INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

WATER QUALITY INDEX OF NARMADA RIVER WATER JABALPUR, MP, INDIA

[1]Anima Upadhyay & [2]Chandrakala, M.
[1,2]Assistant Professor, Department of Chemistry, Sir MVIT, Bangalore, Karnataka, India.
[*]Corresponding author email: animaupadhyay@gmail.com

ABSTRACT
Various physico–chemical parameters were studied to assess the water quality of Narmada river water. Subsequently, using this physico–chemical parameters, water quality index (WQI) was calculated through mathematical calculations. The experimental values of the various parameters were obtained by adopting standard procedures. These experimental values obtained were compared with the standard values suggested by International bodies such as WHO and ISI. The values were then substituted in the mathematical expression to calculate the WQI. Water Quality Indexing is a simple and convenient method to express the quality of water which leads to a single numeric value through which it could be easily suggested that whether the water is fit for human consumption.

KEY WORDS: Physico–chemical parameters, Standard methods, Potable water, Toxicity, Hazardous.

INTRODUCTION

India has a great cultural heritage. Its civilizations are recorded in World's history. Narmada River is the oldest river on the Earth. It flows in the furrows created by the platonic movements of the Earth. The origin of Narmada is from Amarkantak a small place in Madhya Pradesh with lush green hills. This river has both religious and economical importance. It is considered as daughter of Shiva. It flows through the hills and undulating topography it has high energy which is converted into electricity and is used by many states. Its water is also used for agriculture, drinking and other industrial uses. Small towns and big cities have developed on its banks. All these human activities have started polluting the water of river Narmada by releasing its waste containing lot of toxic and hazardous materials. Since big farmers these days use extensive fertilizers and herbicides to get high yield. These chemicals are then discharged in the water and later it reaches the river water. Similarly, industrial effluents are discharged directly without being treated. Sewage disposal in the river also leads to the contamination of its water. Narmada is a major river and its water is useful for the mankind hence it should be kept clean from the impurities and toxic materials. Many authors have studied various physico–chemicals parameters in the water bodies [1– 8] to state the quality of water. The water Quality Index is an excellent approach in this direction, which was developed in the early 1970s. It gives an indication of the health of the water bodies at various points and can be used to keep a track of water quality over a period of time. To calculate the water quality index various physico–Chemical parameters should be studied in detail and then their experimental values are substituted in the mathematical expression as described in the study.

MATERIALS & METHODS

Samples were collected from Jabalpur, Madhya Pradesh, as per the standard procedures. The various Physico–chemical parameters like pH, Alkalinity, Total dissolved solids, Electrical Conductivity, Calcium and Magnesium ions, Total hardness were analyzed and the results were compared with the WHO and ISI standards[9]. Chemicals used for analysis were of AR grade. Glass distilled water was used for the preparation of the reagents. pH and Electrical Conductivity were determined using Digital Systronics pH – meter and Systronics – Conductometer respectively. Temperature of the samples was noted at their sampling points. Standards methods were employed for the determination of the various parameters[10]. The experimental results obtained were then compared with WHO and ISI standards are listed. (Table 1).

Weighted arithmetic water quality index method

Water Quality Index is a method to express the water quality according to the degree of purity. It is now widely used in scientific studies by using the physico – chemical parameters[11–16]. The WQI was calculated[17] by using the following equation:

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

Where, Q_i = quality rating, W_i = Unit weight

The quality rating scale (Q_i) for each parameter is calculated by using the expression:

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

Where, V_{actual} is estimated concentration of ith parameter in the analysed water

V_{ideal} is the ideal value of this parameter in pure water

V_{ideal} = 0 (except pH =7.0 and DO = 14.6 mg/l)

$V_{standard}$ is recommended standard value of ith parameter
The unit weight (W_i) for each water quality parameter is calculated by using the following formula.

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

Where, K= proportionality constant and is taken as unity.

