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SHORT COMMUNICATION

Seasonal Variations and Analysis of Coastal Water Quality using Physico-Chemical Parameters in Mumbai Metropolis

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ABSTRACT

Marine water resources are crucial for both humans and nature because they have numerous positive effects on the economy, society, and ecology. Due to industrialisation and population growth, marine water pollution is currently a major problem on a global scale. The goodness of water is determined by the water's quality and the intended application. Numerous physical, chemical, and biological factors, such as pH, turbidity, DO, and BOD, are considered to assess the water quality. The quality of the water may deteriorate due to human activity, including recreational, commercial, and the discharge of municipal and industrial pollutants, which poses a major threat to the marine ecology. In the current experiment, a total of 14 such physico-chemical parameters were employed to assess the quality of coastal water in a few selected sampling locations in Mumbai Metropolitan over a period of nine months. The study discovered a considerable impact of seasonal variation on coastal water's physico-chemical properties. The paper also discusses how manmade activities have an impact on the same.
Keywords: Physico-chemical parameters, coastal water, water analysis, Mumbai metropolis.

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INTRODUCTION

One of the most intricate, dynamic, and fruitful ecosystems on the planet is the coastal environment. Depending on the fluxes of pollutants and the area's flushing characteristics, India's coastal habitats, including estuaries, streams, and bays, have degraded to varied degrees [1]. The coastal ecosystem, which is the most important renewable resource and the most necessary for consuming animals and plants, must be preserved since the condition of the coastal waters tells us a lot about the resources that can support life [2]. Water, an all-purpose solvent, has the power to dissolve a wide variety of compounds, both organic and inorganic. One of the most significant and plentiful components of the environment is water. Water is a necessity for the life and development of every living thing on Earth. One of the most crucial elements in shaping the land and controlling the climate is water [3], which is under jeopardy as a result of several anthropogenic activities. A variety of mechanisms, including direct discharge into water bodies, runoff from the land, atmospheric deposition, and ocean circulation, result in the widespread dispersion of many contaminants and their entry into coastal waters. The build-up of persistent chemical contaminants in marine species can result in high rates of mortality or illness, which can upset the ecosystem's delicate equilibrium. Fish and shellfish that have been contaminated are no longer safe to eat. Industrial and domestic sewage, agricultural runoff, sediment pollution, oil discharges and spills, and solid waste from domestic, commercial, and marine sources are all examples of pollution sources. Additionally, oil, nutrients, and pathogen pollution can be found in ship ballast.

Many contaminants entering coastal waters have unique chemical properties and call for various data collection and monitoring techniques depending on their inherent characteristics, such as toxicity and persistence in the ecosystem. The detrimental effects of water contamination may have short-term, seasonal, or long-term effects on the ecology. Managers will need to address a variety of human activities that produce pollution in several sites and a variety of contaminants via various channels in order to safeguard coastal waterways. According to MPCB, 2,671 million litres (MLD) of residential waste was produced daily in Mumbai, of which 2,016 MLD were treated before being released into the sea. Approximately 25% of the sewage from the city is discharged directly into the ocean. The open sea is more untamed than the coastlines, which are in closer proximity to the ground. Any water can be considered to be healthy if its physico-chemical and microbiological properties are below WHO-permitted limits. The passage of the seasons also has an impact on these physico-chemical characteristics. Marine vegetation and fauna are heavily influenced by seasonal changes. Colour, temperature, turbidity, pH, dissolved oxygen, and carbon dioxide are significant physico-chemical characteristics. Hardness, total solids, and organic and inorganic chemicals are some additional metrics. The ability of aquatic species to survive is restricted by these conditions. The research and maintenance of the pollution level are aided by the monitoring of these parameters. The primary producers of fish, shellfish, and seaweed for both human and animal food are coastal ecosystems, which also house the majority of the world's ports of commerce. The risk from coastal hazards is amplified by increased development in coastal areas. All main ecosystem categories have experienced significant changes in their size, health, and capacity due to human activity (World Resources 2000-2001). The study's objective is to evaluate the physico-chemical characteristics of a coastal water sample from Mumbai Metropolis, on India's west coast, under various climatic circumstances. The investigation will aid in determining how manmade activities affect the marine ecology.

MATERIAL AND METHODS

Study Site:

The study area includes five coastal sites namely Dadar Beach, Girgaon Chowpatty, Haji Ali, Priyadarshani Park and Bhaucha Dhakka. All coasts are part of the Arabian Sea. Dadar beach and Girgaon Chowpatty has sandy beach while, Haji Ali and Priyadarshani Park has rocky beach. Bhaucha Dhakka is a Dock hence having high source of pollutants because of ship's oil and other human activities. Dadar beach, Girgaon Chowpatty and Haji Ali receives holy waste such as flowers, oils and other things. These sites were studied along with the control site. The control site was taken 200m away from Haji Ali coast in the deep sea. The sampling of water has been done as per the standard method [4].

