which according to WHO /ISI standards is high concentration for drinking water during pre-monsoon season and 65 mg/L during post-monsoon season, Which according to WHO /ISI standards is average concentration for drinking water.

Chloride

Chloride is an essential anion of water. Table salt is the main source of chloride in water, in addition to potassium chloride and magnesium chloride which also make appreciable contribution. In the present study the chloride was found 102 mg/L during pre-monsoon season and 101 mg/L low during post-monsoon season. Which according to WHO /ISI standards are average.

Electrical conductivity

Electrical conductivity is capacity of water to conduct electrical current. It is due to the presence of dissolved salts and minerals. The conductivity was found 134 µs/cm during pre-monsoon season and 98 µs/cm low during post-monsoon season. Which according to WHO / ISI standards are average.

Magnesium

Magnesium is very important element for enzyme activation, growth of chlorophyll and phytoplankton. The main source of Mg is sewage inflows and minerals generate from soil erosion. Magnesium serves mainly as a transition metal in the chlorophyll molecule and play important role in algal photosynthesis. Magnesium ions according to ISI standards should not be exceed 30 mg/L but in the present study it was found 28 mg/L during pre-monsoon season and 25 mg/L during post-monsoon season. The values of Magnesium ions suggest of pre-monsoon season and post-monsoon season are average according to WHO / ISI standards.

Nitrate

Nitrate was higher in winter because of decreased microbial and bacterial activity that reduces the nitrogen conversion into nitrate and nitrite. Lower concentrations of nitrate in surface waters during the summer may be caused by lower nitrate concentrations in ground water discharging to streams and uptake by plants. In the present study the chloride was found 35 mg/L during pre-monsoon season and 21 mg/L during post-monsoon season. Which according to WHO/ ISI standards are average.

pH

pH is defined as the negative logarithm of hydrogen ion concentration. The pH for potable water should be between 7 to 8.5. There are many factors that affect the pH of the water such as presence of dissolved gases, salts, bases, acids. In the present study the pH was found In the present study was found 7.5 during pre-monsoon season and 7.2 during post-monsoon season. Which according to WHO and ISI standards are average during pre-monsoon season and post-monsoon season.

Sulfate

Sulfate is a common anion of water, which comes from its naturally occurring minerals in some soil and rock formations that contains water. In the present study the sulfate was found to be 261 mg/L during pre-monsoon season and 172 mg/L during post-monsoon season. Which according to WHO/ISI standards the value of pre-monsoon season suggest high concentration and value of post-monsoon season suggest average concentration of sulfate ions for drinking water.

Total Dissolved Solids

Total Dissolved Solids is an aggregate of all the dissolved solids present in the water. The amount of Total Dissolved Solids was reported as 478 mg/L during pre-monsoon season and 358 mg/L during post-monsoon season. Which according to WHO/ ISI standards are average during pre-monsoon season and post-monsoon season.

Hardness

Hardness is an important property of water that prevents lathering of water with the soap solution and if exceeds the tolerance limit may lead to serious illness. It causes serious damage to the products of industries and machinery if untreated water is used. The main causes of hardness in water are the presence of bicarbonates, chlorides and sulfates of calcium and magnesium. Total hardness was reported as 88 mg/L during pre-monsoon season and 74 mg/L during post-monsoon season. Which according to WHO / ISI standards are average.

Table 3: Calculation Of WQI For Pre-monsoon season-2022

S.No.	Parameters	Observed values	Standard values	Unit Weight (Wi)	Quality rating (Qi)	Weighted values (WiQi)
1.	Alkalinity	87	200	0.005	43.500	0.217
2.	Calcium	79	75	0.013	105.333	1.369
3.	Chloride	102	250	0.004	40.800	0.163
4.	Electrical Conductivity	134	300	0.003	44.666	0.133
5.	Magnesium	28	30	0.033	93.333	3.079
6.	Nitrate	35	45	0.022	77.777	1.710
7.	pH	7.5	8.5	0.117	88.235	10.323
8.	Sulfate	261	200	0.005	130.500	0.652
9.	Total Dissolved Solid	478	500	0.002	95.600	0.191
10	Total Hardness	88	300	0.003	29.333	0.087
				Σ Wi = 0.207		**Σ WiQi= 17.924**
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 86.589					

ISSN: 0975-8585

Table 4: Calculation Of WQI For Post-monsoon season-2022

S.No.	Parameters	Observed values	Standard values	Unit Weight (Wi)	Quality rating (Qi)	Weighted values (WiQi)
1.	Alkalinity	33	200	0.005	16.500	0.0825
2.	Calcium	65	75	0.013	86.666	1.1266
3.	Chloride	101	250	0.004	40.400	0.1616
4.	Electrical Conductivity	98	300	0.003	32.666	0.097
5.	Magnesium	25	30	0.033	83.333	2.749
6.	Nitrate	21	45	0.022	53.333	1.173
7.	pH	7.2	8.5	0.117	84.705	9.910
8.	Sulfate	172	200	0.005	86.000	0.430
9.	Total Dissolved Solid	358	500	0.002	71.600	0.143
10	Total Hardness	74	300	0.003	24.666	0.073
				Σ Wi = 0.207		**Σ WiQi= 15.945**
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 77.028					

Table 5: Standard Rating of Water Quality as per WQI Values for Determining for Drinking Purpose

S.N.	WQI Classification	Water Quality Grading	Water Quality Rating
1.	0-25	A	Excellent
2.	26-50	B	Good
3.	51-75	C	Poor
4.	76-100	D	Very Poor
5.	Above 100	E	Unsuitable for Drinking Purpose

Water quality index (WQI) is one of the meaningful approaches in surface water and ground water quality assessment. The values of WQI in the sampling location are summarized in Table 3 and Table 4 during pre and post monsoon season-2022.

