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Assessment of Water Quality Index of Two Fresh Water Bodies from Bhiwandi Tahsil, Dist. Tahne

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ABSTRACT
Water quality index integrate the intricate analytical data and generate a single number, indicating the water quality. It is a tool which is used to transform the complex water quality data into an information, which is easy to understand and can be used by general public as well as policy makers.

In the present work, an attempt has been made to evaluate the water quality of Vadape Lake, Bhiwandi, Dist-Thane (Maharashtra), on the basis of Water Quality Index. In all 12 Parameters which include pH, Conductivity, TDS, Alkalinity, Hardness, TSS, Calcium, Magnesium, Chlorides, Nitrate, Sulphate and D/O were taken into consideration for calculating water quality index. The result implies that water quality of the lake is significantly influenced by seasonal changes.

Key words- Physico-chemical parameters, Vadape lake, Water Quality Index.

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I. INTRODUCTION

Water Quality is an important factor to judge environmental changes which are strongly associated with social and economic development. The evaluation of water in the developing countries has become a critical issue in recent years.

One of the most effective ways to communicate information on water trends is by use of suitable indices. Indices are based on values of various Physico-chemical and biological parameters in a suitable water sample. The indices are useful in monitoring programmes to assess eco-system health.

Water Quality Index (WQI) is used to aggregate data on water quality parameters at different times and in different places and to translate this information into a single value.

The WQI was first developed by Horton in early 1970s. It is basically mathematical means of calculating single value from multiple test results. The Index result represents the level of water quality in the given water basin such as lake, river or streams. After Horton, number of workers all over the world developed WQI based on rating of different water quality parameters.

Water quality Index can bridge the gap between water quality monitoring and reporting methods. Integrative index which provide a single number that can express the relative level of impairment of water body and how the quality has changed through time is particularly useful for communicating information to general public. Moreover, WQI moreover provides cost effective water quality assessment ways as well as possibility of evaluating trends.

Numerous studies on water Quality assessment have been carried out using WQI. (N.K. Dhakad et. al., (2008), C. Ramakrishna et.al., (2009), Abdul Hameed et. al., (2010), Babei semiromi et. al., (2011), Mahesh kumar et .al., (2012), Neerja Kalra et. al., (2012), S.P. Gorde and M.V. Jadhav, (2013), I.R. Haboya et. al., (2014), Sayar Yaseen et. al., (2014), M.S Ami et. al., (2014), Ruby Pandey et. al., (2014), S.K. Pathak et. al., (2015), Asheesh Shrivastava et. al., (2015), Gopal Krishnan et. al., (2016), Ram Krishna et. al., (2016), Divya Bhardwaj et. al., (2017).

thane is a district in Northern Maharashtra state in Western India. The district is the Northern most part of the Konkan Low lands of Maharashtra. The district has number of natural Lakes. Artificial lakes have been constructed mainly to supply drinking water to Mumbai. There are two distinct climates in the district. The climate on the Western coastal plains of Thane, Vasai, Palghar and Dahanu taluka is tropical, very humid and warm.

In the developing country like India, water is playing vital role in health management. By keeping in view the targeted development of country, Government of India and government of Maharashtra have aimed to create water bodies as a back bone of economy in all districts. As a result, several earthen dams have been constructed in last three decades in general and in rural part of district Thane in Particular.

Water from most of these water bodies is used by local population for drinking and other purposes. Sometimes these water bodies are not suitable for drinking and other purposes. Wrong agricultural practices also deteriorate water quality by percolation of contaminants. Hence, characterization of water is necessary step to maintain health of local population.

People in rural areas of Bhiwandi use the water from selected water body for drinking and agriculture purposes. Aqua-culture is also practiced in this water body. Several human activities like agriculture, Aquaculture, washing clothes, emersion of Ganesh Idol and bathing etc. are continuously going on in the selected aquatic body, but so far characterization of this water body has not been done.

