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Abstract

This study presents a comparative analysis of water quality parameters in three prominent beaches of Mumbai: Versova Beach, Silver Beach, and Juhu Beach, conducted in the afternoon. Water samples were collected simultaneously from multiple locations along each beach and subjected to comprehensive testing for turbidity, total dissolved solids (TDS), total solids, amount of CO2, biochemical oxygen demand (BOD), pH, total hardness, and conductivity. The results revealed variations in water quality parameters among the beaches, with significant differences observed in pH, turbidity, TDS, BOD, total hardness, total solids and amount of CO2. Juhu Beach exhibited high BOD levels compared to Silver and Versova Beaches, indicating the presence of organic pollutants in the water, whereas the pH level of Versova and Silver Beaches were nearly same i.e. weakly basic. The findings highlight the importance of regular monitoring and targeted interventions to mitigate pollution and safeguard the water quality of Mumbai's beaches for recreational and environmental purposes.

Keyword: Water quality parameters Turbidity, pH Biochemical oxygen demand Total Dissolved Solid Total Solids Total Hardness.

1. INTRODUCTION

Water quality assessment plays a crucial role in understanding the health of aquatic ecosystems and ensuring the well-being of human populations dependent on them. The degradation of water quality in coastal areas poses significant environmental and public health concerns globally. In rapidly urbanizing cities like Mumbai, the deterioration of water quality in beaches has become a pressing issue due to increased anthropogenic activities and inadequate wastewater management practices. The coastal regions of Mumbai boasted picturesque beaches that served as recreational hubs, ecological habitats, and vital components of the city's identity. However, the increasing urbanization and industrialization in Mumbai had placed immense pressure on these coastal ecosystems, raising concerns about the quality of water in its beaches. Understanding the dynamics of water quality parameters in these coastal areas was paramount for ensuring environmental sustainability, safeguarding public health, and promoting responsible coastal management practices.

This research paper aims to conduct a comprehensive analysis of water quality parameters in three iconic beaches of Mumbai: Versova Beach, Silver Beach, and Juhu Beach. These beaches, characterized by their scenic beauty and cultural significance, attracted throngs of visitors and played crucial roles in the city's tourism industry and socio-economic fabric. Nevertheless, the rapid urban development, population growth, and inadequate waste management practices had cast a shadow of concern over the cleanliness of beach water

The primary objective of this study was to comprehensively evaluate and compare key water quality parameters across the selected beaches, including turbidity, amount of CO2, total dissolved solids (TDS), total solids (TS), total hardness of water (TH), biochemical oxygen demand (BOD), pH, and conductivity. By analyzing these parameters, we aimed to elucidate the temporal variations in water quality, discern potential sources of pollution, and assess the overall environmental health of each beach. Through systematic sampling and rigorous laboratory analysis, water samples were collected from multiple locations along each beach, employing standardized protocols to ensure data reliability and consistency.

Concurrently, information pertaining to environmental factors and human activities in the vicinity of each beach was gathered to contextualize the observed water quality trends and pinpoint potential sources of pollution. The findings of this study are expected to provide valuable insights into the current status of water quality in Mumbai beaches, identify areas of concern, and inform policymakers, environmental agencies, and local communities about the need for targeted interventions and management strategies. Ultimately, this research aims to contribute to the sustainable management and conservation of coastal ecosystems and promote public awareness and engagement in preserving the environmental integrity of Mumbai's beaches, thereby encouraging past sustainable development and enhancing the well-being of present and future generations.

2 Material and Methods

2.1. Study Area: The coastal stretch of Mumbai plays a vital role in shaping the city's geography and culture. Multiple beaches are situated along this coastline, yet the water quality varies due to pollution and human activities. In this study, three sampling locations were selected and the selection criteria of the sampling locations were mainly based on the characteristics of the anthropogenic activities along the coast. The sampling locations were: Juhu Beach, Versova Beach and Silver Beach (all three located in Andheri West), which lies between latitude 19.1019□N and longitude 72.8203□E.