RESULTS & DISCUSSION

Temperature

Chemical and biochemical reactions are greatly affected by temperature. Increase in temperature of water increases the rate of chemical reactions in water on one hand and, decreases the solubility of gases in the water on the other. Hence, measurable variations in the temperature of water affect the aquatic life. The temperature of the water for samples S_1, S_2 and S_3were found to be in safe limits. (Table 1)

pH

pH is defined as the negative logarithm of hydrogen ion concentration. The pH of natural water is between 6 and 8. Variations in pH values are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa and also due to the dissolved gases such as carbon dioxide, Hydrogen sulphide, ammonia etc. The pH of S_1, S_2 and S_3were found to be well within the prescribed standard range. (Table 1, Fig 1)

Alkalinity

Alkalinity of water is described as its quantitative capacity to neutralize acids. Compounds like bicarbonates, carbonates and hydroxides in water decreases the H^+ ions and increases the pH of the water. Alkalinity in streams is due to breakdown and dissolution of rocks and soils, plant activities and industrial waste water discharges are also responsible for alkalinity. All the three samples S_1, S_2 and S_3 showed very high alkalinity according to WHO standards but when compared to ISI standards it was found within the standard limits though on the higher side which could be alarming. (Table 1, Fig 1)

Electrical Conductivity

Conductivity of water is defined as the capacity of water to conduct electrical current. Conductivity in water is affected by temperature, mobility of the ions and presence of electrolytes in the form of dissolved inorganic solids such as chloride, nitrate, sulphate, phosphate, sodium, magnesium, calcium, iron and aluminium ions. The Electrical Conductivity in the samples S_1, S_2 and S_3were found to be within the tolerance limits of the standard values. (Table 1, Fig 1)

Total, Temporary and Permanent hardness

Hardness in water is an important parameter as it affects the day to day human life and also the industries to a great extent. The presence of calcium and magnesium in the form of bicarbonates, chlorides and sulphates produces hardness in the water. Hardness is expressed in terms of $CaCO_3$equivalents.Hardness was reported to be very high in all the three samples S_1, S_2 and S_3 according to the WHO standards but was within the tolerance limits of ISI standards. This suggest a regular monitoring of the hardness producing minerals so that they could be kept under check as in the course of Narmada river many tourist attractions are located.(Table 1, Fig 1)

Calcium ions and Magnesium ions

Calcium is the main constituent of the rocks. Hardness is caused due to the presence of calcium and magnesium ions. Excess of Calcium and Magnesium ions leads to the deposition of these in the soft tissues of the living beings causing various kinds of diseases such as stone formation, cancer etc. The presence of Calcium ions was found to be very high according to both the standards in all the samples. Magnesium ions on the other hand were found to be within the limits of WHO standards but high according to ISI standards. (Table 1, Fig 1)

Total Dissolved Solids

Total dissolved solids are the sum of all the chemical ions that are dissolved in the water. It is due to the dissolution of gypsum, rocks, soil etc. The amount of Total Dissolved Solids was well within the permissible range of the said standards in all the samples. (Table 1, Fig 1).

TABLE I: Water Quality Parameters and Their WHO & ISI Standards

Parameters	Method	WHO Standards	ISI Standards	Samples of Narmada river water		
				S_1	S_2	S_3
Temperature	Thermometric	-----	-----	20^0C	20^0C	20^0C
pH	pH metery	7.0 – 8.0	6.5 – 8.5	7.9	8.1	8.0
Electrical Conductivity (µs / cm)	Conductometry	1400	-------	196	200	198
Total Dissolved Solid (mg/L)	Filtration Method	1000	500	128	130	132
Total Hardness (mg/L)	EDTA titration	100	300	182	185	184
Temporary hardness (mg/L)	EDTA titration	-----	-----	62	64	64
Permanent hardness (mg/L)	EDTA titration	-----	------	120	121	120
Calcium ions (mg/L)	EDTA titration	75	75	126	127	126
Magnesium ions (mg/L)	EDTA titration	150	30	56	58	58
Alkalinity (mg/L)	Titration Method	120	200	163	164	162

TABLE 2: Calculation of WQI for S_1 sample

Parameters	Observed values	Standard values	Unit Weight (W_i)	Quality rating (Q_i)	Weighted values (W_iQ_i)
pH	7.9	8.5	0.117647	60.0	7.05882
Electrical Conductivity(µs / cm)	196	300	0.003333	65.3333	0.217775
Total Dissolved Solid (mg/L)	128	500	0.002	25.6	0.0512
Total Hardness (mg/L)	182	300	0.003333	60.6666	0.20222
Calcium (mg/L)	126	75	0.01333	168	2.23999
Magnesium (mg/L)	56	30	0.03333	186.6666	6.22159
Alkalinity (mg/L)	163	120	0.008333	135.8333	1.13189
			$\sum W_i$ = 0.181306		$\sum W_iQ_i$ = 17.123485
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i$ = 94.44521					