The rationale of the present study was to investigate the water quality status of the lake using Physico-chemical parameters. Therefore in the present work an attempt has been made to assess Physico-chemical parameters of water of selected water body for calculating WQI.

II. MATERIAL AND METHODS

Description of study Area

The Lake is located in Vadape village, Bhiwandi city, Thane district. The lake forms the geographical area of$19^0$3'N and $73^0$04E. It is situated at distance of 13km from Bhiwandi. The lake bed has been formed by silt deposition. The lake water depth varies from 2m to 9m. Annual rainfall is of 3224 mm spread over the month of June to September. Atmospheric temperature shows variation from28-32^0C in day time and 18-25^0C during night time.

Objectives of the present study

The objective of the present work is to emphasize on the quality of water body based on Water Quality Index assessment to describe about its suitability for human consumption and other commercial purposes.

Collection of water samples

Water samples from two pre-decided sites were collected in clean Polythene bottles by taking necessary precautions. The bottles were rinsed before sampling and sealed after collection and labelled in the field.

Analysis of water samples

Analysis was carried out for various water quality parameters. The surface water was collected every month during early morning between 8.00 am to 10.00 am. throughout the study period i.e. from January 2014 to December 2015. However, observations recorded during the first year of study period i.e. January 2014 to December 2014 are discussed in the present paper. The methodologies adopted for determination of water quality of various parameters are depicted in Methodology table under heading III.

Air and water temperatures were recorded on the spot. Similarly samples for estimation of Dissolved Oxygen were fixed by adding Winkler's A and B in the BOD bottles. The entire analysis was completed within 24 hrs. of collection by methods mentioned in APHA (2004), Trivedi and Goel (1986) and Trivedi (1993). The study was divided into three marked seasons Pre-Monsoon, Monsoon and Post-Monsoon.

Map of the Vadape lake

III. METHODOLOGY

Physical Parameters	Method
Atmospheric temperature	Thermometric method
Surface water temperature	Thermometric method
Conductivity	Conductivity method
Chemical Parameters	**Method**
pH	Digital pH meter
Total Dissolved Solids	Gravimetric method
Total Alkalinity	Titrimetric method
Total Hardness	EDTA method
Total Suspended Solids	Gravimetric method
Calcium	EDTA method
Magnesium	EDTA method
Nitrate-nitrogen	NEDD method
Sulphates	Turbidimetric method
Dissolved Oxygen	Winkler's iodometric method

IV. CALCULATION OF WATER QUALITY INDEX

Water Quality Index was calculated using the standards of drinking water quality recommended by the (ICMR) Indian Council for

Medical Research, (BIS) Bureau of Indian Standards and (WHO) World Health Organization. The weighted arithmetic index method (Brown et. al.) has been used for the calculation of WQI of the water body. Further quality rating or sub index (qn) was calculated using following expression.

$qn = 100 [Vn – V io] / [Sn – V io]$ (1)

Where,

qn = quality rating for the n^{th} water quality parameter

Vn = estimated value of the n^{th} water quality parameter at a given sampling stations.

Vio = ideal value of n^{th} parameter in pure water (i.e. 0 for all other parameters, except the parameter pH and Dissolved Oxygen, 7.0 and 14.6 mg/L respectively.)

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

$Wn = K / Sn$ (2)

Wn = unit weight for the n^{th} parameter

Sn = standard value for the n^{th} parameter

K = constant for proportionality

The overall water quality index was calculated by compiling the quality rating with the unit weight linearly.

$$WQI = \sum qnWn / \sum Wn$$

Water Quality Index (WQI) and status of Water Quality (Chatterji and Raziuddin 2002)

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

Drinking Water Standards recommending Agencies and Unit Weights. (All values except pH and Electrical Conductivity are in mg/L)

