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Comparison and Evaluation of Physicochemical and Organic Indicators of Pollution in Selected Creeks of Mumbai Western Coastal Region

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ABSTRACT: The current investigation studies the physiochemical parameters and level of organic contamination of water samples obtained from four main creeks of Western Coastal region of Mumbai – Malad creek, Vasai creek, Mahim creek, and Manori creek. The analysis was carried out for such parameters as hardness, salinity, acidity, Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD). Based on the analysis results, significant differences were found regarding the location of the sampled water bodies. Vasai creek displayed the maximum salinity level (15940 ppm) and hardness because of strong tidal influence and high content of dissolved ions in water. Mahim creek indicated the highest acidity (229.68 ppm) due to severe human interference into the environment of this creek. All analyzed creeks demonstrated the high COD level that ranged between 512 and 864 mg/l. This means that high level of organic pollution was observed at these water bodies. Strong connection between COD and BOD confirms the high amount of biodegradable organic pollutants.

KEYWORDS: Water quality, COD, BOD, Creek pollution, Mumbai coast, Physicochemical analysis.

INTRODUCTION

The sea-coasts, and the spots where the rivers enter the sea, are very active in growing up a great deal of life. They also get very easily hurt. Cities at a fast rate, factories littering things out and people disrupting the environment are increasingly threatening these areas. In cities such as Mumbai, the small rivers, which flow to the Arabian Sea, are very important as they assist animals and plants to survive they aid in the movement of nutrients and they aid in the capture of fish. But these areas are in trouble as they keep on receiving sewage, bad things produced in factories and water that run off the streets, which makes the water quality very bad. There are very significant small rivers that are very important to the environment, such as Malad, Vasai, Mahim and Manori. Some studies have looked at how polluted individual small reverser but not many studies have compared the pollution in many small rivers at the same time especially when it comes to looking at the physical and chemical characteristics of the water and the pollution from organic things. It is also due to the fact that the city is growing rapidly and we need to re-examine the water quality and ensure that we are examining the entire area. By observing things such as the saltyness of the water or the hardness of the water or how acidic the water is or how much oxygen the water needs to dissolve organic matter, we can tell how healthy the water is. The level of oxygen that the water must dissolve stuff is highly important in determining the level of pollution the water has. It is by observing how all these things re relate that we can learn a lot about how the environment is being hurt and how pollution is affecting the environment. So this research will compare the chemical properties of some small rivers in the coastal region of Mumbai and this research will pay special attention in taking a look at organic pollution. We will be visiting the rivers in Mumbai to find out the extent of their pollution and how we can assist them. Of great importance are the coastal areas, the small rivers of Mumbai. We have to ensure that we are looking after them. To gain more knowledge about the pollution, in these regions, we will be studying the rivers in Mumbai.

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MATERIALS AND METHODS

I. Study Design and Setting

The research was a comparative experimental study to establish the physicochemical and biological water quality parameters of the selected estuarine creeks in the western coast, region of Mumbai, India. Four major creeks were used to collect water samples, i.e., Malad Creek, Vasai Creek, Mahim Creek, and Manori Creek. The aim of the study was to assess spatial differences in the quality of water, due to human anthropogenic activity as well as the interaction between water and the tide.

II. Sampling Strategy and Sample Collection

Clean, pre-rinsed polyethylene bottles were used to collect water samples in the respective creek. In order to reduce temporal effects sampling was done under comparable environmental conditions. To avoid interference with atmospheric oxygen in samples, airtight glass-stoppered bottles were used to collect the samples to be used in the dissolved oxygen (DO) and the biological oxygen demand (BOD) analysis. All the samples were transported into the laboratory and the samples were subjected to the recommended holding time to ensure that the data is reliable.

III. Chemicals, Reagents, and Instruments

Chemicals were of analytical grade and solutions were made with distilled water. The most important reagents were Ethylenediaminetetraacetic acid (EDTA), silver nitrate ($AgNO_3$), potassium dichromate (K2Cr2O7), sodium thiosulfate ($Na_2S_2O_3$) ammonium buffer solution (pH 10), potassium chromate indicator, ferroin indicator, and the reagents of Winkler. Glassware of the lab such as burettes, pipettes, conical flasks, volumetric flasks, CO_2 digestion tubes were utilized. Titrimetric measurements and normal laboratory procedures were used to measure analytically.($Na_2S_2O_3$)

IV. ANALYTICAL METHODS

1. Determination of Total Hardness

Total hardness was out to by complexometric titration which we used EDTA as the titrant. For total hardness Eriochrome Black T was the indicator we used, for calcium hardness Patton and Reeder indicator was used. We calculated magnesium hardness by difference. Results we reported in mg/L as CaCO3.