TABLE 3: Calculation of WQI for S_2 sample

Parameters	Observed values	Standard values	Unit Weight (W_i)	Quality rating (Q_i)	Weighted values (W_iQ_i)
pH	8.1	8.5	0.117647	73.3333	8.62744
Electrical Conductivity(µs/cm)	200	300	0.003333	66.6666	0.22219
Total Dissolved Solid(mg/L)	130	500	0.002	26.0	0.052
Total Hardness (mg/L)	185	300	0.003333	61.6666	0.20553
Calcium(mg/L)	127	75	0.01333	169.3333	2.25721
Magnesium(mg/L)	58	30	0.03333	193.3333	6.443798
Alkalinity (mg/L)	164	120	0.008333	136.666	1.138837
			$\sum W_i$ = 0.181306		$\sum W_iQ_i$ = 18.947005
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i$ = 104.5034					

TABLE 4: Calculation of WQI for S_3 sample

Parameters	Observed values	Standard values	Unit Weight (W_i)	Quality rating (Q_i)	Weighted values (W_iQ_i)
pH	8.0	8.5	0.117647	66.6666	7.84312
Electrical Conductivity(µs/cm)	198	300	0.003333	66.0	0.21999
Total Dissolved Solid(mg/L)	132	500	0.002	26.4	0.0528
Total Hardness (mg/L)	184	300	0.003333	61.3333	0.20442
Calcium(mg/L)	126	75	0.01333	168.0	2.23944
Magnesium(mg/L)	58	30	0.03333	193.3333	6.44379
Alkalinity (mg/L)	162	120	0.008333	135.0	1.124955
			$\sum W_i$ = 0.181306		$\sum W_iQ_i$ = 18.128515
Water Quality Index (WQI) = $\sum W_iQ_i / \sum W_i$ = 99.98850					

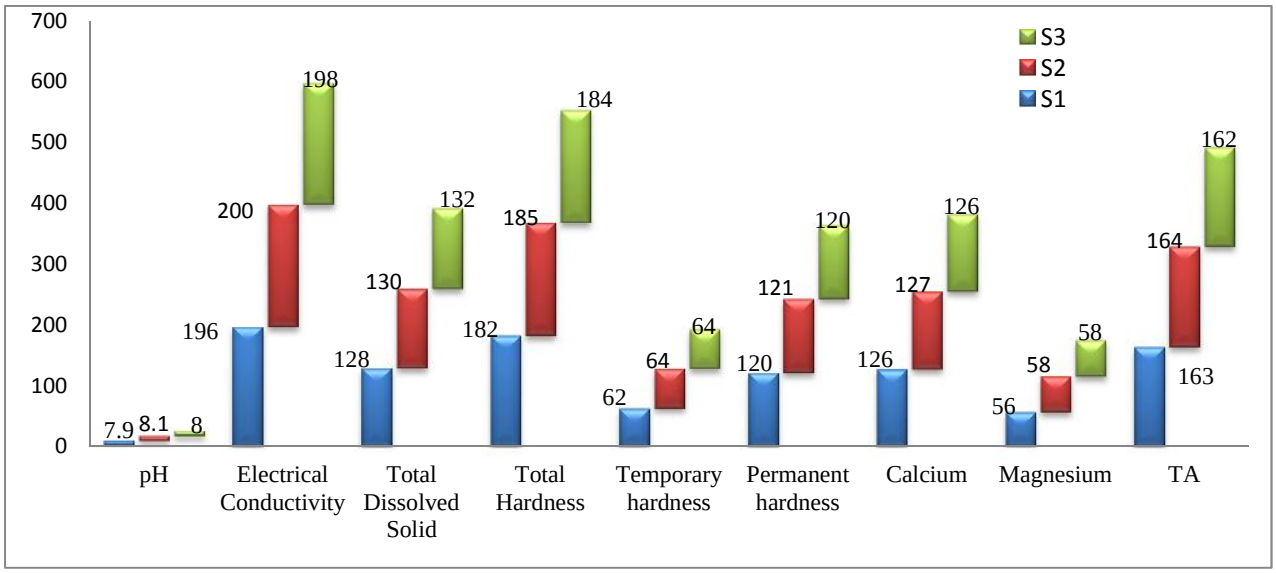

FIGURE 1: Representation of various parameters and their comparison with WHO and ISI standards

TABLE 5: water Qaulity Index (WQI) status of water quality [18]

Water Quality Index Level	Water Quality Status
0 – 25	Excellent water quality
26 – 50	Good water quality
51 – 75	Poor water quality
76 – 100	Very poor water quality
> 100	Unsuitable for drinking

CONCLUSION

The Water Quality Index was calculated for all the samples (Tables 2 - 4) and was found to be 94.44, 104.5 and 99.99 for the samples S_1, S_2 and S_3 respectively. The present study conducted on the Narmada River water reveals that the quality of the water is very poor (Table 5) [18]. Narmada River water is a chief source for drinking and irrigation, hence it should be free from the impurities. People consuming it directly without treatment suffer great health hazards which are significantly visible in the rural and tribal areas. Narmada water is also providing electricity to Madhya Pradesh and Gujarat. In the electricity production water should be free from impurities and hardness otherwise it adversely affects the turbines and boilers.