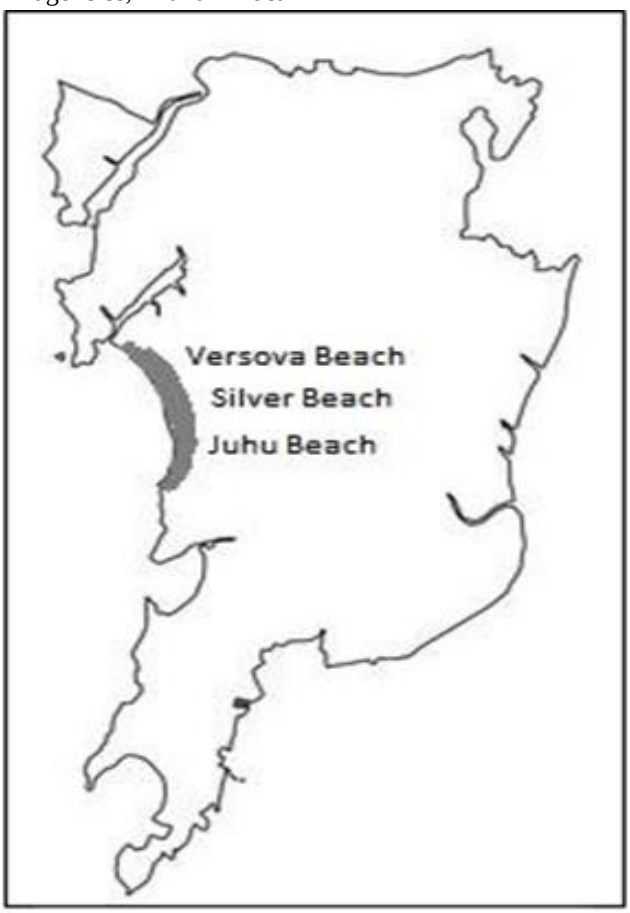

Figure 1: Study Area of Mumbai Coast

2.2. Sample and Sampling Procedure: All the three samples were collected in the afternoon between 12:00 pm to 2:00 pm on the same Demand" method. This method involves measuring the amount of oxygen consumed by microorganisms in a water sample over a 5- day incubation period.

2.3. Sample Analysis: The collected sample underwent analysis for pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total solid (TS), dissolved carbon dioxide (CO2), biochemical oxygen demand (BOD) and total hardness. The most stable readings for pH, turbidity and electrical conductivity (EC) were obtained electronically using a pH meter, nephelometer and conductometer respectively. Total dissolved solids (TDS) and Total Solids (TS) was determined using gravimetric method. Total hardness and amount of CO2 was obtained by titrimetric methods while BOD was calculated using "Five-Day Biochemical Oxygen while it was intermediate in Juhu Beach and highest in Versova beach. The elevated turbidity levels noted at Versova beaches may be linked to construction activities and human impact.

3 Results and Discussions

The current research conducted a comparative assessment of the physical and chemical properties of water samples collected along the coastline. The following table presents the outcomes of all parameters for the three samples.

Table 1: Water Quality Parameters observed at different beaches

Water Quality Parameters		Sampling Locations	
	Juhu Beach	Silver Beach	Versova Beach
pH	7.59	8.34	8.25
Turbidity	15	8.4	42
Electrical Conductivity (mS)	48.5	48.3	48.2
Amount of CO2 (mg/L)	176	58.52	293.26
TDS (mg/L)	21.64	39.18	38.02
Total Solids (mg/L)	37.2	40.02	38.10
BOD (mg/L)	0.0065	0.0015	0.0020
Total Hardness (ppm)	80	92	52

3.1. pH. The pH levels varied between 7.59 and 8.34, with the lowest recorded at Juhu beach and the highest recorded at Silver beach. The pH range of 7 to 9 supports aquatic life. As all three beaches sustain aquatic ecosystems, the pH levels falls within the range of 7 to 9.

3.2. Turbidity. The turbidity of beach water is influenced by suspended particles that diminish water clarity and raise density. Turbidity is also majorly affected by construction runoff, dredging, sewer discharge, animal activities. Turbidity values varied between 8 and 45 NTU. The lowest turbidity was recorded in Silver Beach day. The samples were stored in pristine containers and appropriately labelled. These containers were rinsed with distilled deionized water prior to use. All samples were stored in a refrigerator and analyzed within 48 hours.

3.3. Electrical Conductivity (EC). The ability of beach water to conduct electricity is a reflection of its electrical conductivity, which is determined by factors like salinity, temperature, and the presence of dissolved ions. Higher electrical conductivity in beach water could indicate the presence of dissolved substances, chemicals, and minerals, potentially impacting water quality. The electrical conductance values showed a high degree of similarity among all three samples.

