

Pollution Monitoring Study of Water Samples Collected from Vashi Creek by Determining Water Quality Index

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ABSTRACT : Drinking good quality of water is the basic requirement of human physiology. From the very dawn of human civilization, due to uncontrolled greed, the over utilization of natural resources has been taken place which caused unparallel devastation. Recently, with the unplanned growth of industrialization, rapid urbanization and degradation of aquatic resources, by using them as dumping grounds for sewage, deforestation, depletion of water resources has played a crucial role in deterioration of aquatic ecosystems on the earth. To understand the quality of water, Water Quality Indices (WQI) is most commonly used as a valuable and unique rating to depict the overall water quality. Water Quality Index enables simpler interpretation of different physico-chemical parameters to communicate the information on water quality trends to the general public or to the policy makers and water quality management. In the present study WQI has been used to determine the water quality of water samples collected from Vashi Creek using standards such as Indian Council of Medical Research.

KEYWORDS: water pollution, industrialization, water quality index, physico-chemical parameters, Indian Council for Medical Research

I. INTRODUCTION

The importance of water for sustenance of life cannot be overemphasized. Whether it is in use of running water in our homes, rearing cattle and growing crops in our farms, or the increased uses in industry, remain immeasurable^[1]. Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. Water sources may be mainly in the form of rivers, lakes, glaciers, rain water, ground water etc. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. The availability and quality of water either surface or ground, have been deteriorated due to some important factors like increasing population, industrialization, urbanization etc^[2]. Urbanization, industrialization and many other anthropogenic activities as well as few natural processes affect the water resources badly. Unplanned resource consumption finally put threat to the water ecosystem. Water bodies are usually taken as the dumping grounds for domestic and industrial sewage^[3]. Once these water resources are polluted, its quality cannot be restored by minimizing the factors that contribute to the pollution. It therefore becomes very expedient to regularly monitor the quality of water, the pollutant levels and the possible sources of the pollution for better evaluation exercises with implications for public health, sanitation policy and planning, and sanitation design and development^[4].

Water pollution is usually caused by human activities. Different human sources add to the pollutions of water. There are two types of sources, point and non point sources, point sources discharge pollutants at specific locations through pipe-lines or sewers into the surface water. Non point sources are sources that cannot be traced to a single site of discharge. The point sources are factories, sewage treatment plants, underground mines, oil wells, oil tankers and agriculture. The non point sources include acid deposition from the air, traffic, pollutions those are spread through

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rivers and pollutants those enter the water through ground water. Non point pollution is hard to control because the perpetrators cannot be traced. However the point sources pollution can be controlled by taking suitable and appropriate preventive measures. The point sources pollution can be broadly classified as municipal, industrial and agricultural. Municipal water pollution consists of waste water from homes and commercial establishments^[5]. Industrial Sector was the principal economic driver for Navi Mumbai. Around 391 industries are located in the Thane Belapur Industrial Belt (TBIA) of Navi Mumbai. A few decades' back heavy industrialization and consequent urbanization have occurred along the banks of the creek. In this study water samples were collected from Vashi creek and were evaluated by analyzing physicochemical parameters. The study under consideration deals with the pollution caused by untreated sewage or effluent water into the Vashi Creek.

II. STUDY AREA

The Vashi creek has its origin from Thane creek. Thane creek meets Ulhas river in north through a small connection to link it to the Mumbai harbor. However, the creek extends from the river to the Vashi bridge. Due to increased population, rapid industrialization and uncontrolled urbanization, discharge of the waste is expected to bring about the change in quality of water. The present study was conducted to understand the pollution level of Vashi creek by evaluating physico-chemical parameters. During collection of water samples hand gloves were used for safety. Polythene bottles were used for water sampling and samples were collected from Sector 8, Vashi, Navi Mumbai. It is located in 19° 4' 31.37" N latitude and 72° 59' 6.75" E longitude. The area under study is shown in below figure 1.



Figure 1 Vashi creek and its surroundings.

III. MATERIALS AND METHODS

Five water samples of approximately one liter volume were sampled on each day from surface at a distance of 2 feet from bank after every 15 minutes. The five samples collected on a particular day were combined and the total volume of the final sample was approximately 5 liters and the analysis was initiated on that day. The physicochemical parameters of water were analyzed using the methods as described in APHA.