Sample collection and analysis

The sampling of water was carried out fortnightly during in the morning time throughout the study period. Water samples were collected from the coasts of a particular distance in thoroughly washed and pre-sterilized bottles. The temperature, pH and dissolved oxygen analysis has been done at the time of water collection. The collected samples were stored at room temperature for further analysis. The sampling of water and Physico-chemical analysis of water has been done using the standard methods described by Grasshoff et. al. [4] and APHA [5].

RESULT AND DISCUSSION

The physical and chemical characteristics showed some significant differences between the sampling sites and seasons. The majority of studies along India's east coast define the seasons according on either climatology factors, such as temperature, rainfall, or wind regime, i.e., summer, SW, post monsoon (transition), and NE. The results of the current study are divided into two seasons, dry (January to June) and wet (July to December), based on the pattern of rainfall over Mumbai's Arabian Sea coast. Wastewater is defined as any body of water that has undergone adverse anthropogenic influence. It includes liquid waste discharged by domestic dwellings, commercial buildings, industries, and/or agriculture and can include a wide range of potential contaminants and concentrations. Because of the enormous productivity of phytoplankton, oceans play an essential part in controlling global hydrology and climate, and they are a significant carbon sink and supplier of oxygen. Coastal habitats draw people from all over the world because of their natural splendour. People prefer seaside areas for living, as well as for recreation, tourism, and leisure [6].

Variations of different parameters investigated were as follows:

Colour:

To almost all the sites the water appeared colourless except for the Dadar beach and Girgaon chowpatty, where the water was brownish in the month of September. This may because of the many reasons like September is the end of monsoon in Mumbai so there is a mixing of water with runoff sediments from the

city area. Also there was a Ganpati festival in the same month. Both the sites are sandy coasts, so there may be contribution of dissolved particles. For the month of October water at the site appeared greenish at Dadar beach whereas at site 3 viz. Haji Ali, water appeared blue on the coast. The water at site 5 (Bhaucha Dhakka) appeared dirty throughout the study period.

Temperature:
For optimum growth, aquatic organisms from bacteria to fish require a specific temperature range [5]. All the sites had surface temperatures between 18 and 35°C, with minimum and maximum values throughout the winter and summer seasons, respectively [7]. A waterway's temperature matters because it has an impact on the concentration of dissolved oxygen in the water. As the temperature drops, more oxygen will dissolve in the water.

pH:
The pH scaled between 7.00 and 7.46. All six coasts were discovered to have a mildly alkaline environment during the winter. During the study period, there was no discernible pH difference. The pH of the water under study is within the WHO range of 6.50 to 8.50 in both seasons. Therefore, this water might be considered neutral and unpolluted [8].

Turbidity:
The amount of sediment, plankton, or other organic matter in a body of water known as turbidity is a measurement of the water's opacity, or capacity to transmit light. Cloudiness can be used to estimate the water's suspended particulate content. As turbidity increases, these light-blocking particles are concentrated more, making water denser and less transparent. Turbidity is measured in nephelometric turbidity units (NTUs), which are a unit of computation. In the present study the turbidity was maximum at site 1 (Dadar) as high as 192 NTU in the month of September which is above accepted value. This may because of Ganpati immersion as reported by Gund et al [9] and Kondulkar et al [10]. The minimum value was observed at site 6 which was a control site with turbidity of 5 NTU in the month of May. The decrease of turbidity in summer was also reported by Parekh et al [11].

Conductivity:
The total dissolved ions can be measured accurately and quickly using conductivity, which is inversely proportional to the total solids. Compared to purer water, saltier water conducts electricity more easily. A substance's ability to act as a channel or medium for electricity is known as its EC (Electrical Conductivity). The number of ions in water increases as the value of dissolved solids rises [12]. Conductivity values were minimum at site 2 at Girgaon Chowpatty (0.0065mS/cm) in winter and maximum at site 3 (0.0412 mS/cm) at Haji Ali coast during summer season.

Total Solids:
It is the total of all suspended and dissolved solids. It is a word used to describe the material remnant left in the vessel following evaporation. The maximum value obtained for control site (57 mg/L) in the month of May. This may because of high rate of precipitation during summer season. The lowest value is seen at Girgaon Chowpatty (27 mg/L) in September month which is an end of monsoon and has diluted the materials.

Nitrate:
The value of nitrate ranges from 10 mg/L to 30 mg/L. The maximum value (30 mg/L) was observed in the month of October (Bhaucha Dhakka) and minimum (10mg/L) in the month of November (winter) which was an agreement with Manjare et al [13]. The low nitrate level indicates low organic pollutants in the sea.