2. Determination of Salinity (Chloride Content)

Salinity by argentometric titration (Mohr's method) in which chloride ions were precipitated using the standard solution of silver nitrate and potassium chromate as indicator. Absorbance readings were obtained, and the cessation point was defined by the occurrence of a brick red precipitate from silver chromate. These were presented as results in chloride of ppm.

3. Determination of Acidity

The titration of samples with standard sodium hydroxide solution using methyl orange and phenolphthalein indicators was performed to measure acidity. Acidity (in both mineral and total)

4. Determination of Chemical Oxygen Demand (COD)

COD was determined using the dichromate reflux method . Samples were digested with potassium dichromate in acidic medium at 150°C for 2 hours . The supererogatory dichromate was titrated with ferric ammonium sulfate using ferroin indicator . COD values were calculated and expressed in mg/L .

5. Determination of Biological Oxygen Demand (BOD)

We determined BOD by tracking the drop in dissolved oxygen during incubation periods of 1 , 3 , and 5 days under controlled conditions. Initial and last DO readings came from Winkler's method . BOD equaled the difference in oxygen concentration , reported in mg/L .

6. Measurement of Additional Physicochemical Parameters

We measured pH , temperature , total dissolved solids (TDS), total suspended solids (TSS), and electric conductivity with normative procedures and calibrated instruments.

RESULTS

The physicochemical and biological characteristics of water samples collected from Malad Creek, Vasai Creek, Mahim Creek, and Manori Creek were analyzed. The results obtained for different parameters are presented below.

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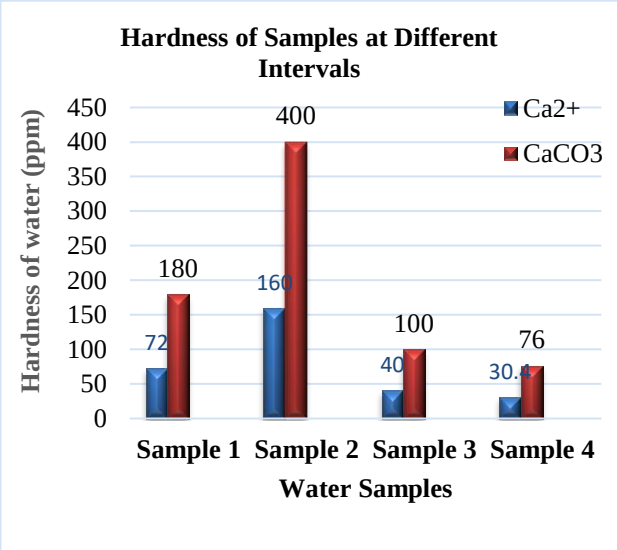
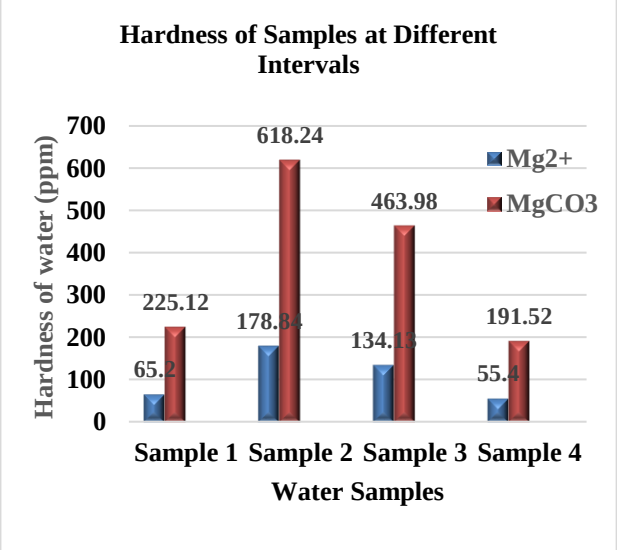
1. Total Hardness: The concentrations of calcium (Ca^{2+}), magnesium (Mg^{2+}), and their corresponding carbonate forms were determined for all sampling sites. The results are summarized in Table 1.

