International Journal of Chemical Science
www.chemicaljournals.com
Online ISSN: 2523-2843, Print ISSN: 2523-6075
Received: 20-08-2022, Accepted: 05-09-2022, Published: 21-09-2022
Volume 6, Issue 2, 2022, Page No. 23-28

Assessment of drinking water quality status by water quality index: A case study of maldevta waterfall, Dehradun, Uttarakhand- India

Sonu Dwivedi*
Associate Professor, Department of Chemistry D.B.S. (PG) College, Dehradun, Uttarakhand, India

Abstract
At this time especially uncontaminated water is meagre and with speedy computerization and deforestation, it is not an everlasting contribution of nature. It is so important for daily life that it is impossible to live without it. Moreover, there is no substitute for it. Hence water resources should be used in the best possible economic way and research should be carried on for finding out dry methods of production. In this study, Water Quality Index (WQI) of Maldevta waterfall, 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 values of Calcium, Nitrate, Total Dissolved Solid which exceeded the permissible limit during both monsoon seasons. The calculated Water Quality Index value are 100.091 during pre-monsoon season and 91.937 during post-monsoon season. This water quality rating study clearly shows that, the status of the water body is not suitable for drinking. This research offered the need of an effective Assessment of the waterfalls quality and its utility for human health.

Keywords: human health, industrialization, nature, urbanization, waterfall

Introduction
Next to air, water is the most important substance for the existence of life on the earth. Water accounts for about 70% of the mass of our body. In human body water is of utmost physiological importance and has specific functions to perform: It acts as a solvent for the secretory and excretory products, it acts as a carrier of nutritive elements to tissues and removes waste materials from them and Water is a best solvent for electrolytes. It helps to regulate electrolyte balance of the body and maintains a healthy equilibrium of osmotic pressure exerted by solutes dissolved in water. A state of good health is possible as long as osmotic pressure exerted by the solutes remain constant, it acts as a regulator of body temperature. Water is more important than food, Deprivation of water brings about death much more quickly than that of food. In Uttarakhand, a large portion of population lives in the hilly areas and about 90 % of the rural population depends upon the natural water sources for their daily water demand [1]. Due to the topography and high slops of the state, the drinking water supply department is mainly dependent on surface water sources to meet the rising demand of water [2]. Therefore, economic, agricultural and social activities within Dehradun district require urgent need to maintain the status of water sources. The water quality analysis is a most important part of hydro geological investigations to quantify the composition of chemical characters.
Water quality indices are contraption to govern circumstances of water quality and, such as any other contraption vital apprehension concerning controller and pivotal theory of water. It is a conventional process of demonstrate water quality that extend a steady and standardized unit of calculate whatever greet to substitute in the predominant manner of water. WQI is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality [3]. 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 [4]. 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.

Materials and Methods
Study area
Dehradun is the capital of the Indian state of Uttarakhand, near the Himalayan foothills. Dehradun valley that lies between Shivalik range of Himalaya that's the reason found many waterfall near Dehradun district and Maldevta waterfall is one of them. Maldevta Waterfall situated in Maldevta area of Rispana Valley, which beautifully decorate itself as bride during monsoon. The low-height Mountains make this area as one preferred

destination for people to experience green mountain peaks from so near. Maldevta waterfall is 20 km from Dehradun city and 1 km by foot. The waterfall is 10m high and this make a natural medium size pool. It lies on 30.3199264 latitude and 78.103986 longitude. Therefore, frequent water quality monitoring of water source of Malldevta waterfalls, Dehradun is essential in order to protect its mass population from waterborne diseases and to develop appropriate preventive measures, in case of contamination [5].

