UGC JOURNAL NUMBER 44557

International Journal of Allied Practice, Research and Review

Website: www.ijaprr.com (ISSN 2350-1294)

Water Quality Index of Harni Pond, District Vadodara, Gujarat

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Abstract - The current study reported physicochemical parameters of Harni pond of Vadodara District of Gujarat in Summer, Monsoon and Winter seasons of the year 2016-17 to find out Water Quality Index for its suitability for drinking purpose. WQI, is generally used for water resources like rivers, streams and lakes, etc for evaluation of quality of these water resources. WQI, basically a number having no dimension. It represents only a single number that has combined many water quality factors. The single number is obtained by normalizing values to subjective rating curves. For the calculation of WQI physic-chemical parameters like pH TDS, Total hardness, Total Alkalinity, Calcium and Magnesium, Chloride, Sulphate, Dissolved oxygen (DO) and Biological oxygen demand (BOD) had been considered. The Water Quality Index was found to be 155.45, 138.88 and 199.62 for monsoon, winter and summer season respectively. This indicates that WQI for all seasons the three exceeds 100 which state that the status of water quality is totally unsafe (unfit) for drinking purpose.

Keywords: ***Physicochemical parameters, Water Quality Index, Aquatic ecosystems, Harni pond***

I. Introduction

Water ecosystem, especially freshwater ecosystem , are some of the most important resources in the replenishment and purification of water sources used by human. Unfortunately , the sustainability of a large amount of these ecosystem is being negatively affected by land development. Increased use of underground aquifers , creation of water division system, industrial and household waste water contamination and the eradication of wetlands and marsh areas all pose a threat to these ecosystem that help to provide us with fresh water .

Inland fresh water resources have gained great concern in the recent years which are highly affected by various kinds of anthropogenic activities. Thus to review stratagies for conservation and utilization of freash water resources in a better way, a scientific study is required. 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 (Chauhan et al 2012, Chaterjee et al 2002).

Water Quality is an important factor to judge environment changes, which are strongly associated with social and economic development. The objective of water quality index is to turn complex water quality data into information that is understandable and used by the public. A water quality index based on some very important parameters provides a single indicator of water quality. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water system with number (Pandey and Sudram, 2002).

For any aquatic ecosystem, its physicochemical properties are mainly governed by the existing meteorological conditions. They are essential for determining the structural and functional status of natural water (Parashar et al 2006). Harni pond of Vadodara district of Gujarat is geographically located at latitude 22°20'18.83"and 73°13'03.84' 'longitude. It is a well-maintained serene pond till recently. But in the present years it has been observed that its condition deteriorated very quickly over the past few years and is also characterized by high levels of organic contamination. It is found to receive domestic waste and sewage continuously and is also used for cloth washing, animal bathing. All these lead to fast deterioration in the quality of water making the pond water totally unsafe for various domestic purposes. Therefore, the present study was under taken to assess the quality of Harni pond water at five different sampling points in three seasons with special reference to physicochemical properties to decide its WQI of the year 2016-17.

II. Materials and methods

The analysis of Physico-chemical characteristic of water collected from five different sampling points in three different seasons of the year 2016-17 followed the methods described in APHA , 2012. For Calculation of Water Quality Index has been calculated by using the standards of drinking water quality recommended by the WHO (1992), BIS (1993) and ICMR (1975). The weighted arithmetic index method (Brown et. al.1972) has been used for the calculation of WQI of the pond.

Further quality rating or sub index (qn) was calculated using the following expression.

Qn = 100 x [Vn-Vo] / [Sn-Vo]

Where, qn = Quality rating for the nth water quality parameter.

Vn = Estimated value of the nth parameter at a given sampling station.

Sn = Standard permissible value of the nth parameter.

Vo = Ideal value of nth parameter in a pure water.

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

corresponding parameters.
Wn = k/n

Where, Wn = Unit weight for the nth parameter. Sn = Standard value for nth 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.