The calculated Water Quality Index value are 86.589(Table 3) during pre monsoon season and 77.028 (Table 4) during pre-monsoon season. This water quality rating study clearly shows that, the status of the water body is not suitable for drinking. It is also observed that the pollution load is relatively high during pre monsoon season when compared to the post monsoon season. This might be due to the domestic waste is directly discharge in the surrounding people also use this lake to wash their cloths, take bath, sanitation etc., the cattle of the villagers also take bath in this water body.

CONCLUSION

The water quality analysis results in the present study indicated that most of the physicochemical parameters investigated were within the Standard values for drinking water except Calcium and Sulfate which exceeded the permissible limit during pre monsoon seasons and average during post monsoon season.WQI results suggested that the water source of Garud Chatti Waterfall are 'D' grade during pre and post monsoon season. Therefore, the water cannot be recommended for drinking and other domestic purposes without subjecting it to purification. Thus, there is a need to properly manage wastes in the surrounding and control and monitor human activities.

ACKNOWLEDGEMENT

The author is sincerely thankful D.B.S. (P.G.) College, Dehradun and Uttarakhand Jal Sansthan (UJS), Dehradun for providing technical support to carry out the study.

REFERENCES

[1] Kalavathy S, Sharma R, Sureshkumar P. Water quality Index River Cauvery in Tiruchirappalli

district,Tamilnadu. Arch Environ Sci 2011; 5: 55-61.
[2] Ramakrishnaiah CR, Sadashivaiah C, Ranganna G. Assessment of Water Quality Index for theGroundwater in Tumkur Taluk, Karnataka State, India. E-Journal of Chemistry 2009; 6(2): 523-530.
[3] Kushtagi S, Srinivas P. Studies on chemistry and Water Quality Index of ground water in Chincholi Taluk, Gulbarga district, Karnataka India. International Journal of Environmental Science 2012; 2: 1154-1160.
[4] Salami L, Fadayini MO, Madu C. Assessment of a Closed Dumpsite and Its Impact on Surface and Groundwater Integrity: A Case of OkeAfa Dumpsite, Lagos, Nigeria. IJRRAS 2014; 18(3): 222-230.
[5] Kim AG, Cardone CR. Scatterscore: a reconnaissance method to evaluate changes in water quality. EnvironmentalMonitoring and Assessment 2005; 11: 227-295.
[6] Sargonkar A, Deshpande V. Development of an Overall index of Pollution for Surface water based on a General Classification Sheme in India Context. Environmental Monitoring and Assessment 2003; 89: 43-67.
[7] Vairavamoorthy K, Gorantiwar SD, Pathirana A. Managing urban water supplies in developing countries - climate change and water scarcity scenarios. Phys. Chem. Earth 2008; Parts A/B/C 33:330-339.
[8] Nwankwoala HO, Udom GJ. Hydrochemical facies and ionic ratios of groundwater in Port Harcourt, Southern Nigeria. Res J Chem Sci 2011; 1(3):87-101.
[9] Khanna R, Bhutiani R. Determination of water quality index for the evaluation of surface water quality for drinking Purpose. International Journal of Science and Engineering 2013; 1: 09-14.
[10] Tyagi S, Dobhal R. Water quality assessment in terms of water quality index." American Journal of Water Resources 2013; 1: 34-38.
[11] Tebbutt THY. Principles of water quality control. Pergamon press Oxford, England, 1983, 3rd Edn. pp. 42.
[12] Liu CW, Kuo YM. Application of factor analysis in the assessment of ground water quality in a blackfoot disease area in Taiwan, Sci. Total Environ 2003; 313: 77–89.
[13] Verma P, Solanki H. Study of Water Quality of Hamirsar Lake – Bhuj. An International Journal of Bioscience Reporter 2010; 8: 145- 153.
[14] Thakor FJ, Chauhan NB.Water Quality Index (W.Q.I.) of Pariyej Lake Dist. Kheda – Gujarat. Current World Environment 2011; 6: 225-231.
[15] https://en.wikipedia.org/wiki/
[16] American Public Health Association. American Water Works Association (AWWA) and Water Environment Federation (WEF). Standards for Examination of Water and Wastewater 2017, 23rd Ed., American Public Health Association, Washington, DC, USA.
[17] Bureau of Indian Standards. Specification for Drinking Water. IS: 10500, Bureau of Indian Standards 2012, New Delhi.
[18] Verma PU,Chandawat DK. Seasonal variation in physico-chemical and phytoplankton analysis of kankaria lake, Int. J. Life Sciences Leaflets 2011; 19: 842-854.
[19] Upadhyay A, Chandrakala M. Water Quality Index of Ganga River Water, Rishikesh, Uttarakhand, india, International Journal for Research in Applied Sci. & Eng. Technology 2017; 5: 2876-2880.
[20] Brown RMN, O' Connor MFA. Water quality index –crossing the physical barrier (Jenkis, S H ed) In: Proc. Intl. Conf. on Water Poll. Res. Jerusalem 1972; 6: 787 – 797.