S. No	Parameters	Std. Values	Recomm. Agencies	Unit weight
1	pH	6.5-8.5	ICMR / BIS	0.219
2	Conductivity	300	ICMR	0.371
3	TDS	500	ICMR / BIS	0.0037
4	Total Alkalanity	120	ICMR	0.0155
5	Total Hardness	300	ICMR / BIS	0.0062
6	TSS	500	WHO	0.0037
7	Calcium	75	ICMR / BIS	0.025
8	Magnesium	30	ICMR / BIS	0.061
9	Chloride	250	ICMR	0.0074
10	Nitrate	45	ICMR / BIS	0.0412
11	Sulphate	150	ICMR / BIS	0.01236
12	Dissolved O_2	5	ICMR	0.3723

Seasonal variation of the Physico-Chemical Parameters of Vadape Lake (Jan-Dec-2014) (All values except pH and Electrical Conductivity are in mg/L)

Seasons / Parameters	Pre-Monsoon	Monsoon	Post-Monsoon
PH	7.25±0.38	7.2±0.38	7.48±0.29
Conductivity	0.386±0.03	0.329±0.12	0.323±0.04
TDS	418.75±210.90	352.5±137.54	330±205.15
Alkanity	230±65.45	170.63±13.03	215±30.92
Hardness	90.5±13.82	76.25±0.82	82.75±10.52
TSS	81.25±29.02	72.5±36.82	85±37.74
Calcium	30.66±5.81	16.58±2.09	27.46±6.61
Magnesium	14.09±6.38	31.45±7.58	13.79±6.81
Chloride	36.56±12.70	40.66±17.57	22.54±2.52
NO3	49.87±23.53	16.93±10.14	65.37±67.12
SO4	113.98±88.46	199.59±44.69	98.03±16.54
D/O	4.23±1.49	4.43±0.72	7.25±1.41

Calculation of Water Quality Index in Pre-Monsoon season (2014) (All values except pH and Electrical Conductivity are in mg/L)

Sr.No.	Parameters	Observed value	Std.values	Unit weight	Quality rating	Wnqn
1	PH	7.25	6.5-8.5	0.219	16.666	3.65
2	Conductivity	0.386	300	0.371	0.1287	0.0477
3	TDS	418.75	500	0.0037	83.75	0.3099
4	Alkanity	230	120	0.0155	191.67	2.9708
5	Hardness	90.5	300	0.0062	30.167	0.187
6	TSS	81.25	500	0.0037	16.25	0.0601
7	Calcium	30.66	75	0.025	40.881	1.022
8	Magnesium	14.09	30	0.061	46.967	2.8665
9	Chloride	36.56	250	0.0074	14.624	0.1082
10	NO3	49.87	45	0.0412	110.822	4.5664
11	SO4	113.98	150	0.01236	75.987	0.9391
12	D/O	4.229	5	0.3723	108.02	40.216
				∑Wn=1.14	∑qn=736.313	∑Wnqn=36.942

WQI= 40.949

Calculation of Water Quality Index in Monsoon season (2014)
(All values except pH and Electrical Conductivity are in mg/L)

Sr.No.	Parameters	Observed value	Std. values	Unit weight	Quality rating	Wiqp
1	PH	7.2	6.5-8.5	0.219	13.333	2.9192
2	Conductivity	0.329	300	0.371	0.1096	0.0406
3	TDS	352.5	500	0.0037	70.500	0.0406
4	Alkanity	170.63	120	0.0155	142.191	0.2808
5	Hardness	76.25	300	0.0062	25.416	0.1575
6	TSS	72.5	500	0.0037	14.500	0.0536
7	Calcium	16.58	75	0.025	22.106	0.5526
8	Magnesium	31.45	30	0.061	104.83	6.3948
9	Chloride	40.66	250	0.0074	16.264	0.1203
10	NO3	16.95	45	0.0412	37.622	1.5500
11	SO4	199.59	150	0.01236	133.060	1.6446
12	D/O	4.43	5	0.3723	105.93	39.438
				∑Wiz=1.14	∑qz=685.86	∑Wiqp=53.172