WQI = Σqn Wn/ΣWn

III. Results and Discussion

For evaluation of WQI for the pondwater, parameters like pH TDS, TH, TA, Calcium and Magnesium, Chloride, Sulphate, DO and BOD has been considered. Water quality index of Harni pond water is established from important various physicochemical parameters in different seasons. The average values of various physicochemical parameters from five different sampling points are presented in Fig 1. Water Quality Index and Status of water quality (Chatterji and Raziuddin 2002) is shown in Table No 1 and Drinking Water standards recommending agencies and unit weight is shown in Table No 2. Season wise water quality index calculations are depicted in the Table 3.

pH

PH is one of the most important factors that server as an index for the pollution. The average PH values of the pond water were 6.64 during rainy season, 6.84 during winter season and 6.06 during summer season. The PH of water was relatively high in the winter season and low in monsoon and summer season. However, when the average values for three seasons are taken into account the Pond water was found to be neutral and was within the ICMR standards (6.5 – 8.5)

TDS

The estimated total dissolved solids in water of the pond was 373 mg/L during rainy season, 323 mg/L during winter season and 445 mg/L during summer season. The concentration is high during summer season, which may be due to addition of sewage and other domestic discharge into the pond. Gupta and Singh (2000) also reported high concentration of TDS in the Damodar river due to mixing of sewage and industrial water.

Total Hardness

The observed average total hardness value was 399 mg/L during rainy season, 478 mg/L during winter season and 495 mg/L during summer season, Higher values of hardness during summer can be attributed to low water level and high rate of evaporation of water and addition of calcium an d magnesium salts. Mohanta et al., (1996) stated that addition of sewage, detergents and large scale human use might be

the cause of elevation of hardness. Kannan (1991) has classified water on the basis of hardness values in the following manner, 0 – 60 mg/L soft, 61 – 120 mg/L Moderately hard, 121 – 160 mg/L. hard and greater than as 180 mg/L very hard. Hardness below 300 mg/L is considered potable but beyond this limit produces gastrointestinal irritation, (ICMR, 1975). The pond water was hard but the hardness values were beyond permissible limits.

Total Alkalinity

Alkalinity value less than 100 mg/L is desirable for domestic use. According to USPHA the maximum permissible limit is 120 mg/L. The observed average value of total alkalinity was 168 mg/L during rainy season, 164 mg/L during winter season and 134 mg/L in summer season. Total alkalinity values in our observations indicated that the water was hard. Higher values of alkalinity registered during rainy season might be due to the presence of excess of free CO2 product as a result of decomposition process coupled with the mixing of sewage and domestic waste. The average value of alkalinity during three seasons was reported to be 155.3 indicating that the water of the pond is alkaline. Jain et. al (1996) also reported similar finding in the study of the Halali Reservoir.

Calcium and Magnesium

The observed average value of calcium was 57.19mg/L during rainy season 50 mg/L during winter season and 73 mg/L during summer season. The quantities of calcium in natural water depend upon the type of rocks. Small concentration of calcium is reducing corrosion in water pipes. While the observed average value of magnesium was 63.40 mg/L during rainy season, 53.25 mg/L during winter season and 77.7 mg/L during summer season. Magnesium hardness particularly associated with the sulphate ion has laxative effect on persons unaccustomed to it (Khursid, 1998).

Water Quality	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 1: Water Quality Index and Status of Water Quality (Chatterji and Raziuddin 2002)

Chloride

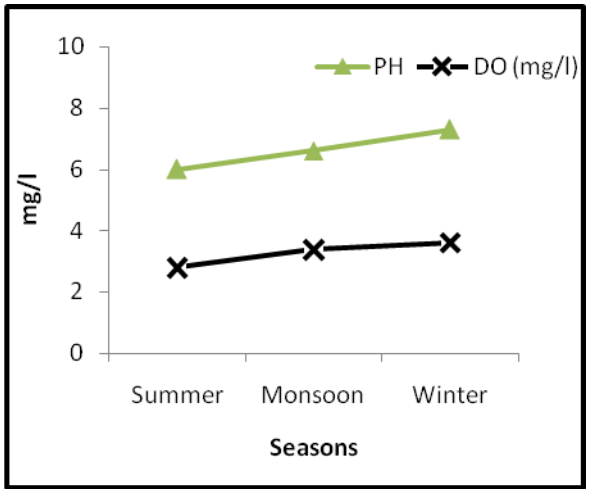
Chloride occurs in all types of natural waters. The high concentration of chloride is considered to be an indi cation of pollution due to high organic waste of animal origin (Singh and Ray, 1995). Chloride value obtained in the study was 127 mg/L during rainy season, 127 mg/L during winter season and 297 mg/L in summer season. Except for summer season, the chloride in the pond water was found within the acceptable limit of 250 mg/L. In natural surface water the concentration of chloride was normally low.

