International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 11; Issue 03 (B); March 2022; Page No.419-423
DOI: http://dx.doi.org/10.24327/ijcar.2022.423.0093

Research Article

DETERMINATION OF WATER QUALITY INDEX OF ELISHA LAKE, NADIAD, DIST.KHEDA, GUJARAT, INDIA

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A R T I C L E I N F O

Article History:
Received 6th December, 2021
Received in revised form 15th January, 2022
Accepted 12th February, 2022
Published online 28th March, 2022

Key words:
Elisha Lake, Determination, W.Q.I, Physico–Chemical, Season, Permissible Limits.

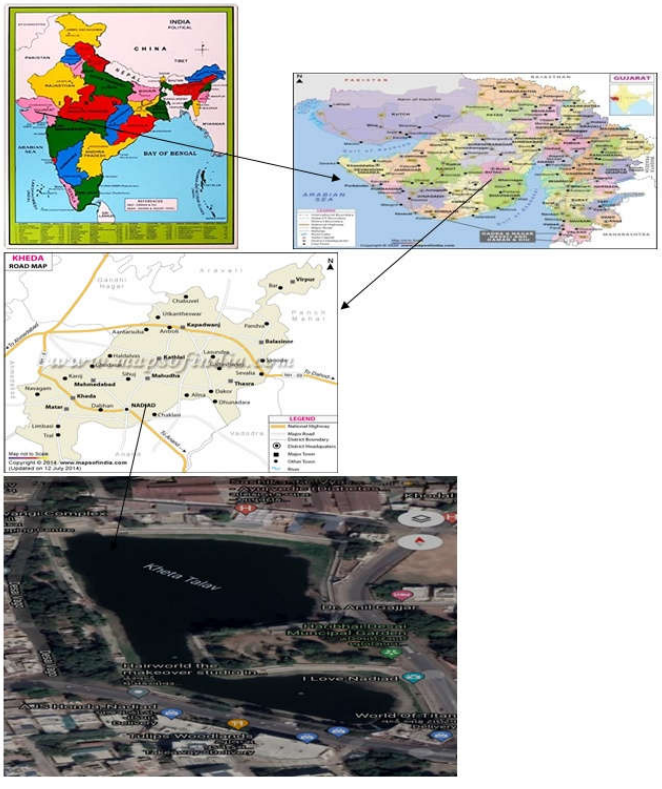
A B S T R A C T

Determination of Water Quality of Elisha Lake. Four different locations were selected in Elisha Lake, its Physico Chemical analysis such as, pH, Total Alkalinity, Total Hardness, T.D.S, Calcium, Magnesium, Chloride, Nitrate, Sulphate, D.O during March.2021-Feb.2022. The present studies calculate the Water Quality Index of lake and assess the impact of industries, agriculture and human activities. W.Q.I has been calculated of Elisha Lake, District: Kheda, Gujarat (India). Total ten Physico– Chemical parameters were monitored for the calculation of W.Q.I in Rainy, Winter and Summer seasons. The parameters namely pH, Total Alkalinity, Calcium, Magnesium, Chloride, Sulphate, were exceeding the permissible limits as prescribed by Indian Standards. However, The W.Q.I values in the present investigation were reported to be more than 40, Indicating that the Water Quality is 47.87 in Rainy and 111.03 Winter season and 156.50 in Summer season and used for drinking purpose after purification .The Pollution load is relatively lighter during Summer season which compare to the Winter and Rainy Season. Results obtained are compared in term of their highest value and lowest values among three seasons in term of 10 parameters.