Table I: Total Hardness Parameters of Water Samples (mg/L or ppm)

Parameter	Sample 1 Malad creek (ppm)	Sample 2 Vasai creek (ppm)	Sample 3 Mahim creek (ppm)	Sample 4 Manori creek (ppm)
Ca^{2+}	72	160	40	30.4
$CaCO_3$	180	400	100	76
Mg^{+2}	65.2	178.84	134.13	55.40
$MgCO_3$	225.12	618.24	463.98	191.52

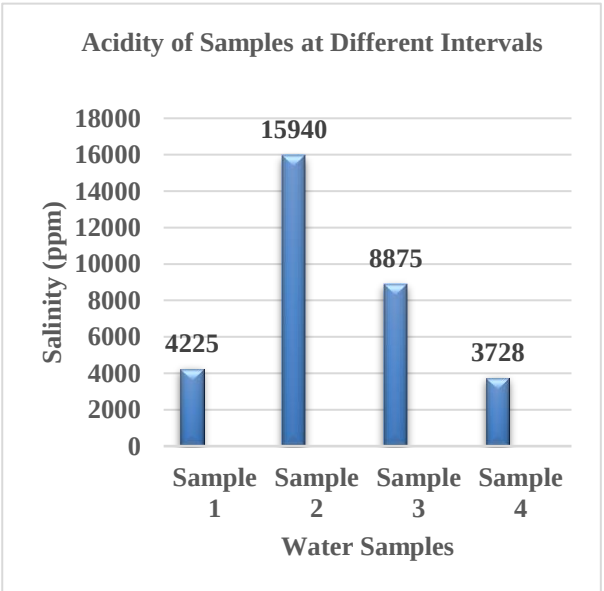




2. Salinity (Chloride Content): Salinity values, expressed as chloride concentration, are presented in Table 2.

Table II: Salinity of Water Samples (ppm)

Parameter	Salinity
Sample 1 Malad creek (ppm)	4225
Sample 2 Vasai creek (ppm	15940
Sample 3 Mahim creek (ppm)	8875
Sample 4 Manori creek (ppm)	3728



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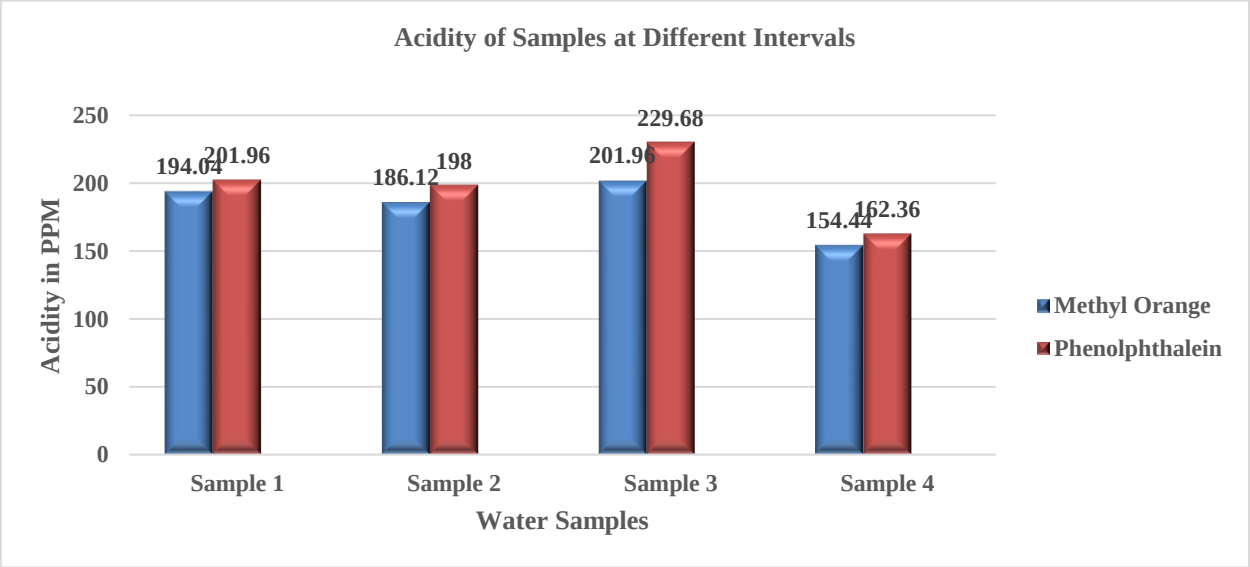
3. Acidity: Acidity was evaluated through titration, employing methyl orange and phenolphthalein to identify the respective endpoints.

