Share Your Innovations through JACS Directory

Journal of Advanced Chemical Sciences

Visit Journal at https://www.jacsdirectory.com/jacs

ISSN: 2394-5311

Assessment of Drinking Water Quality Status by Water Quality Index: A Case Study of Jharipani Waterfall, Mussoorie, Uttarakhand, India

Sonu Dwivedi*

Department of Chemistry, D.B.S. (PG) College, Dehradun – 248 001, Uttarakhand, India.

ARTICLEDETAILS

Article history:
Received 13 February 2023
Accepted 02 March 2023
Available online 24 March 2023

Keywords:
Drinking Water
Agriculture
Water Resources

ABSTRACT

Water is one of the most valuable and essential natural resources for sustenance of life on earth and for any developmental activity. Water resources, being exploited from time to time, may become short of supply or may not be easily available at any site. Surface water is commonly present with different degrees of availability and distribution of the earth. There has been an increase in surface water management and utilization for agriculture, domestic, industry and rural supply schemes for the development of nations. Increasing consumption of water resources due to anthropogenic influences on urban, industrial and agricultural needs and erratic precipitation due to metrological changes greatly degrade water sources. In this study, Water Quality Index (WQI) of Jharipani waterfall, Mussoorie was analyzed with the ten physicochemical parameters such as alkalinity, calcium, chloride, electrical conductivity, magnesium, nitrate, pH, sulfate, total dissolved solid and total hardness to know the suitability for drinking purpose during pre and post monsoon seasons of the year 2022. The value of calcium and total dissolved solid which exceeded the permissible limit during pre-monsoon seasons but average during post monsoon season. The calculated Water Quality Index values are 83.371 during pre-monsoon season and 74.599 during post monsoon season. This water quality rating study clearly shows that, the status of the water body is not suitable for drinking. According to Standard Rating of Water Quality, it is very poor in pre monsoon season and poor in post monsoon season and not healthy for drinking purpose.

1. Introduction

Water contamination in urban environment is a major issue and is complicated by large number of potential source of contamination [1]. India has wide spectral variations of meteorological, topographical, geo-morphological, hydrological, geological, and hydrogeological conditions. The chemistry of groundwater is an important factor determining its use for domestic, irrigation and industrial purposes. Utilization of land varies from place to place due to rapid urbanization and industrialization, without following the strict environmental norms, causing a lot of variation of quality of groundwater within a short distance, which constrains the developmental activities drastically everywhere [2]. The urban aquifers are the only natural resource for drinking water supply, they are often perceived as of lesser relevance for the drinking water supply, leading to crisis in terms of drinking water scarcity, becoming increasingly polluted thereby decreasing their potability [3-4]. Once contamination of groundwater in aquifers occurs by means of industrial activities and urban development, it persists for hundreds of years because of very slow movement of water in them and prompts investigations on their quality [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 [8] are considered as the major sources of water pollution and ultimately of waterborne diseases. 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 Jharipani waterfall in Mussoorie Tehsil of Uttarakhand, India about suitability of their water quality for drinking purpose.

2. Experimental Methods

2.1 Study Area

Very few places have Raw beauty. Jharipani in one of the waterfalls (Fig. 1) that is not taken over by commercial activity. Not for the everyday tourist. It has a difficult approach and a 2 km trek. This place is really nice to spend some good time in pure natural environment. The verdant hills around Jharipani offer a kaleidoscopic view of the imposing Shivalik range. The cascading Jharipani Fall is located on Mussoorie-Jharipani road about

*Corresponding Author:somdwivedi5@gmail.com(Sonu Dwivedi)

https://doi.org/10.30799/jacs.249.23090101

9 km from Mussoorie. It lies on 30.48365 latitude and 77.93591 longitude. This colossal waterfall cascades with vigor to form icy cool natural pools here. On the other end of the waterfall, one can admire a glaring view of Doon Valley and the gorgeous step fields that intensifies the beauty of this place. The entire stretch around Jharipani Falls is naturally abundant. Therefore, frequent water quality monitoring of drinking water source of Jharipani Fall is crucial in order to preserve its multitude from chronic ailment and to develop suitable obstructive estimate in instance of stain [15].

Fig. 1 Study area Mussoorie-Jharipani waterfall

2.2 Collection and Analysis of Water Samples

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].

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 .

2.3.1 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.

2.3.2 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,

$$W_i = K/S_i$$

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 and 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 and total hardness. the data of physicochemical parameters water of Jharipani waterfall, Mussoorie obtained from pre and post monsoon season 2022 and standard permissible value WHO and ISI was presented in Table 1.