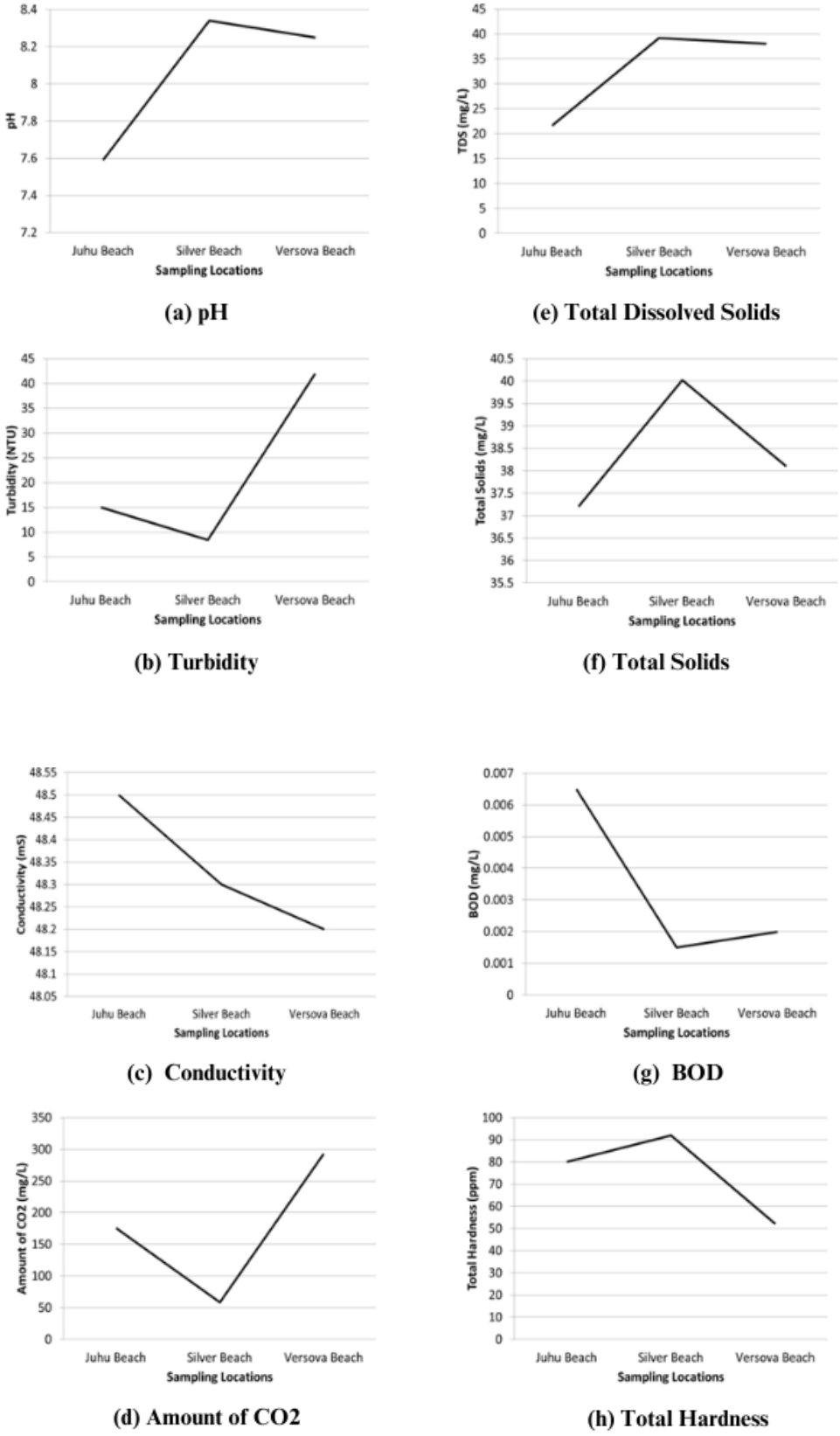

Figure 2: Distribution of values for (a) pH, (b) turbidity, (c) conductivity, (d) amount of CO2, (e) TDS, (f) Total solids, (g) BOD, (h) Total hardness

3.4. Amount of CO2. The presence of CO2 in water influences pH levels by transforming it into carbonic acid, resulting in decreased pH values. The quantification of CO2 was conducted through titration with sodium hydroxide (NaOH). The concentration of CO2 in Versova Beach water is 293.26 mg/L, significantly higher than the levels in Silver Beach at 58.52 mg/L and Juhu Beach at 176 mg/L. Notably, the CO2 content in Silver Beach water is notably lower compared to the other two beaches. The amount of CO2 in Silver Beach water may be less due to differences in pollution levels. Juhu Beach has been found to have high levels of faecal matter and trash, which can lead to increased bacterial growth and potentially higher CO2 levels while the high concentration of dissolved CO2 in Versova Beach water is likely due to a combination of natural processes such as upwelling, turbulence, and the oxidation of organic matter, as well as the influence of borate ions and the dissolution of atmospheric CO2 in low saline waters.