INTRODUCTION

Water is extremely elementary to life. One cannot imagine a form of life that might exist without water. On the surface of the earth, Water in the form of ocean, sea, glaciers, freshwater bodies, rivers, wells like etc. occupies about 71.00 % of the area while, the landmass occupies about 29.00 % of the area [1,2]. Water is most essential for existence of life on earth and is a major component for all forms of life from micro-organism to men. Various Physico-Chemical parameters have a significant role in determining the portability of Water. The use of fertilizers, pesticides and manure are main source of Water pollution in this area. Water is one of the most important factor for every living organism on this planet. Water is generally used for drinking fisheries and other domestic purpose in the in this area. Water is the precious gift of nature to human beings, is going to be polluted day by day with increasing urbanization. Although three forth part of earth is being surrounded by water but a little portion of it can be used for drinking purpose.

Therefore we carried out studies of Physico – Chemical parameters of surface water in Gujarat state whether they are fit for drinking or some other purposes of various central area in Gujarat state [3].



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The major hazard in drinking Water supplies is microbial contamination which is due to agricultural land waste, domestic sewage and industrial effluent [4] etc. On the other hand lakes also provide a habitat for invertebrates, fishes and aquatic birds. Therefore scientific study needs to review strategies for conservation and better utilization of lakes. It is with their background, Water Quality Index (*W.Q.I*) provides a single number that expresses overall Water quality at a certain location and time, based on several Water quality parameters[5,6]. The objective of Water Quality Index is to turn complex Water quality data into information that is understandable and used by the public. A single number cannot tell the whole story of Water quality parameters that are not included in the index. However, a Water Quality Index based on some very important parameters can provide a single indicator of Water Quality.

METHODOLOGY

Study Area

Elisha lake is located 22.6915 latitude and 72.8633 longitude at an altitude 36m/118 feet above the mean sea level. It is situated in Nadiad and comes under Kheda district. Elisha lake is an old lake.

Samples Collections

Samples of Water were collected from four sites of the lake once every month March.2021- Feb.2022. One liter P.E.T. bottles were used for collection of Water samples from a depth of 30 cm. During morning hours between 8.00 – 10.00 AM. For Dissolved Oxygen measurement, a 300 ml capacity BOD bottle was used for collection of water sample and the Oxygen was fixed at the sampling site before being carried to the laboratory. The parameter pH was monitored at the sampling site and other parameters like Total Alkalinity, Total Hardness, Total Dissolved Solids, Calcium, Magnesium, Chloride, Nitrate and Sulphate were analyzed in the laboratory as per the standard procedures. APHA [2005]- **[7,8]**.

The concept of Water Quality Index was first proposed by Horton (1965). For the calculation of Water Quality Index. 10 important Physico – Chemical parameters were chosen.

W.Q.I has been calculated by using the standards of drinking Water Quality recommended by the World Health Organization (*WHO*) – 1992 **[9]** , Bureau of Indian Standards (*BIS*) - 1993 and Indian Council for Medical Research (*ICMR*) - 1975. The weighted arithmetic index method (Brown *et. al*.) has been used for the calculation of *W.Q.I* of the lake. Further quality rating or sub index (qn) was calculated using the following expression.

$$qn = 100\left[Vn - V_{10}\right] \Big/ \left[Sn - V_{10}\right]$$

Where, qn = Quality rating for the n^{th} water quality parameter.
Vn = Estimated value of the n^{th} parameter at a given sampling station.
Sn = Standard permissible value of the n^{th} parameter.
V_{10} = Ideal value of nth parameter in a pure water.

Ideal value in most cases $V_{10} = 0$ except in certain parameters like P^H and Dissolved Oxygen. Calculation of quality rating for P^H and $DO\left(V_{10} \neq 0\right)$ is 7.0 and 14.6 mg/L respectively.

Unit weight was calculated by a value inversely proportional to the recommended standard values Sn of the corresponding parameters.

$Wn = K / Sn.$

Where, Wn = Unit weight for the n^{th} parameter.
Sn = Standard value for n^{th} parameter.
K = Constant for proportionality.

The overall Water Quality Index (*W.Q.I*) was calculated by aggregating the quality rating with the unit weight linearly.

$$\therefore W.Q.I. = \sum qnWn \Big/ \sum Wn$$

Table 1 Water Quality Index (W.Q.I.) and status of water quality (Chatterji and Raziuddin 2002)

Water Quality Index	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	Unfit for drinking

Table 2 Method used for Physico-Chemical analysis of water (All values except pH is in mg/L.)