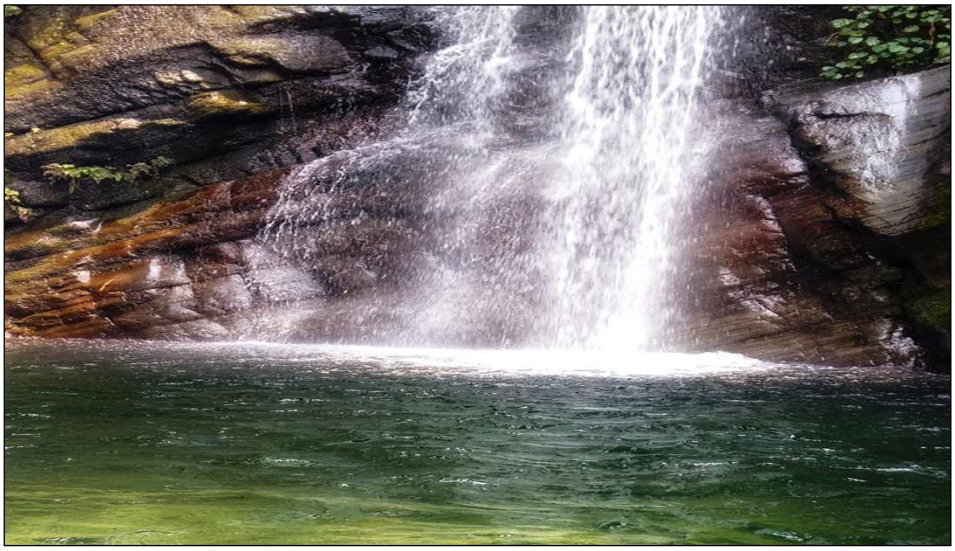

Fig 1: View of Study area

Collection and Analysis of Water Sample

The water specimen were calm in the pre and post monsoon season 2021 and scrutinize for 10 physicochemical parameters by following the usual method. The parameters pH are electrical conductivity were watched at the specimen area and other parameters like TDS, alkalinity, total hardness, calcium, magnesium, chloride, nitrate and sulphate were analyzed in the laboratory as per the slandered methods of APHA [6]. 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 BIS [7].

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 [8]. 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 [9] and the same formula was applied to calculate the WQI The weighted arithmetic index method [10] 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

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

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 (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 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 Maldevta waterfall 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	186
2.	Calcium	EDTA titration	75	75	125
3.	Chloride	Argentometric titration method	250	250	165
4.	Electrical Conductivity	Conductometry	400	300	264
5.	Magnesium	EDTA titration	150	30	28
6.	Nitrate	UV Spectrophoto-metric method	50	45	48
7.	pH	pH metery	8.0	8.5	8.1
8.	Sulfate	Turbidimetric method	250	200	158
9.	Total Dissolved Solid	Filtration Method	1000	500	854
10.	Total Hardness	EDTA titration	100	300	256

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	148
2.	Calcium	EDTA titration	75	75	97
3.	Chloride	Argentometric titration method	250	250	165
4.	Electrical Conductivity	Conductometry	400	300	189
5.	Magnesium	EDTA titration	150	30	29
6.	Nitrate	UV Spectrophoto-metric method	50	45	46
7.	pH	pH metery	8.0	8.5	7.4
8.	Sulfate	Turbidimetric method	250	200	188
9.	Total Dissolved Solid	Filtration Method	1000	500	675
10.	Total Hardness	EDTA titration	100	300	175

The values of various physicochemical parameters of Maldevta 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 186 mg/L during pre-monsoon season and 148 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 high 125 mg/L during pre-monsoon season and 97 mg/L high during post-monsoon season. Which according to WHO /ISI standards are very high concentration for drinking water in both season.

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 165 mg/L during pre-monsoon season and 165 mg/L 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 264µs/cm during pre-monsoon season and 189µs/cm 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 28mg/L during pre-monsoon season and 29 mg/L during post-monsoon season. This value suggest average 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 48 mg/L to be high during pre-monsoon season and 46 mg/L high during post-monsoon season. Which according to WHO/ ISI standards is high in both season.

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 8.1 during pre-monsoon season and 7.4 low during post-monsoon season. Which according to WHO is high and ISI standards is average during pre-monsoon season and according to WHO/ ISI standards is average during post-monsoon.

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 158 mg/L during pre-monsoon season and 188 mg/L during post-monsoon season. Which according to WHO/ISI standards are average in both monsoon.