WQI= 46.64

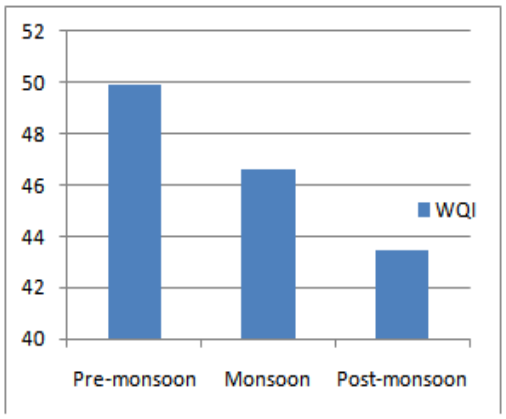
Calculation of Water Quality Index in Post - Monsoon season (2014)
(All values except pH and Electrical Conductivity are in mg/L)

Sr.No.	Parameters	Observed value	Std. values	Unit weight	Quality rating	Wiqp
1	PH	7.48	6.5-8.5	0.219	32.00	7.008
2	Conductivity	0.323	300	0.371	0.1077	0.0399
3	TDS	530	500	0.0037	106	0.3922
4	Alkanity	215	120	0.0155	179.167	2.777
5	Hardness	82.75	300	0.0062	27.583	0.17102
6	TSS	85	500	0.0037	17	0.0629
7	Calcium	27.46	75	0.025	36.613	0.9153
8	Magnesium	13.79	30	0.061	45.967	2.8040
9	Chloride	22.54	250	0.0074	9.016	0.0667
10	NO3	65.37	45	0.0412	145.267	5.985
11	SO4	98.03	150	0.01236	65.353	0.8078
12	D/O	7.68	5	0.3723	76.562	28.504
				∑Wiz=1.14	∑qz=740.63	∑Wiqp=49.533

WQI= 43.45

Seasonal changes in WQI values

Sr. No.	Season	WQI values
1	Pre Monsoon	49.95
2	Monsoon	46.64
3	Post Monsoon	43.45



Bar diagram showing variation in WQI

V. RESULT AND DISCUSSION

pH - Amongst the 12 parameters selected for forming Water Quality Index, pH is the most important factor which determines the stability of the water for various purposes.

In the present study pH ranged between 7.2-7.48. The values are within guidelines of WHO and BIS.Overall average values of three seasons are taken into account. The water body was found to be slightly alkaline in nature. Ambasht (1971) Peter (1975), Shardnedu and Ambasht (1988) Swarnalatha and Narsingarao (1993), Sinha (1995), have made similar observations in their studies on different water bodies.

Electrical Conductivity - Conductivity is a measure of capacity of a substance or solution to conduct electric current. It also determines the total dissolved solids in water. The Electrical Conductivity ranged from 0.323 to 0.386 µmhos/cm, maximum value was recorded in Pre-monsoon season and minimum value was recorded in Post-monsoon season. .These values are within the guidelines limit of WHO and BIS. In our study conductivity did not show significant seasonal variation.

Total dissolved solids - The amount of total dissolved solids (TDS) in water indicates salinity of water. Total dissolved solids in water comprise mainly of inorganic salts and small amount of organic matter. Total dissolved solids in water originate from natural sources and depend upon location / geological nature of the water body drainage rainfall, bottom deposits and inflowing water.

The permissible total dissolved solids for drinking water is 500mg/L. It is found from the analysis, that range of TDS levels in the study area is 352.5 to 530 mg/L. TDS values are found to be within permissible limits during Pre-monsoon and Monsoon. However during Post-monsoon it was found to be beyond desirable limit of 500 mg/L. High values of TDS may affect persons who are suffering from kidney and heart diseases. Water containing high solids may cause laxative or constipation effects.

Total Alkalinity - According to BIS the maximum permissible limit is 120 mg/L. The observed average value of total alkalinity was in the greater range of 170-230mg/L. Total alkalinity values in the study indicates that water was very hard. High values of alkalinity registered during Pre-monsoon and Post-monsoon might be due to presence of excess of free CO2 product as a result of decomposition process coupled with mixing of sewage and domestic wash. The lower value of Alkalinity observed during Monsoon may be due to utilization of CO2 during Phytoplankton growth. Jain et al (1996), and Kannkiya et al (2014) reported, similar observations.