Parameter (Unit)	Method
pH	*pH Probe*
Total Alkalinity	Volumetric
Total Hardness	Volumetric
T.D.S.	Gravimetric
Calcium	Volumetric
Magnesium	Volumetric
Chloride	Volumetric
Nitrate	Colorimetric
Sulphate	Volumetric
D.O.	Volumetric

Table 3 Drinking water standards recommending agencies and unit weight. (All values except pH is in mg/L.)

Parameter	Standards	Recommended Agency	Unit Weight
pH	6.5 - 8.5	*ICMR / BIS*	0.2190
Total Alkalinity	120	*ICMR*	0.0155
Total Hardness	300	*ICMR / BIS*	0.0062
T.D.S.	500	*ICMR / BIS*	0.0037
Calcium	75	*ICMR / BIS*	0.025
Magnesium	30	*ICMR / BIS*	0.062
Chloride	250	*ICMR*	0.0074
Nitrate	45	*ICMR / BIS*	0.0413
Sulphate	150	*ICMR / BIS*	0.0124
D.O.	5	*ICMR / BIS*	0.723

Table 4 Seasonal variations of the Physico – Chemical parameters of the Elisha Lake (All values except P^H is in mg/L.)

Parameter	Seasons		
	Rainy Season	Winter Season	Summer Season
pH	8.38	9.08	9.245
Total Alkalinity	151.5	171.6	347
Total Hardness	144.5	189.8	323
T.D.S.	67.5	110.1	145.4
Calcium	14.5	45	89.5
Magnesium	22	50	76
Chloride	46.5	82.5	180.5
Nitrate	16.16	15	31
Sulphate	4.5	7.5	13.5
D.O.	7.9	5.95	5.05
Water Quality Index	47.87	111.03	156.50

Table 5 Calculation of Water Quality Index in Rainy Season

Parameter	Observed Values (Vn)	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	WnQn
pH	8.38	6.5 - 8.5	0.2190	8.38	20.148
Total Alkalinity	151.5	120	0.0155	126.25	1.956
Total Hardness	144.5	300	0.0062	48.166	0.298
T.D.S.	337.5	500	0.0037	337.5	0.2497
Calcium	14.5	75	0.025	19.333	0.48
Magnesium	22	30	0.062	73.333	4.546
Chloride	46.5	250	0.0074	18.6	0.137
Nitrate	16.16	45	0.0413	35.91	1.4830
Sulphate	4.5	150	0.0124	3	0.0372
D.O.	7.9	5	0.723	69.791	25.96
			$\sum Wn =$ 1.155	$\sum Qn =$ 740.263	$\sum WnQn$ =55.29

Water Quality Index $= \sum WnQn / \sum Wn =$

$$55.29 / 1.155 = 47.87$$

Table 6 Calculation of Water Quality Index in Winter Season

Parameter	Observed Values (Vn)	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	WnQn
P^H	9.08	6.5 - 8.5	0.2190	9.08	30.36
Total Alkalinity	171.6	120	0.0155	143	2.216
Total Hardness	189.8	300	0.0062	63.266	0.3922
T.D.S.	550.5	500	0.0037	550.5	0.4073
Calcium	45	75	0.025	60	1.5
Magnesium	50	30	0.062	166.6	10.329
Chloride	82.5	250	0.0074	33	0.2442
Nitrate	15	45	0.0413	33.33	49.42
Sulphate	7.5	150	0.0124	5	0.062
D.O.	5.95	5	0.723	89.58	33.323
			$\sum Wn =$ 1.1155	$\sum Qn$ =1153.35	$\sum WnQn$ =128.25