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

S. No.	Parameters	Method	WHO Standards	ISI Standards	Pre-monsoon	Post-monsoon
1.	Alkalinity	Titration Method	120	200	117	107
2.	Calcium	EDTA titration	75	75	85	64
3.	Chloride	Argentometric titration method	250	250	176	114
4.	Electrical Conductivity	Conductometry	400	300	162	156
5.	Magnesium	EDTA titration	150	30	21	16
6.	Nitrate	UV spectro-photometric method	50	45	23	23
7.	pH	pH metery	8.0	8.5	7.9	7.4
8.	Sulfate	Turbidimetric method	250	200	164	176
9.	Total Dissolved Solid	Filtration Method	1000	500	589	387
10.	Total Hardness	EDTA titration	100	300	98	67

3.1 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 average alkalinity that was reported in the present study was found to be high 117 mg/L during pre-monsoon season and 107 mg/L during post-monsoon season which are according to WHO /ISI standards.

https://doi.org/10.30799/jacs.249.23090101

Cite this Article as: Sonu Dwivedi, Assessment of drinking water quality status by water quality index: A case study of Jharipani waterfall, Mussoorie, Uttarakhand, India, J. Adv. Chem. Sci. 9(1) (2023) 784–787.

3.2 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 85 mg/L which is according to WHO /ISI standards, are high concentration for drinking water during pre-monsoon season and 64 mg/L during post-monsoon season, which is according to WHO /ISI standards, are average concentration for drinking water.

3.3 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 average chloride was found 176 mg/L during pre-monsoon season and 114 mg/L low during post-monsoon season which are according to WHO /ISI standards.

3.4 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 162 µs/cm during pre-monsoon season and 156 µs/cm low during post-monsoon season as average which are according to WHO / ISI standards.

3.5 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 21 mg/L during pre-monsoon season and 16 mg/L during post-monsoon season. These values suggest average concentration of magnesium ions.

3.6 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 23 mg/L during pre-monsoon season and 23 mg/L during post-monsoon season which are according to WHO/ ISI standards.

3.7 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 as 7.9 during pre-monsoon season and 7.4 during post-monsoon season, which are according to WHO and ISI standards, are average during pre-monsoon season and post-monsoon season.

3.8 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 164 mg/L during pre-monsoon season and 176 mg/L during post-monsoon season, which are according to WHO/ISI standards, are average concentration for drinking water.

3.9 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 589 mg/L during pre-monsoon season and 387 mg/L during post-monsoon season, which is 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.

3.10 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 98 mg/L during pre-monsoon season and 67 mg/L during post-monsoon season.

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 2 and Table 3 during pre and post monsoon season-2022.

Table 2 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	117	200	0.005	58.500	0.292
2.	Calcium	85	75	0.013	113.33	1.473
3.	Chloride	176	250	0.004	70.400	0.281
4.	Electrical Conductivity	162	300	0.003	54.000	0.162
5.	Magnesium	21	30	0.033	70.000	2.31
6.	Nitrate	23	45	0.022	51.111	1.124
7.	pH	7.9	8.5	0.117	92.941	10.87
8.	Sulfate	164	200	0.005	82.000	0.410
9.	Total Dissolved Solid	589	500	0.002	117.80	0.235
10	Total Hardness	98	300	0.003	32.666	0.097
				Σ Wi = 0.207		Σ WiQi= 17.258
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 83.371					

Table 3 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	107	200	0.005	53.500	0.267
2.	Calcium	64	75	0.013	85.333	1.109
3.	Chloride	114	250	0.004	45.600	0.182
4.	Electrical Conductivity	156	300	0.003	52.000	0.156
5.	Magnesium	16	30	0.033	53.333	1.759
6.	Nitrate	23	45	0.022	51.111	1.124
7.	pH	7.4	8.5	0.117	87.058	10.18
8.	Sulfate	176	200	0.005	88.000	0.440
9.	Total Dissolved Solid	387	500	0.002	77.400	0.154
10	Total Hardness	67	300	0.003	22.333	0.066
				Σ Wi = 0.207		Σ WiQi= 15.442
	Water Quality Index (WQI) = Σ WiQi / Σ Wi = 74.599					

Table 4 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 83.371 (Table 2) during pre-monsoon season and 74.599 (Table 3) 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 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.