Total Hardness - Calcium and magnesium dissolved in water are the two most common minerals that make water, hard. It is important to measure hardness for determining the accessibility of water for domestic, drinking and many industrial supplies. The degree of hardness of drinking water has been classified by (WHO - 2004). In terms of its equivalent CaCO3 concentration (Table) and accordingly the lake water belong to medium hard category.

Classification of Water depending upon the Hardness (WHO 2004).

Classification	**Hardness range (mg/L)**
Soft	0-75
Med. Hard	75-150
Hard	150-300
Very Hard	Above 300

Calcium and Magnesium - The observed average value of Calcium was in the range of 16.48-30.66. The quantities of Calcium in natural water depend on geology, types of rocks present in the catchment area. While the observed average value of Magnesium was in the range of 14.09-31.45 mg/L. According to the result obtained in the present study, calcium and magnesium content is found within permissible limit given by BIS.

Chloride - Chloride is one of the most important parameter in assessing the water quality. According to Munawar (1970) high concentration of chloride indicate higher degree of organic pollution. In the present study the concentration of Chloride fluctuated between 22.54-36.56 mg/L. Seasonally, chloride was found to be high during Monsoon and low during post- monsoon.

Nitrate - Nitrate occurs in water from various sources and due to human activities, agriculture and manure, disposal of domestic and industrial waste. During present investigation, Nitrate was recorded in the range of 16.93 to 65.37. Lowest value was recorded during Monsoon whereas highest value was observed during Post-monsoon. High level of nitrate observed in the present investigation may be attributed for extensive application of Nitrogenous-fertilizers in agriculture during monsoon.

Sulphate - The prominent form of sulphur in an aquatic ecosystem is of immense importance-as it affects eco-system productivity, abundance and distribution of biota etc. Nearly all assimilation of Sulphur takes places sulphate, but during decomposition of organic matter sulphur is reduced to hydrogen sulphite which is oxidized rapidly. In an aquatic environment, Sulphate does not limit the growth and distribution of biota. Sulphate in Lake Water is primarily related to the types of minerals found in the watershed and to acid rain. Industries and utilities that burn coal, release sulphur compounds into atmosphere which are carried into lakes by rainfall. The range of Sulphate recorded during the present study is 98.03-199.59 mg/L.

Dissolved Oxygen - It is an important parameter which is essential for the metabolism of all aquatic organisms that possess aerobic respiration. The dissolved oxygen concentration depends on the physical, chemical and biochemical activities in water body, and its measurement provide good indication of water quality. The DO values were found in the range of 4.23mg/L to 7.25 mg/L. The lowest DO was observed in Pre-monsoon season and the highest value was recorded in Post-monsoon season. The concentration of dissolved oxygen was more during post-monsoon and least during Pre-monsoon. Thus indicating variation of dissolved oxygen with respect to temperature. This observation is in conformity with the observation of Reddy et al (1982). Ghosh and George (1989). Swarnalatha and Narsingarao(1993).

VI. CONCLUSION

Water Quality index of the present water body is established from various important Physico - chemical parameters in different seasons. The values of the various physico - chemical parameters

for calculation of water quality index are presented in Table 3. Season wise water quality index calculations are depicted in table 4, 5, 6. The Water Quality Index calculated for the water body in different seasons is 49.949, 46.64 and 43.45 in Pre-monsoon, Monsoon, and post-monsoon seasons respectively.

Application of Water Quality Index (WQI) in this study has been found useful in assessing quality of Water. This method appears to be more systematic and gives comparative evaluation of the water quality in different seasons. From the WQI values obtained during the study in different seasons there seems to be no significant change in water quality in different seasons. Further the study clearly indicates that the lake water can be used for human consumption without any treatment.

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