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IV. WATER QUALITY INDEX (WQI)

The introduction of Water Quality Indices (WQI) is an effective tool for measurement of level of contamination. WQI is defined as, “a rating reflecting the composite influence of different water quality parameters on overall quality of water”^[6]. Water quality index provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into information that is understandable and used by the public^[7].

A general WQI approach is based on the most common factors, which are described in the following three steps:

1. Parameter Selection: This is carried out by judgment of professional experts, agencies or government institutions that is determined in the legislative area. The selection of the variables from the 5 classes namely oxygen level, eutrophication, health aspects, physical characteristics and dissolved substances, which have the considerable impact on water quality, are recommended.

2. Determination of Quality Function (curve) for Each Parameter Considered as the Sub-Index: Sub-indices transform to non-dimensional scale values from the variables of its different units (ppm, saturation percentage, counts/volume etc.).

3. Sub-Indices Aggregation with Mathematical Expression: This is frequently utilized through arithmetic or geometric averages^[2].

However, a huge number of water quality indices viz. Weight Arithmetic Water Quality Index (WAWQI), National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), Oregon Water Quality Index (OWQI) etc. have been formulated by several national and international organizations. These WQI have been applied for evaluation of water quality in a particular area^[2]. The most commonly used water quality index is Weighted Arithmetic Water Quality Index method wherein water quality is classified according to the degree of purity by using the most commonly measured water quality variables.

Hence in this study Weighted Arithmetic Water Quality Index is used for the calculation by using the standards recommended by Indian Council for Medical Research (ICMR) and Bureau of Indian Standards (BIS). The calculation of WQI is as follows^[2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,22].

$$i) \quad WQI = \frac{\sum Q_i W_i}{\sum W_i}$$

Where, WQI = Weighted Arithmetic Water Quality Index

Q_i = Quality rating scale for each parameter

W_i = Unit weight for water quality parameter

ii) The calculation for quality rating scale (Q_i) for each parameter is as follows:-

$$Q_i = 100 [(V_i - V_o) / (S_i - V_o)]$$

(Let there be i water quality parameters and quality rating or subindex (Q_i) corresponding to i th parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value)

Where, V_i = estimated concentration of i th parameter in the analysed water

V_o = ideal value of this parameter in pure water

$V_o = 0$ (except pH = 7.0 and dissolved oxygen DO = 14.6 mg/l)

S_i = recommended standard value of i th parameter

Calculation of quality rating for pH & DO ($V_o \neq 0$)

$$Q_{pH} = 100 (V_{pH} - 7.0) / (8.5 - 7.0) \text{ and } Q_{DO} = 100 (V_{DO} - 14.6) / (5.0 - 14.6).$$

iii) The calculation for unit weight (W_i) is as follows:-

$$W_i = K / S_i$$

Where, K = proportionality constant and is calculated by the equation: - $K = 1 / \sum (1/S_i)$

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly.

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The rating of water quality according to this WQI is given as follows [2,3,6,7,8,9,10,11,13,14,15,17,18,22].-

WQI Value	Rating of water quality	Grading
0 - 25	Excellent water quality	A
26 - 50	Good water quality	B
51 - 75	Poor water quality	C
76 - 100	Very poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Table no.1 WQI value and status of water quality as per Weighted Arithmetic Water Quality Index Method

V. STANDARDS & GUIDELINES

According to the use or purpose of water, the guidelines and the tolerance limit of water differs. The WQI has been calculated using the standards of drinking water recommended by Indian Council for Medical Research (ICMR), World Health Organization (WHO) and Bureau of Indian Standards (BIS).

