INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACY AND CHEMISTRY

Available online at www.ijrpc.com

Review Article

DOI: https://dx.doi.org/10.33289/IJRPC.12.4.2022.12(40)

ASSESSMENT OF DRINKING WATER QUALITY STATUS BY WATER QUALITY INDEX: A CASE STUDY OF SAHASTRADHARA, DEHRADUN, UTTARAKHAND, INDIA.

Sonu Dwivedi

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

ABSTRACT

It has been reported that in India, 50 to 70% of the pollutant load of river, Lakes and streams is from domestic sewage. So obviously it is of no use to apply strict laws only to factories and industries, if municipalities are given free hand to discharge their domestic wastes into water bodies without any treatment. In this study, Water Quality Index (WQI) of Sahastradhara, Dehradun 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 2021. The value of Calcium, Magnesium, Sulfate which exceeded the permissible limit during both monsoon seasons and Total Dissolved Solid at exceeded the permissible limit during pre monsoon seasons but average during post monsoon season. The calculated Water Quality Index values are 101.061 during pre monsoon season and 87.348 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 very poor category and not healthy for drinking purpose.

Keywords: Domestic wastes, Physicochemical parameters, Pollution and Water bodies.

INTRODUCTION

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. The freshwater is of vital concern for mankind[1]. The surface water bodies are the most important sources of water for human activities are unfortunately under a severe environmental stress and are being threatened as consequence of developmental activities[2-3].Water scarcity is increasing worldwide and pressure on the existing water resources is increasing due to growing demand of different sectors such as domestic, agriculture and industrial, hydropower etc[4-5]. Therefore evaluation of water quality is important research topic in the recent years. Water is one of the most important factors for every living organism on this planet[6]. Water is generally used for drinking, fisheries and other domestic purposes in this area. The available fresh water to man is hardly 0.3 to 0.5% of the total water available on the earth and therefore its judicious use in imperative. Lakes are one of the important water resources used for irrigation, drinking, fisheries and flood control purposes[7]. Drinking water quality has been debated generally discharge of direct domestic and industrial effluent wastes, leakage from improperly maintained water tanks and poor management of farm wastes are considered as the major sources of water pollution and ultimately of waterborne diseases[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 thedeveloping 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 Kaliga driver Sahasradhara in Dehradun district of Uttarakhand, India about suitability of their water quality for drinking purpose.

2. MATERIALS AND METHODS

2.1 STUDY AREA

Sahastradhara, meaning thousand fold spring is one of the most popular tourist destinations located in Dehradun district Uttrakhand state of India. It lies on 30.387231 latitude and 78.131606 longitude. This place is situated on the banks of the small river, Kaligad which is a tributary of Song river. The place has magnificent beauty of nature where water drips from the limestone stalactites, making the water abundant in sulphur. It is a warehouse of excellent beauty of caves, waterfalls and terrace farming on steppe by the local people. Its magnificent nature attracts people from faraway places. This place is at about 11 km from the city of Dehradun.Therefore, frequent water quality monitoring of drinking water source of Kaligadriver, Sahasradhara, Dehradun is essential in order to protect its mass population from waterborne diseases and to develop appropriate preventive measures, in case of contamination[15].

Fig. View of Study area

2.2 COLLECTION AND ANALYSIS OF WATER SAMPLE

The water sample were collected in the pre and post monsoon season 2021 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].

2.3 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, UnweightedSolway 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

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

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.

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 (Wi) 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

3. 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 Sahastradhara, Dehradun obtained from pre and post monsoon season 2021 and standard permissible value WHO and ISI was presented in Table1 and Table 2.

Table 1: Water quality parameters and there WHO &

ISI standards in pre-monsoon season-2021

S. No.	Parameters	Method	WHO Standards	ISI Standards	Sample
1.	Alkalinity	Titration Method	120	200	142
2.	Calcium	EDTA titration	75	75	98
3.	Chloride	Argentometric titration method	250	250	188
4.	Electrical Conductivity	Conductometry	400	300	185
5.	Magnesium	EDTA titration	150	30	43
6.	Nitrate	UV Spectrophoto-metric method	50	45	21
7.	pH	pH metery	8.0	8.5	8.2
8.	Sulfate	Turbidimetric method	250	200	342
9.	Total Dissolved Solid	Filtration Method	1000	500	625
10.	Total Hardness	EDTA titration	100	300	195

Table 2: Water quality parameters and there WHO & ISI standards in post-monsoon season-2021