3.5. Total Dissolved Solids. The TDS is the total amount of solids dissolved in the water including carbonates, chlorides, sulphates, calcium, magnesium, sodium and non-volatile solids. The TDS varied from 21.64 to 39.18 mg/L. The highest value obtained was

39.18 mg/L recorded at Silver Beach and the lowest value obtained was 21.64 mg/L at Juhu Beach. The low TDS value at Juhu Beach is likely due to the local water supply and geology. The value for TDS at Versova Beach was moderate with 38.02 mg/L. An elevated TDS level affects the taste of water leading to an increasing amount of toxins present and harmful for human consumption.

3.6. Total Solids. These are the total of all solids in a water sample which include the total suspended solids, total dissolved solids and volatile suspended solids. The TS varies from 37.72 to 40.02 mg/L with not much difference in values. The highest value obtained was 40.02 mg/L recorded at Silver Beach and the lowest value obtained was 37.72 mg/L at Juhu Beach. The values at Versova Beach id 38.10 mg/L. Higher levels of solids give mucky appearances on the coasts.

3.7. Biological Oxygen Demand (BOD). Biochemical Oxygen Demand is defined as the amount of dissolved oxygen required by bacteria while decomposing organic matter under aerobic conditions. The presence of free oxygen in water is an indication of the ability of that water to support biological life. This may be due to the mixing of untreated industrial effluents and the dumping of municipal solid waste into water. The BOD is an indication of the organic load of municipal wastewater. The values of BOD vary from 0.0015 mg/L to 0.0065 mg/L. The highest value of BOD is 0.0065 mg/L at Juhu Beach and the lowest is 0.0015 mg/L. This variation in value is due to the difference in pollution levels and organic matter present in the water. The water at Juhu beach is subject to higher levels of pollution from various sources such as urban run-off, sewage, and industrial waste, leading to a higher BOD. The lower the BOD, the dissolved oxygen present in the water is high. This indicates that the water is less polluted by organic matter.

3.8. Total Hardness. The concentration of calcium and magnesium in the water samples from Silver Beach, Juhu Beach, and Versova Beach was measured using the EDTA titration method. This technique is widely used to determine the total hardness of water, which is a measure of the concentration of calcium and magnesium ions. The results of the analysis showed that the total hardness of the water samples varied significantly. Silver Beach had the highest total hardness of 92 ppm, while Versova Beach had the lowest total hardness of 52 ppm. Juhu Beach had a total hardness of 80 ppm, which is higher than the average total hardness of 60 ppm for seawater. These results suggest that the water quality at these beaches may be affected by the presence of high levels of calcium and magnesium ions, which can have negative impacts on aquatic life and human health. The reason why Silver Beach has a higher total hardness value could be due to differences in the geology and hydrology of the areas where the beach is located.

4 Conclusion

The results of the study underscore the significance of consistent monitoring and strategic actions to address pollution and preserve the water quality of Mumbai's beaches. The study of water quality parameters at three beaches in Mumbai provided a comprehensive assessment of various factors to evaluate the environmental health of these coastal areas. The statistical evaluation of the water quality parameters resulted in the classification of the three beaches into three categories based on their pollution levels: minimal, moderate, and high. Among the three, Juhu Beach had the highest pollution level, while Silver Beach had the lowest. Juhu Beach's pollution is due to human activity, poor waste management, and industrial discharges. Nearby urban areas and businesses add to pollution through runoff carrying pollutants. Silver Beach's lower pollution is attributed to a cleaner location with fewer visitors and potentially better waste management

practices. The fluctuations in water quality at Versova Beach were primarily due to the influence of nearby construction sites. The primary focus of this research was to emphasize the importance of consistent monitoring of water quality parameters which can help identify sources of pollution and track changes in water quality over time. This information can then be used to develop targeted interventions to address specific pollution sources and improve water quality.

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