Sr. no.	Parameters	Standards	Recommended agency	Unit weight
1	pH	6.5-8.5	ICMR/BIS	0.2190
2	Total suspended solids (TSS)	500	WHO	0.0037
3	Biochemical oxygen demand (BOD)	5.00	ICMR	0.3723
4	Chemical oxygen demand (COD)	20	ICMR	0.02507
5	Chloride	250	ICMR	0.0074
6	Total dissolved solids (TDS)	500	ICMR/BIS	0.0037
7	Sulphate	150	ICMR/BIS	0.01236

Table no. 2 Permissible limit as per ICMR, WHO and BIS for respective parameters and their unit weight

VI. RESULTS

The water samples collected from Vashi creek were analyzed for seven physico-chemical parameters and the results are as follows:-

Parameters	pH (--)	Total suspended solids (TSS) (mg/l)	Biochemical Oxygen Demand (BOD) (mg/l)	Chemical Oxygen Demand (COD) (mg/l)	Chloride as Cl ⁻ (mg/l)	Total dissolved solids (TDS) (mg/l)	Sulphate as SO ₄ ²⁻ (mg/l)
Date of analysis							
01/07/16	7.52	61	18	24	89	56	45
04/07/16	7.89	75	17	38	51	89	37
05/07/16	6.10	69	14	17	23	91	39
06/07/16	5.46	94	10	20	33	113	56
07/07/16	7.92	110	12	28	61	210	43.1
08/07/16	8.45	59	34	26	44	78	24.1
11/07/16	5.78	40	63	39	37	62	25.9
12/07/16	6.92	661	20	44	11	743	10.3
13/07/16	6.02	89	28	19	29	185	47
14/07/16	6.89	63	50	47	86	132	35.9
15/07/16	6.47	984	34	64	30	854	21.4
18/07/16	6.56	570	19	34	21	680	33.8

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19/07/16	7.23	87	19	21	57	142	21.7
20/07/16	7.15	770	55	31	39	812	63.5
21/07/16	8.02	33	21	44	22	68	11.7
22/07/16	7.34	51	32	42	40	98	26.3
26/07/16	7.84	826	55	39	56	800	19.5
27/07/16	6.05	72	38	49	38	185	6.04
28/07/16	6.09	630	40	41	44	550	23.1
29/07/16	7.12	1015	16	39	28	1206	41.5
30/07/16	6.68	40	17	43	24	209	8.9
31/07/16	7.43	124	11	30	75	330	26.9
02/08/16	6.80	977	14	34	18	1226	58
03/08/16	10.11	168	24	58	40	250	0.6
04/08/16	9.08	378	32	49	18	172	0.5
05/08/16	6.23	69	10	26	39	329	60
06/08/16	6.67	246	21	50	30	298	15.8
07/08/16	6.68	172	19	41	143	532	12.6
09/08/16	6.93	292	26	32	67	345	17.9
10/08/16	6.66	186	20	52	157	595	17.5
11/08/16	6.83	290	17	48	226	678	39.7
12/08/16	6.22	98	31	47	169	556	26.6
13/08/16	6.99	1776	26	69	30	1570	17.5
14/08/16	6.42	222	19	33	254	682	24.8
15/08/16	6.69	93	21	44	74	245	23
16/08/16	6.79	83	35	97	187	139	22.4
17/08/16	6.41	750	32	41	85	127	31.2
18/08/16	5.56	1042	58	99	26	1390	28.5
19/08/16	7.03	650	99	17	94	760	26.9
22/08/16	7.81	136	40	60	12	303	41.7
23/08/16	8.33	172	38	53	53	156	58.2
24/08/16	7.22	748	26	41	97	1089	43
25/08/16	6.28	690	11	22	43	779	30
26/08/16	6.30	887	22	37	36	1460	23.9
27/08/16	6.97	99	23	34	86	259	14.5
29/08/16	6.81	470	58	104	61	560	20.9
30/08/16	6.12	890	24	55	50	900	17.4
31/08/16	6.49	1220	17	24	29	1947	50.2
Average	6.95	403	29	43	64	522	29

Table no. 3 Results of physicochemical parameters of water samples collected from Vashi creek

The above table 3 shows the analysis results of seven different physico-chemical parameters which were analyzed on that particular day. The pH values varied from 5.46 to 10.11. The Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) showed high very high results at some instances. The water samples results for Biochemical Oxygen Demand (BOD) parameter were above the tolerance limit as recommended by ICMR. The Sulphate parameter found to be well within the tolerance limit.