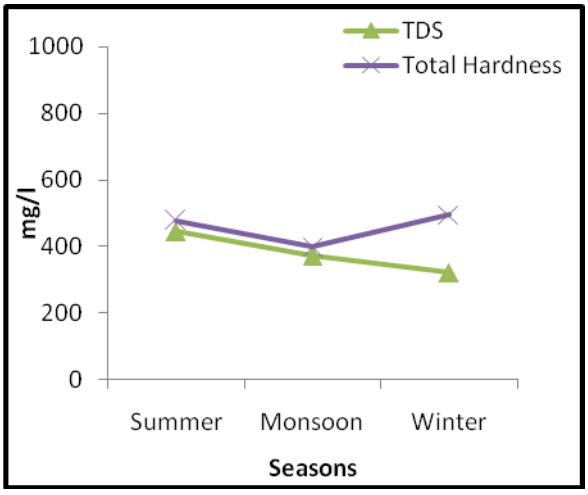
Sulphate

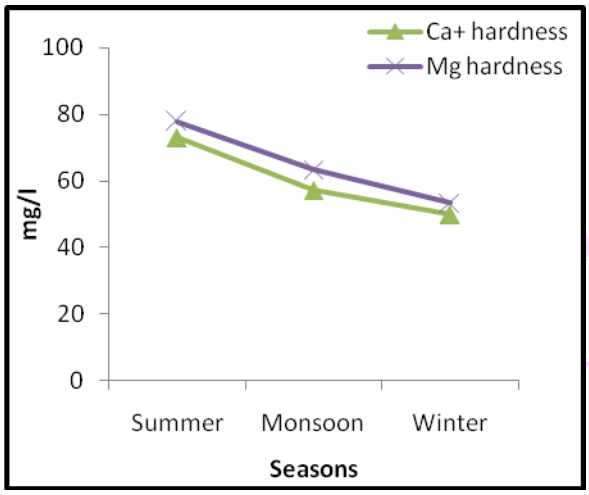
Sulphate ion does not affect the taste of water if present in low concentration. The sulphate ion concentration in 14 mg/L during rainy season, 23.8 mg/L during winter season and 35.4 mg/L during summer season. The sulphate in Harni pond water was found within the acceptable limit of 150 mg/L.

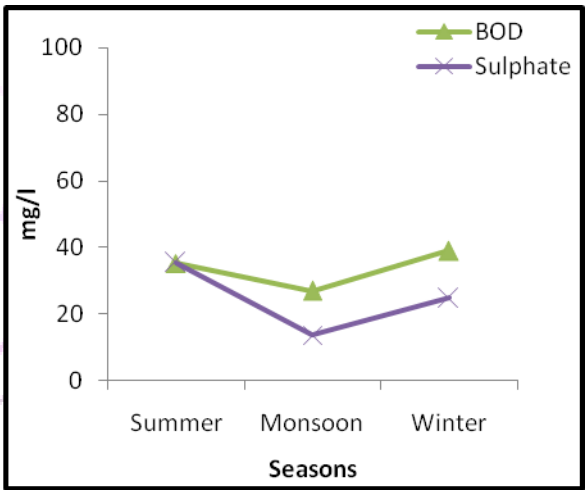
Parameters	**Standards**	**Recommended Agency**	**Unit Weight (Wn)**
pH	6.5-8.5	ICMR / BIS	0.2190
Total Alkalinity (Mg/L)	120	ICMR	0.0155
Total Hardness(Mg/L)	300	ICMR / BIS	0.0062
TDS(Mg/L)	500	ICMR / BIS	0.0037
Calcium (Mg/L)	75	ICMR / BIS	0.025
Magnesium(Mg/L)	30	ICMR / BIS	0.062
Chloride (Mg/L)	250	ICMR	0.0074
Sulphate(Mg/L)	150	ICMR / BIS	0.0124
DO(Mg/L)	5	ICMR / BIS	0.723
BOD(Mg/L)	5	ICMR	0.3723

Table 2 Drinking Water standards recommending agencies and unit weight.