Water Quality Index $= \sum WnQn / \sum Wn =$ 111.03/128.5=111.03

Table 7 Calculation of Water Quality Index in Summer Season

Parameter	Observed Values (Vn)	Standard Values (Sn)	Unit Weight (Wn)	Quality Rating (Qn)	Wn Qn
P^H	9.245	6.5 - 8.5	0.2190	9.245	32.703
Total Alkalinity	347	120	0.0155	289.16	4.481
Total Hardness	323	300	0.0062	107.66	0.667
T.D.S.	727	500	0.0037	727	0.5379
Calcium	89.5	75	0.025	119.3	2.982
Magnesium	76	30	0.062	253.3	15.70
Chloride	180.5	250	0.0074	72	0.5328
Nitrate	31	45	0.0413	291.1	12.02
Sulphate	13.5	150	0.0124	9	0.116
D.O.	5.05	5	0.723	99.47	37.002
			$\sum Wn =$ 1.155	$\sum Qn =$ 1977.23	$\sum WnQn$ =180.76

Water Quality Index $= \sum WnQn / \sum Wn =$

$$180.766 / 1.155 = 156.50$$

SUMMARY AND DISCUSSION

The Physico-Chemical parameters of Water Quality were analyzed using standard methods given in APHA, *et al* (2005). The values of various Physico – Chemical parameters for calculation of Water Quality Index are presented in Table: 4. While season wise Water Quality Index calculations are depicted in the Table 5, 6 and 7. The Water Quality Index of Rainy season, Winter season and Summer season are 47.87, 111.03 and 156.50 respectively. Which indicate that the Water quality is good to unfit for drinking used for human consumption after purification system (Chatterji and Raziuddin 2002)- **[9].** It is also observed that the pollution load is relatively higher during Summer season when compared to the Winter and Rainy season. The above water Quality is also supported by the following Physico – Chemical parameters variations observed during the different seasons of the study.

pH

pH is a measurement of the acidic or basic Quality of water**[10,11]**. The average pH values of the lake water was 8.38 mg/L during rainy season, 9.08 mg/L during winter season and 9.24 mg/L during summer season. The P^H of water was relatively high in the Summer season and low in Rainy and Winter season. However, when the average values for three seasons are taken into account that the water body was slightly alkaline**[12].** Swaranalatha and Narasingrao [1993]- **[13].** The P^H values of water samples of present study ranged from 8.0 to 10.0. Elisha Lake (Kheta Lake). These values are within the prescribed limit of standards (WHO – 2002).

Total Alkalinity

Alkalinity value greater than 178 mg/L is desirable for domestic use APHA (2005). The observed average value of total alkalinity was 151.5 mg/L during Rainy season,171.6 mg/L during Winter season and 347 mg/L during summer season. Total alkalinity values in our observations indicated that the water was hard. Higher values of alkalinity registered during Summer season, lower during Winter and Rainy season. D. K. Bhoi *et. al*. (2011) also reported similar findings in the study of Pariyej lake.**[14]**

Total Hardness

The observed average Total Hardness value was 144.5 mg/L during rainy season, 189.8 mg/L during winter season and 323 mg/L during Summer can be attributed to low water level and high rate of evaporation of water and addition of Calcium and Magnesium salt. Mohanta and Patra (2000) stated that addition of sewage, detergents and large scale human use might be the cause of elevation of hardness**[15,16].** Elisha Lake water was moderately hard but the value of hardness in Summer were up to permissible limits. Hardness below 300 mg/L is considered potable but beyond this limit produces gastrointestinal irritation (ICMR 1975).