Phosphate:
Sediments from rocks and soil, effluent from wastewater treatment facilities and onsite sewage disposal systems, detergents and fertilisers that have run off from properties due to poor land management practises and storm water pollution, and decomposing organic matter are the main sources of phosphorus in local catchments.

The concentration of phosphate in coastal waters is influenced by the amount of freshwater that mixes with seawater in the zone of land-sea interaction [2]. Phosphate content of the water varied from minimum of 0.0 mg/L at Girgaon Chowpatty in the month of September to the maximum of 5.5 mg/L for the same site in November.

Sulphate:
The minimum value found was 7 mg/L to the maximum of 70 mg/L at the same site (Dadar beach) for October and May respectively. It was under permissible value and could be concluded that the values increased with increase in temperature. It was in confirmation with Kalpana at al [14].

DO:

In some ways, the amount of oxygen in water reveals how healthy it is overall. That is, if oxygen levels are high, it is reasonable to assume that water pollution levels are also low. In contrast, if oxygen levels are low, it is likely that there is a strong demand for oxygen and that the body of water is not in good health.

The research site affects the amount of dissolved oxygen in the saltwater. Due to wave movement and the oxygen generated by the phytoplankton during photosynthesis, surface water is much more saturated than deep water. DO content varied from 0.2 to 5.6 mg/L. It was found below the WHO permissible limit during September, October months for almost all sites. Temperature and biological activity are linked to seasonal fluctuations in DO concentration. The highest DO value is seen in the month of December for all 6 sites which is considered as the coldest month in Mumbai (temp range 15-32°C). The depletion in DO indicates that the coastal areas are polluted [14] [15]. Diffusion and aeration, photosynthesis, respiration, and decomposition all have an ongoing impact on the concentrations of dissolved oxygen.

BOD:

The highest BOD value of 179 mg/L is seen for Bhaucha Dhakka and Haji Ali in the month of May and October respectively. The least value is 15 mg/L for few places. Greater amounts of organic matter are present in the water bodies as a result of sewage water contamination, as shown by higher BOD levels and lower DO values [14].

Oil and grease:

The processing and treatment of these materials for final disposal must consider the oil and grease content of household, as well as some industrial, wastes and sludge. One of the most major types of toxins that should be avoided in the maritime environment is oil and grease. Grease and oil are organic hazardous pollutants that harm aquatic species' ecosystems. They emerge from many sources to create a layer on the water's surface that reduces the amount of dissolved oxygen [16]. Animal fats, vegetable oils, and petroleum oils all have identical physical characteristics and have an equivalent impact on the environment. By using a partition-infrared technique, Total Oil and Grease (TOG) evaluates both hydrocarbons and oils and fats from both animal and plant sources [5]. The organic stuff will decompose when untreated waste water builds up and is allowed to go septic, creating unpleasant conditions. Untreated wastewater also has a lot of pathogenic microbes in it. Additionally, wastewater contains nutrients that might start the growth of aquatic plants. It may also contain harmful substances or substances with the potential to cause cancer or mutagenesis. The rapid and painless removal of wastewater from its sources of production, followed by treatment, reuse, or dispersal into the marine environment, is required to safeguard both the environment and public health.

Potassium:

All cells need potassium, which is mostly used as an enzyme activator and stored in all nearby plant tissues. Values of potassium were maximum of 2200 ppm at Girgaon and Control in September and were the minimum of 210 ppm at Control in December (winter). Similar observations were also submitted by Vijaya Kumari et al [17].

Sodium:

The maximum sodium content observed during the month of November in all the sites (94000 ppm) and minimum sodium content observed during the month of February almost all the sites (1000ppm). The high sodium values are largely due to the proximity of sea. The present data also reveals the potassium was lower than the sodium which might be due to the preferential absorption and incorporation into silicate minerals. Similar results were reported by Vijaya Kumari et al [17].

CONCLUSION

There is a shift in the physico-chemical characteristics of the water when the season changes; this is brought on by ebb and flow, flushing of rainwater, change in temperature, and salinity as the season changes. Additionally, the water quality of the coastal habitat is deteriorated by heavy pollution from both industrial inputs and home waste outflow.

The physico-chemical parameters of water quality that were analysed over the course of the nine-month study from five coastal areas and a control site showed that the water quality is declining as a result of anthropogenic activities like garbage disposal and throwing, municipal waste along the coast, and religious rituals. Physical and chemical indicators like DO and BOD have demonstrated the impact of human activity. Seasonal fluctuations can be seen in variables including temperature, turbidity, nitrate, phosphate, and sulphate. Anthropogenic activities are the main factor affecting the seasonal fluctuations of environmental variables in the coastal system. Dadar beach's water samples were significantly more contaminated than those from other locations as also reported by Indrani et al [18]. Therefore, waste effluent discharge must

be carefully managed to guarantee that it has little to no harmful impact on the coastal habitat. Thereby, it is essential to safeguard both the coastal ecology and public health.

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