4. Conclusion

Water sources are suitable for diverse uses like irrigation, recreation and other domestic uses except drinking. Water Falls are play critical role

https://doi.org/10.30799/jacs.249.23090101

Cite this Article as: Sonu Dwivedi, Assessment of drinking water quality status by water quality index: A case study of Jharipani waterfall, Mussoorie, Uttarakhand, India, J. Adv. Chem. Sci. 9(1) (2023) 784–787.

in the quality and supply of drinking water by ensuring a continuous flow of surface water The water quality of the Jharipani waterfall, Mussoorie has been assessed on the basis of results of analysis of water samples for important physicochemical parameters at site. An attempt has been also made to investigate the impact of anthropogenic activities, both in the waterfall and in the catchment area of the waterfall, 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 standard values for drinking water except that calcium 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 Jharipani is 'D' grade during pre-monsoon season and 'C' 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 surrounding and control and monitor human activities in Jharipani waterfall in its floodplain in order to ensure that such activities have minimal negative effects on the water source in Jharipani be elastic.

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] M. Jayaprakash, L. Giridharan, S. Venugopal, S.P. Krishna Kumar, P. Periyakali, Characterization and evaluation of the factors affecting the geochemistry of groundwater in Neyveli, Tamil Nadu, India, Environ. Geol. 54 (2008) 855-867.
[2] N. Subba Rao, Seasonal variation of groundwater quality in a part of Guntur district, Andhra Pradesh, India, Environ. Geol. 49 (2006) 413-429.
[3] S. Dixit, S.K. Gupta, S. Tiwari, Nutrients overloading of a freshwater lake in Bhopal, India, Elect. Green J. 21 (2005) 2-6.
[4] K.K. Tiwari, R.N. Prasad, N.C. Mondal, Geochemical parameters for assessment of groundwater quality around urban and suburban areas of Dausa city in Rajasthan, India, J. Appl. Geochem. 14 (2012) 184-193.
[5] A.N. Jerry, Basic environmental technology (water supply, waste disposal and pollution control), Wiley, New York, 1986.
[6] C. Chaterjee, M. Raziuddin, Determination of water quality index of a degraded river in Asanol Industrial area, Raniganj, Burdwan, West Bengal, Nature Environ. Pollut. Technol. 2 (2002) 181-189.
[7] F.J. Thakor, B. Chauhan, Water Quality Index of Pariyej Lake Dist. Kheda – Gujarat, Curr. World Environ. 6 (2011) 225-231.
[8] P. Jain, P. Sharma, Chemical analysis of drinking water of villages of Sanganer Tehsil Jaipur district, Int. J. Env. Sci. Technol. 2 (2005) 373-379.
[9] R. Khanna, R. Bhutiani, Determination of water quality index for the evaluation of surface water quality for drinking Purpose, Int. J. Sci. Eng. 1 (2013) 09-14.
[10] S. Tyagi, R. Dobhal, Water quality assessment in terms of water quality index, Am. J. Water Resour. 1 (2013) 34-38.
[11] T.H.Y. Tebbutt, Principles of water quality control, 3rd Edn., Pergamon Press Oxford, England, 1983.
[12] C.W. Liu, Y.M. Kuo YM, Application of factor analysis in the assessment of groundwater quality in a blackfoot disease area in Taiwan, Sci. Total Environ. 313 (2003) 77–89.
[13] P. Verma, H. Solanki, Study of water quality of Hamirsar Lake – Bhuj, Int. J. Biosci. Rep. 8 (2010) 145-153.
[14] F.J. Thakor, N.B. Chauhan, Water Quality Index of Pariyej Lake Dist. Kheda – Gujarat, Curr. World Environ. 6 (2011) 225-231.
[15] https://en.wikipedia.org/wiki/Sahasradhara (Accessed on: 12.12.2022)
[16] American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF), Standards for examination of water and wastewater, 23rd Edn., 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] P.U. Verma, D.K. Chandawat, Seasonal variation in physico-chemical and phytoplankton analysis of Kankaria lake, Int. J. Life Sci. Leaflets 19 (2011) 842-854.
[19] A. Upadhyay, M. Chandrakala, Water quality index of Ganga river water, Rishikesh, Uttarakhand, India, Int. J. Res. Appl. Sci. Eng. Tech. 5 (2017) 2876-2880.
[20] R.M.N. Brown, M.F.A. O' Connor, Water quality index –crossing the physical barrier (S.H. Jenkis, Ed.) In: Proc. Intl. Conf. on Water Poll. Res. Jerusalem 6 (1972) 787–797.

https://doi.org/10.30799/jacs.249.23090101

Cite this Article as: Sonu Dwivedi, Assessment of drinking water quality status by water quality index: A case study of Jharipani waterfall, Mussoorie, Uttarakhand, India, J. Adv. Chem. Sci. 9(1) (2023) 784–787.