ACKNOWLEDGEMENT

Authors extend thanks to the institution for providing infrastructure to conduct the study.

REFERENCES

[1]. Burim Haxhibeqiri, Faton Maloku and Ferdi Brahushi (2014) Physico-chemical and Bacteriological Analysis of The River Drini l Bardhe. European Scientific Journal Special edition 3.

[2]. Dr. Leena Singh and S.K Choudhary (2013) Physico-Chemical Characteristics of River Water of Ganga in Middle Ganga Plains. International Journal of Innovative Research in Science, Engineering and Technology, 2.

[3]. Janeshwar Yadav, Sujit Pillai and Atul Upadhyay. (2012) Analysis of Physico – chemical Parameters of Kunda River (major Tributary of Narmada From Nimar Region)Int J. Chem .Sci10, 1654-1656.

[4]. Manoj Kumar Solaki, O.P., Gupta, D.K, Singh and Shukdeo Prasad Ahirwar (2014) Comparative Physico – chemical Analysis of River Water and Underground Water in Winter Season of Rewa City, MP, India. International Research Journal of Environment Sciences3, 59-61.

[5]. Mehari Muuz Weldermariam (2013) Physico–Chemical Analysis of GudBahri River Water of wukro, Eastern Tigrai, Ethiopia. International Journal of Scientific and Research Publications, 3.

[6]. Yadav, R.C. and Srivastava, V.C. (2011) Physico – Chemical properties of the water of river Ganga at Ghazipur. Indian J.Sci.Res.2, 41- 44.

[7]. Jadhav, S.D., Jadhav and Jawale, R.W. (2013) Physico-Chemical and Bacterilogical Analysis of indrayani River Water Alandi, Pune District (Maharashtra) India. International Journal of Scientific & Engineering Research 4.

[8]. Vinod Jena, Sapna Gupta and Natalija Matic (2013) Assessment of Kharoon River Water Quality at Raipur by Physico – Chemical Parameters Analysis. Asian J. Exp. Biol. Sci 4, 79 – 83.

[9]. Guideline for Drinking Water, World Health Organization (1993). Geneva, 1: 52-82.

[10]. Dara, S. S. (2001) A Textbook on Experiments and Calculations in Engineering Chemistry. S Chand & Co. Lt.

[11]. Dhirendra Mohan Joshi, Alok Kumar and Namita Agrawal (2009) Studies On Physicochemical Parameters to Assess The Water Quality Of River Ganga For Drinking Purpose In Haridwar District. Rasayan J. Chem2, 195-203.

[12]. K. Jomet Sebastian, Sadanand M and Yamakanamardi (2013) Assessment of Water Quality Index of Cauvery and Kapila River and Their Confluence, International Journal of Lakes and riversl, 59-67.

[13]. Pathak, S.K., Shambhu Prasad and Tanmay Pathak (2015) Determination of Water Quality Index River Bhagirathi in Uttarkashi, Uttarakhand, India. Social Issues and Environmental Problems 3.

[14]. Priyanka Chugh, Amarjit Kaur, Harpreet Kaur, Satish Kumar and Sahota, H.S. (2014) On Water Quality Standards and Water Quality Indices. International Journal of Science and Research 3.

[15]. Ruby Pandey, Divya Raghuvanshi and D.N Shukla (2014) Assessment of Physico–Chemical Parameters of River Ganga at Allahabad With Respect To WQI. International Journal of Innovative Research in Science, Engineering and Technology 3.

[16]. Shweta Tyagi1, Bhavtosh Sharma, Prashant Singh and Rajendra Dobhal (2013) Water Quality Assessment in Terms of Water Quality Index. American Journal of Water Resources 1, 34-38.

[17]. Cude, C. (2001) Oregon water quality index: A tool for evaluating water quality management effectiveness. Journal of the American Water Resources Association 37, 125 – 137.

[18]. Chaterjee, C and Raziuddin. (2002) Determination of water quality index (WQI) of a degraded river in Asanol industrial area, Raniganj, Burdwan, West Bengal. Nature, Environment and Pollution Technology 1, 181 – 189.