Table III: Acidity of Water Samples (mg/L as $CaCO_3$)

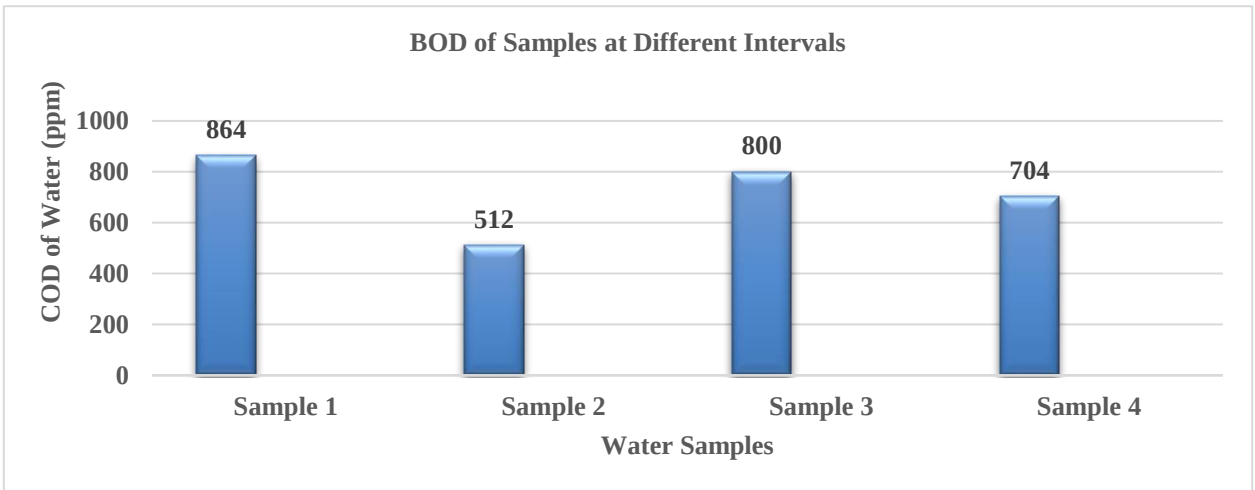
Sampling Location	Methyl Orange Acidity	Phenolphthalein Acidity
Malad Creek	194.04	201.96
Vasai Creek	186.12	198.00
Mahim Creek	201.96	229.68
Manori Creek	154.44	162.36



4. Chemical Oxygen Demand (COD)

Table IV: Chemical Oxygen Demand (mg/L)

Parameter	Sample 1 Malad creek (ppm)	Sample 2 Vasai creek (ppm)	Sample 3 Mahim creek (ppm)	Sample 4 Manori creek (ppm)
COD	864	512	800	704