Total Dissolved Solids

The total Dissolved solids in water of Elisha Lake was 337.5 mg/L during rainy season, 550.5 mg/L during winter season and 727 mg/L during Summer season. Gupta and Singh (2000) also reported high concentration of TDS in the Damodar river due to mixing of sewage and industrial water. Gray N. F. (2005) reported that the hardness in the water is due to the Dissolved minerals from sedimentary rocks, seepage and run-

off. Detergents and soaps also aggravate the situation – Ahluwalia V. K. (2008)- **[17,18]**

Calcium

The observed average value of Calcium was 14.5 during rainy season,45 mg/L during winter season and 89.5 mg/L during Summer season. The quantities of Calcium in natural water depend upon the type fo rocks. Small concentration of Calcium is reducing corrosion in water pipes- D. K. Bhoi *et al*., (2011)- **[19].**

Magnesium

The observed average value of Magnesium was 22 mg/L during Rainy season, 50 mg/L during Winter season and 76 mg/L during Summer season. The values of Magnesium Winter, Summer season were not in permissible limits, Magnesium hardness particularly associated with the Sulphate ion has laxative effect on persons unaccustomed to it. (Khursid 1998)-**.** The recorded increase in Ca and Mg concentration during pre monsoon may be the effect of bacterial decomposition. Jaybhaye and Madlapure (2005) reported high values of Calcium and Magnesium in Parola dam, Dist. Hingoli, Maharashtra.

Chloride

Chloride occurs in all types of natural waters. The high concentration of Chloride is considered to be an indication of pollution due to high organic waste of animal origin (Singh, 1995). The observed Chloride value was 46.5 mg/L during rainy season, 82.5 mg/L during winter season and 180.5 mg/L in summer season. The higher values of Chloride recorded in summer season. Similar results were also reported by D.K.Bhoi *et al*., (2011) from Pariyej lake, Kheda district, Gujarat. The high values may be attributed to low water levels during Summer season- **[20,21].**

Nitrate

The Nitrate ranged from 16.16 mg/L during rainy season,15 mg/L during winter season and 31 mg/L during summer season during . In present study water sample of rainy and winter showed low concentration of Nitrate well below permissible levels in Rainy, Winter but higher in Summer as per the standards. According to Jhingram and Sugunan (1990) the water with the 0.2 to 0.5 ppm of Nitrate is of high productive reservoirs, upto 0.2 ppm Nitrate is medium productive reservoirs and in low productive reservoirs, the Nitrates are negligible. According to the above classification present reservoir belongs to high productive nature.**[16,17]**

Sulphate

Sulphate ion does not effect the taste of water if present in low concentration. The observed average value of Sulphate was 4.5 mg/L during rainy season, 7.5 mg/L during winter season and 13.5 mg/L during summer season.[18,19] The Sulphate value in Elisha Lake (Kheta Lake) water was found within the acceptable limit of 150 mg/L.

Dissolved Oxygen (D.O)

Dissolved Oxygen (D.O.) is important to the health of aquatic ecosystem because all aquatic organisms need Oxygen to survive**. [20,21]** The average Dissolved Oxygen (D.O.) was 7.9 mg/L during rainy season, 5.95 mg/L during winter season and 5.05 mg/L during summer season. The maximum Dissolved Oxygen in the water of Elisha Lake was recorded in rainy season. Thereafter it started declining gradually and in summer reached the lowest concentration**.[22,23]** The maximum DO in rainy season may be due to low atmospheric temperature and minimum D.O. was recorded in Summer season may be due to high metabolic rate of organism similar result was also reported by munawar [1970] – and Bhoi *et al*. [2005] – **[27,28]**

CONCLUSION

The W.Q.I. values in the present investigation of Elisha Lake (Kheta Lake) in rainy season, winter season and summer season are 47.87,111.03,156.60 and respectively. Which indicate that the water quality is good to unfit for drinking.

Acknowledgement

The authors with to express their gratitude to Nadiad Education Society for laboratory facilities. For analytical work Central Salt and Marine Chemical Research Institute, (CSMCRI) Bhavnagar. The authors are thankful to the UGC for financial assistance in the form of Minor Research Project.

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How to cite this article:

Bhoi D. K *et al* (2022) 'Determination of Water Quality Index of Elisha Lake, Nadiad, Dist. Kheda, Gujarat, India', *International Journal of Current Advanced Research,* 11(03), pp. 419-423.
DOI: http://dx.doi.org/10.24327/ijcar.2022.423.0093

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