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Sr. No.	Parameters	Observed values (V _i)	Standard values (S _i)	Unit weight (W _i)	Quality rating (Q _i)	Q _i W _i
1	pH	6.95	6.5-8.5	0.2190	3.33	0.73
2	Total Suspended Solids	403	500	0.0037	80.6	0.30
3	Biochemical oxygen demand	29	5.00	0.3723	580	215.93
4	Chemical oxygen demand	43	20	0.02507	215	5.39
5	Chloride	64	250	0.0074	25.6	0.19
6	Total dissolved solids	522	500	0.371	104.4	38.73
7	Sulphate	29	150	0.01236	19.33	0.24
				Σ W _i = 1.01	Σ Q _i = 1028.26	Σ Q _i W _i = 261.51
WQI = Σ Q_i W_i / Σ W_i = 258.92						

Table no. 4 Calculation of Water Quality Index (WQI)

The average values of all the physico-chemical parameters were calculated and these values were used for Water Quality Index calculation. The overall WQI showed a high value of 258.92. From the above table 4 it is clear that BOD is the major contribution parameter for the overall WQI high value, which was followed by TDS and COD. The overall Water Quality Index of water samples collected from Vashi creek was calculated using Weighted Arithmetic Water Quality Index equations.

VII.DISCUSSION

WQI is established through the measurement of various important physicochemical parameters of the surface water ^[11]. The values of various physicochemical parameters for the calculation of WQI are presented in Table 4. The value of Water Quality Index of the creek was found to be 258.92 which indicate (as per table no. 2) that water is unfit for drinking purpose. The Q_iW_i value for BOD was greater as compared to all the other parameters with the value of 215.93. This clearly indicates that the waterbody is eutrophic making it unsuitable for drinking purpose. The TDS (38.73) was next to BOD in Q_iW_i value followed by COD (5.39). The average values of BOD, COD and TDS were above the permissible limit recommended by ICMR except for pH, chloride, TSS and sulphate. However, the average values of some parameters such as pH, chloride, TSS and sulphate were within the permissible limits there were instances where these parameter were above the limit.

pH is less, algae die, fish cannot reproduce and it cause acidity, corrosion, irritation of mucous membranes, tuberculosis and other health problems in humans ^[13]. Biochemical Oxygen Demand one of the most important factor that indicates the depletion of dissolved oxygen in the water. Since water contains organic matter and bacteria which oxidizes organic matter during the process of consuming oxygen. The decrease in oxygen content has several important consequences: I) it makes the watercourse partially or completely anaerobic and this lead to the development of odors, flavors, and toxic materials in the water. II) When the water becomes anaerobic, many animals such as fish die, and their remains putrefy and add further foul odors and organic matter to the water. III) Even if odors do not develop, water depleted of oxygen has a flat taste. IV) Decomposition of organic materials takes place much more slowly in the absence of oxygen; the purification process in the water course are therefore slow, and a thick, unsightly, organic-rich sediment may accumulate on the bottom of the watercourse. V) Certain undesirable animals, such as the red bloodworms (chironomid larvae), develop to very large numbers in waters depleted of oxygen. The consumption of oxygen by bacteria is called the biochemical oxygen demand, usually abbreviated BOD, the extent of oxygen consumption determined by the amount of oxidizable organic matter present in the water. The BOD commonly used as a measure of organic pollution degree in water ^[20]. Chemical Oxygen Demand is another evaluation that used to measure the level of water contamination by organic matter. In this evaluation, the organic matter is oxidized via oxidizing agent (potassium dichromate). The COD is usually higher than the BOD because some organic materials in the water that are resistant to microbial oxidation and hence not involved in BOD will be easily chemically oxidized ^[20]. The average values of BOD and COD was found to be above the permissible limit of ICMR indicating the waterbody is being polluted and cannot

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be used for drinking purpose. TSS is used to describe the strength of waste water, where more TSS in waste water, more polluted in waste water. TSS give the best indicator for the turbidity of the water, where suspended solids turn the water into milky or muddy looking owing to light scattering from very small particles^[20].

VIII. CONCLUSION

The WQI provides a systematic and reliable method to determine the water quality. Since the WQI calculated in this study was above 100, discharge of industrial waste and/or sewage waste into the waterbody should be avoided. Based on observed WQI results it can be concluded that effective treatment measures are urgently required to augment the water quality by defining an appropriate water quality management plan which in turn will support any future plan for sustainable creek restoration. Regular monitoring of water quality is needed to understand extend of water pollution so as to take required corrective and preventive measures.

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