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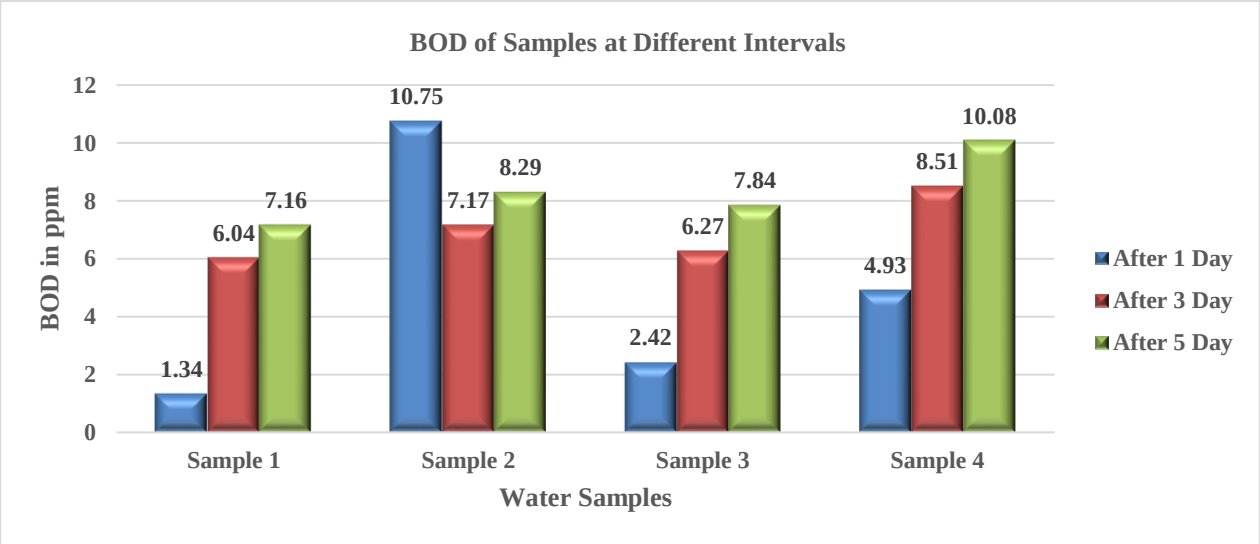
5. Biological Oxygen Demand (BOD)

BOD values were determined over multiple incubation periods.

Table V: Biological Oxygen Demand (mg/L)

Parameter (BOD)	Sample 1 Malad creek (ppm)	Sample 2 Vasai creek (ppm)	Sample 3 Mahim creek (ppm)	Sample 4 Manori creek (ppm)
After 1 Day	1.34	10.75	2.42	4.93
After 3 Day	6.04	7.17	6.27	8.51
After 5 Day	7.16	8.29	7.84	10.08



6. Physicochemical Parameters

The measured values of pH, total dissolved solids (TDS), total suspended solids (TSS), conductivity, and temperature.

Table V I:

Parameter	Sample 1 Malad creek	Sample 2 Vasai creek	Sample 3 Mahim creek	Sample 4 Manori creek
pH	8.69	7.20	5.50	5.1
TDS (ppm)	5360	9370	9260	5390
TSS (mg)	17	171	17	16
CONDUCTIVITY (mS)	13.68	43.1	26.7	12.60
TEMPERATURE (°C)	28°	29°	29°	27°