PH
DO (mg/l)
mg/l
10
8
6
4
2
0
Summer
Monsoon
Winter
Seasons


TDS
Total Hardness
mg/l
1000
800
600
400
200
0
Summer
Monsoon
Winter
Seasons


Ca+ hardness
Mg hardness
mg/l
100
80
60
40
20
0
Summer
Monsoon
Winter
Seasons


BOD
Sulphate
mg/l
100
80
60
40
20
0
Summer
Monsoon
Winter
Seasons

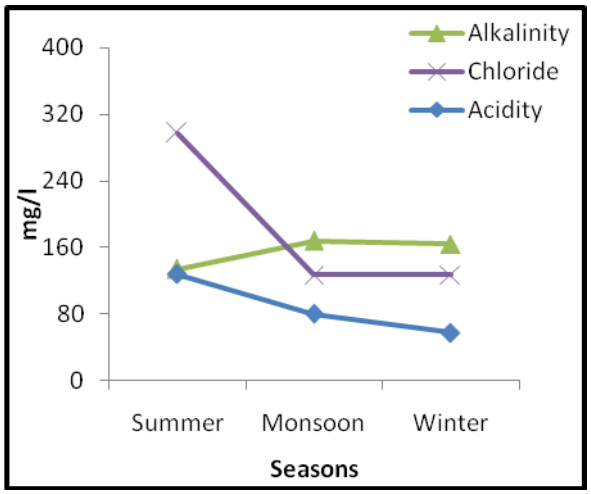


Figure 1: Seasonal Variation in physico-chemical parameters of Harni pond

DO

The average dissolved oxygen was 3.8 mg/ L during rainy season, 3.6 mg/L during winter season and 2.8 mg/L during summer season. The maximum dissolved oxygen in the water of the pond was recorded in rainy season. Thereafter it started declining gradually and in summer reached the lowest concentration. This can be attributed to addition of effluents containing oxidizable organic matter and consequent biodegradation and decay of vegetation at higher temperature leading to consumption of oxygen from water. Concentration below 5 mg/L may adversely affect the functioning and survival of biological communities and below 2 mg/L may lead to fish mortality. Water without adequate DO may be considered waste water. Presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs. (Shanthi et al. 2002).

BOD

The BOD values were found to be 3.53 mg/l, 5.31 and 9.08 in Summer,Monsoon and Winter season respectively. 5.31 mg/l and in Winter 9.08 (3.6) mg/l. Biological Oxygen Demand (BOD) is one of the most common measures of pollutant organic material in water. BOD indicates the amount of putrescible organic matter present in water. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water. Except for Winter season, BOD of pond water was found within the permissible limit of ICMR.

WQI

The Water Quality Index for the pond is shown in Table No: 3

Sr. No	Parameter	Rainy season		Winter season		Summer season	
		Quality Rating(Qn)	WnQn	Quality Rating(Qn)	WnQn	Quality Rating(Qn)	WnQn
1	PH	72	15.768	32	7.008	188	41.172
2	Total alkalinity	140	2.17	136.8	2.120	112.1	1.737
3	Total Hardness	133	0.824	165	1.023	159.4	0.988
4	Calcium	76.2	1.905	66.4	1.66	97.4	2.435
5	Magnesium	211.3	13.100	177.8	11.023	259.2	16.070
6	Chloride	50.9	0.376	50.952	0.377	118.8	0.879
7	Sulphate	9.2	0.114	16.5	0.204	23.6	0.292
8	DO	116.8	84.446	114.3	82.638	122.9	88.856
9	TDS	74	0.27	64	0.23	89	0.32
10	BOD	96	69.40	57	41.21	115	83.14
			∑=188.373		∑=147.493		∑=235.889
		WQI=246.690		**WQI=193.154**		**WQI=308.916**	

Table No:1 Water Quality Index (WQI) Of Harni pond in three different seasons.

The Water Quality Index was found to be 155.45, 138.88 and 199.62 for monsoon, winter and summer season respectively**.** This indicates that WQI for all seasons the three exceeds 100 which state that the status of water quality is totally unsafe (unfit) for drinking purpose.

Thakor et al., 2011 had calculated the Water Quality Index (W.Q.I.) of Pariyej Lake located in Kheda distrct and assessed the impact of industries, agriculture and human activities. The WQI values in their investigation were reported to be less than 75 (67.201, 68.43 and 70.37) for different season indicating that the water quality is poor and not totally safe for human consumption.

IV. Conclusion

The calculated Water Quality Index for Harni pond in three different seasons was found exceeding 100 which indicates that the quality of the pond water is poor and is not suitable for drinking purpose.

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