S. No.	Parameters	Method	WHO Standards	ISI Standards	Sample
1.	Alkalinity	Titration Method	120	200	134
2.	Calcium	EDTA titration	75	75	87
3.	Chloride	Argentometric titration method	250	250	121
4.	Electrical Conductivity	Conductometry	400	300	168
5.	Magnesium	EDTA titration	150	30	34
6.	Nitrate	UV Spectrophoto-metric method	50	45	13
7.	pH	pH metery	8.0	8.5	7.6
8.	Sulfate	Turbidimetric method	250	200	287
9.	Total Dissolved Solid	Filtration Method	1000	500	425
10.	Total Hardness	EDTA titration	100	300	163

The values of various physicochemical parameters of Sahastradhara 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 high 142 mg/Lduring pre-monsoon season and 134 mg/L low 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 high 98 mg/L during pre-monsoon season and 87 mg/L low during post-monsoon season. Which according to WHO /ISI standards are very high 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 188 mg/L to be high during pre-monsoon season and 121 mg/L low during post-monsoon season. Which according to WHO /ISI standards is 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 185µs/cmto be high during pre-monsoon season and 168µs/cm low during post-monsoon season. Which according to WHO / ISI standards is 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 43mg/L to be high during pre-monsoon season and 34mg/L low during post-monsoon season. This

value suggest a very high concentration of Magnesium ions.

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 21 mg/L to be high during pre-monsoon season and 13 mg/L low during post-monsoon season. Which according to WHO/ ISI standards is 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 the chloride was found 8.2 to be high during pre-monsoon season and 7.6 low during post-monsoon season. Which according to WHO is high and ISI standards is average during pre-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 342 mg/L during pre-monsoon season and 287 mg/L low during post-monsoon season.Which according to WHO/ISI standards are very high concentration 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 625 mg/L during pre-monsoon season and 425 mg/L low during post-monsoon season. Which according to WHO is average but according to ISI standards is high concentration for drinking water in pre-monsoon season and average according to WHO/ ISI standards in post-monsoon.

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 195 mg/L to be high during pre-monsoon season and 163 mg/L low during post-monsoon season. Which according to WHO / ISI standards is average.

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-2021.

Table 3: Calculation Of WQI For pre-monsoon season-2021

S.No.	Parameters	Observed values	Standard values	Unit Weight (Wi)	Quality rating (Qi)	Weighted values (WiQi)
1.	Alkalinity	142	200	0.005	71.000	0.355
2.	Calcium	98	75	0.013	130.000	1.690
3.	Chloride	188	250	0.004	75.200	0.300
4.	Electrical Conductivity	185	300	0.003	61.700	0.185
5.	Magnesium	43	30	0.033	143.400	4.732
6.	Nitrate	21	45	0.022	46.600	1.025
7.	pH	8.2	8.5	0.117	96.500	11.290
8.	Sulfate	342	200	0.005	171.000	0.855
9.	Total Dissolved Solid	625	500	0.002	146.660	0.293
10	Total Hardness	195	300	0.003	065.000	0.195
				Σ Wi = 0.207		**Σ WiQi= 20.92**
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 101.061					

Table 4: Calculation of WQI For post-monsoon season-2021

S.No.	Parameters	Observed values	Standard values	Unit Weight (Wi)	Quality rating (Qi)	Weighted values (WiQi)
1.	Alkalinity	134	200	0.005	67.000	0.335
2.	Calcium	87	75	0.013	116.000	1.508
3.	Chloride	121	250	0.004	49.600	0.198
4.	Electrical Conductivity	168	300	0.003	56.000	0.168
5.	Magnesium	34	30	0.033	113.000	3.729
6.	Nitrate	13	45	0.022	28.900	0.635
7.	pH	7.6	8.5	0.117	89.400	10.459
8.	Sulfate	287	200	0.005	143.500	0.716
9.	Total Dissolved Solid	425	500	0.002	85.000	0.17
10	Total Hardness	163	300	0.003	54.300	0.163
				Σ Wi = 0.207		**Σ WiQi= 18.081**
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 87.348					

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

S.No.	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

The calculated Water Quality Index value are 101.061(Table 3) during premonsoon season and 87.348 (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 seasons. This might be due to the domesticwaste 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