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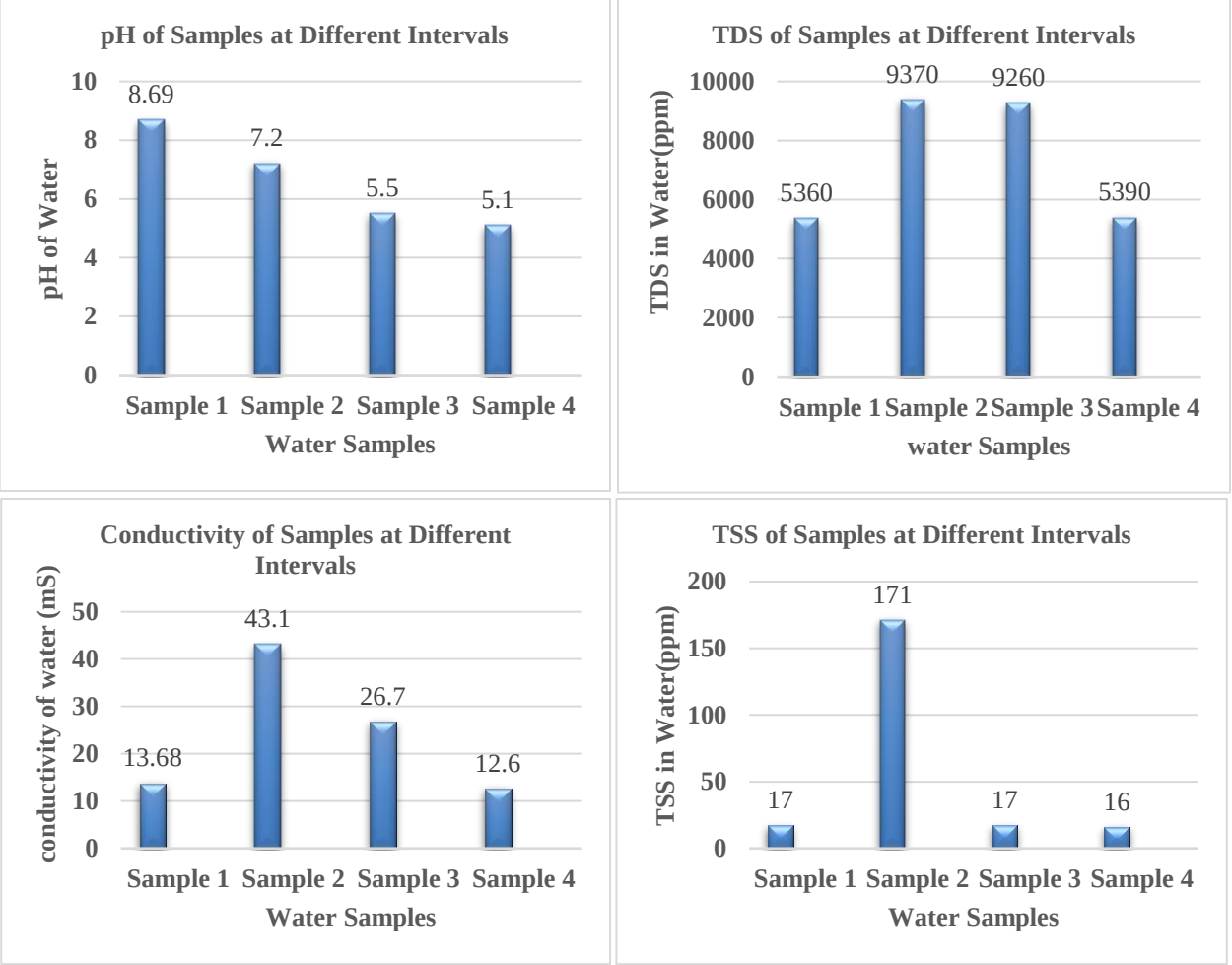

DISCUSSION

The research demonstrates that there is extensive spatial variation in the water quality across the four creeks which is mainly as a result of anthropogenic activities. Vasai Creek exhibits the greatest hardness and salinity, which means a high mineral content and tidal effects in combination with industrial effluent. Manori Creek on the other hand has relatively lower values implying relatively lower contamination. The degree of acidity is high in all the sites but the greatest values are found in Mahim Creek, which implies that there are both strong and weak acids that are caused by the sources of pollution. The values of COD are tremendously high in all samples, particularly in Malad and Mahim creeks, which are well above the acceptable limits (<250 mg/L), which is the confirmation of a heavy organic and inorganic contamination. The values of the BOD increase with time in all samples and indicate active microbial degradation and high organic load, especially in Vasai and Manori creeks. Physicochemical parameters are also in support of these findings: pH is either alkaline or acidic, TDS are unnaturally high (>9000 ppm in certain locations), and conductivity is associated with a high ionic content. Comparing with the permissible limits, the majority of the parameters (COD, BOD, TDS, salinity) are much higher than the allowable levels, which means that the water quality does not fit the domestic use criteria and negatively affects aquatic life. The strengths of the study are the multi-parameter analysis and comparative assessment, whereas limitations are the single-time sampling and lack of the microbial or heavy metals analysis. The results indicate that wastewater treatment and monitoring should be improved, and future research should be concerned with the seasonal difference and the identification of the source of pollution.

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CONCLUSION

The research shows that the water quality of the four estuarine creeks varies greatly, and the overall findings show that there is a lot of environmental degradation. High levels of hardness, salinity, acidity, COD, BOD, TDS and TSS at most of the sampling sites indicate a high level of pollution especially in the Vasai and Mahim creeks. When compared to permissible limits it can be seen that a number of key parameters are beyond acceptable limits and are a source of stress to aquatic ecosystems. The research gives us a detailed comparative evaluation of physicochemical and biological parameters, and the degree of contamination of these urban creeks. These results underscore the importance of powerful monitoring and management plans in order to deal with water pollution and safeguard estuarine ecosystem.

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