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 854 mg/L during pre-monsoon season and 675
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 both 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 264 mg/L during pre-monsoon season and 175 mg/L 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 analysis. 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	186	200	0.005	093.000	0.465
2.	Calcium	125	75	0.013	0167.000	2.171
3.	Chloride	165	250	0.004	066.000	0.264
4.	Electrical Conductivity	264	300	0.003	088.000	0.264
5.	Magnesium	28	30	0.033	093.300	3.078
6.	Nitrate	48	45	0.022	106.700	2.347
7.	pH	8.1	8.5	0.117	95.294	11.138
8.	Sulfate	158	200	0.005	079.000	0.395
9.	Total Dissolved Solid	854	500	0.002	170.800	0.341
10	Total Hardness	256	300	0.003	085.300	0.256
				Σ Wi = 0.207		Σ WiQi= 20.719
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 100.091					

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	148	200	0.005	74.000	0.370
2.	Calcium	97	75	0.013	129.300	1.680
3.	Chloride	165	250	0.004	66.000	0.264
4.	Electrical Conductivity	189	300	0.003	63.000	0.189
5.	Magnesium	29	30	0.033	96.600	3.187
6.	Nitrate	46	45	0.022	102.200	2.248
7.	pH	7.4	8.5	0.117	87.000	10.179
8.	Sulfate	188	200	0.005	94.000	0.470
9.	Total Dissolved Solid	675	500	0.002	135.00	0.270
10	Total Hardness	175	300	0.003	58.300	0.174
				Σ Wi = 0.207		Σ WiQi= 19.031
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 91.937					

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

The calculated Water Quality Index value are 100.09 1(Table 3) during pre-monsoon season and 91.937 (Table 4) during post-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 is might be due to The domestic waste is directly discharge in, The surrounding Peoples 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

Nevertheless, the waterfall water is acceptable for assorted utilize such as inundation, amusement and auxiliary household utilize besides drinking. Waterfalls are extremely foremost as they sustain into and design our substantial water sources. Consequently adequate health of our substantial water sources turn on tolerable aggregate and status of their influent and further compact tributary. These water sources relax deprecatory part in

the status and provide of drinking water by confirm a sustained move of surface water and serving recreate hypogeal water level. The water quality of the Maldevta waterfall in Dehradun has been check out on the basis of ramification of analysis of water samples for important physicochemical parameters at site. The water quality probe consequency 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, Nitrate, Total Dissolved Solid which exceeded the permissible limit during both monsoon seasons. WQI results suggested that the water source of Maldavta waterfall is 'E' grade during pre-monsoon season and 'D' grade during post-monsoon season. Consequently, the water cannot be mention for drinking and other domestic purposes beyond command it to disinfection. Thus, there is a obligation to accurately handle disuse in the city and domination and supervise anthropoid pursuit in Maldevta waterfall.

Acknowledgement
The author is sincerely thankful Uttarakhand Jal Sansthan (UJS), Dehradun for providing technical support to carry out the study.

References

1. Jain CK, Bandyopadhyay A, Bhadra A. Assessment of ground water quality for drinking purpose, District Nainital, Uttarakhand, India. Environment Monitoring Assessment,2010:166:663-676.
2. Tyagi S, Dobhal R, Kimothi PC, Adlakha LK, Singh P, Uniyal DP. Studies of river water quality using river bank filtration in Uttarakhand, India. Water Quality Exposure and Health,2013:5:139-148.
3. Verma P, Solanki H. Study of Water Quality of Hamirsar Lake – Bhuj. An International Journal of Bioscience Reporter,2010:8(1):145-153.
4. Thakor FJ, Chauhan NB. Water Quality Index (W.Q.I.) of Pariyej Lake Dist. Kheda – Gujarat. Current World Environment,2011:6(2):225-231.
5. https://en.wikipedia.org/wiki/
6. American Public Health Association (APHA). American Water Works Association (AWWA) and Water Environment Federation (WEF). Standards for Examination of Water and Wastewater, American Public Health Association, Washington, DC, USA, 2017, (23).
7. Bureau of Indian Standards (BIS). Specification for Drinking Water. IS: 10500, Bureau of Indian Standards, New Delhi, 2012.
8. Verma PU, Chandawat DK. Seasonal variation in physico-chemical and phytoplankton analysis of Kankaria Lake. Int. J. Life Sciences Leaflets,2011:19:842-854.
9. 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(11):2876-2880.
10. 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.