Globally, there is increasing awareness that the water will be one of the most critical natural resources in future. However, the river water is suitable for diverse uses like irrigation, recreation and other domestic uses except drinking. Small river Kaligad which a tributary of Song river, Sahastradhara, Dehradun and other such rivers (tributaries) are very important as they feed into and create our big rivers. Therefore good health of our big rivers depends on adequate quantity and quality of their tributaries and other small streams.These rivers play critical role in the quality and supply of drinking water by ensuring a continuous flow of surface water and helping recharge underground aquifers. The water quality of the river Kaligad at Sahastradhara in Dehradun has been assessed on the basis of results of analysis of river water samples for important physicochemical parameters at site. An attempt has been also made to investigate the impact of anthropogenic activities, both in the river and in the catchment area of the river, on the river water quality. The water quality analysis results in the present study indicated that most of the physicochemical parameters investigated were within the WHO limits and ISI for drinking water except that Calcium, Magnesium, Sulfate which exceeded the permissible limit during both monsoon seasons and Total Dissolved Solid at exceeded the permissible limit during pre monsoon seasons but average during post monsoon season. WQI results suggested that the water source of Sahastradhara is ‘E’ grade during pre-monsoon season and ‘D’ grade during 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 town and control and monitor human activities in river Sahastradhara in its floodplain in order to ensure that such activities have minimal negative effects on the river in Sahastradhara stretch. Though the nutrient concentrations were low in the river stretch near Sahastradhara, care must be taken by inhabitants to avoid abusing the river.

ACKNOWLEDGEMENT

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

REFERENCES

1. Gupta P and Roy S. Evaluation of spatial and seasonal variations in groundwater quality at Kolar Gold

fields, India. American Journal of Environmental Engineering. 2012;2(2):19-30.
2. Srivastava YN. Environmental pollution. Ashish Pub. House, New Delhi. 1995;IstEdn: 35.
3. Acharya and Radadia BB. Determination of water quality index and suitability of a rural fresh water body in Ghuma village, district Ahmedabad, Gujarat. International Research Journal of Life Sciences Leaflets. 2013;2:68-75.
4. Li P and Qian H. Assessment of groundwater quality for irrigation purposes and identification of hydrogeochemical evolution mechanisms in Pengyang County, China. Environ. Earth Sci. 2013;69(7):2211–2225.
5. DubeyAK and Bhatia RK. Use of Water Quality Index Result of Robertson Lake Jabalpur in Remote Sensing Application. GRD Journals-Global Research and Development Journal for Engineering, 2016;1(10):95-98.
6. Chaterjee C and Raziuddin M. Determination of water quality index (WQI) of a degraded river in Asanol Industrial area, Raniganj, Burdwan, West Bengal. Nature Environment and Pollution Technology. 2002;(2):181-189.
7. Thakor FJ Chauhan B. Water Quality Index (W.Q.I.) of Pariyej Lake Dist. Kheda – Gujarat. Current World Environment. 2011;6(2):225-231.67,2013ife ences Leaflets 2:68-67,2013fe
8. Jain P and Sharma P. Chemical analysis of drinking water of villages of sanganer Tehsil, Jaipur district. Int. J. Env. Sci. Technol. 2005;2:373-379.
9. Khanna R and 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 and Dobhal R. Water quality assessment in terms of water quality index." American Journal of Water Resources. 2013;1(3):34-38.
11. TebbuttTHY. Principles of water quality control. Pergamon press Oxford. England. 1983;3rdEdn.:42.
12. Liu CW and Kuo YM. Application of factor analysis in the assessment of groundwater quality in a blackfoot disease area in Taiwan. Sci. Total Environ. 2003;313(3):77–89.
13. Verma P and Solanki H. Study of Water Quality of Hamirsar Lake – Bhuj. An International Journal of Bioscience Reporter. 2010;8(1):145-153.
14. Thakor FJ and Chauhan NB . Water Quality Index (W.Q.I.) of Pariyej Lake Dist.Kheda – Gujarat. Current World Environment. 2011;6(2):225-231.
15. https://en.wikipedia.org/wiki/Sahastradhara.
16. American Public Health Association (APHA). American Water Works Association (AWWA) and Water Environment Federation (WEF). Standards for Examination of Water and Wastewater. 23rd Ed.,American Public Health Association, Washington, DC, USA. 2017.
17. Bureau of Indian Standards (BIS). Specification for Drinking Water. IS: 10500, Bureau of Indian Standards, New Delhi. 2012.
18. Verma PU and 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 and Chandrakala M. Water Quality Index of Ganga River Water, Rishikesh, Uttarakhand, india. International Journal for Research in Applied Sci. & Eng. Technology. 2017;5(XI):2876-2880.
20. Brown RMN and 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.