CLUSTER ANALYSIS OF PHYSICOCHEMICAL CHARACTERISTICS OF WATER SAMPLES FROM THE RIVERINE END OF THANE CREEK, MAHARASHTRA, INDIA.

Sheetal Chaudhari Pachpande¹, Madhuri Pejaver² and M.J. Gholba³

¹² Department of Zoology, ³ Department of Statistics
VPM’s B.N.Bandodkar College of Science affiliated to University of Mumbai, Chendani Bunder Road, Thane West, Thane, Maharashtra 400601 (India)
sheetalpachpande@gmail.com¹, mkpejaver@gmail.com², mgholba@gmail.com³

ABSTRACT

Water forms the major component of the wetland ecosystems such as mangroves. Mangroves usually occur at the interface of land and ocean and exhibits high productivity rates and rich biodiversity. Thane creek is one among the global mangrove ecosystems which harbor’s rich mangrove vegetation that supports diversity of organisms. However, in recent years, discharge of wastewater from various sources such as treatment plants, release of effluents from various industries, dumping of solid waste leads to alteration of chemistry of water. In the present paper, changes in physico-chemical factors such as pH, temperature, suspended solids, dissolved oxygen and nutrient dynamics were studied and the results indicate deterioration of the water quality of the creek. Cluster analysis was performed for the results obtained from physico-chemical studies to indicate the inter-relationships of various parameters. The research highlights the need for proper management strategy to improve the water quality of the creek to enhance productivity.

Keywords: Thane Creek, Mangroves, physico-chemical, creek

INTRODUCTION

Water is fundamental to the biochemistry of all living organisms as the Earth’s ecosystems are linked and maintained by the water. In total 71% of the earth’s surface is occupied by ocean water. At the interface of land and ocean are present the coastal margins, commonly referred as wetland ecosystems.

Wetland ecosystem such as mangroves, salt marshes etc., are subject to both marine (tides, waves, the influx of saline water) and to the riverine influences (flow of fresh water and sediment). Several studies (Wolanski et al. 1980; Wolanski 1994; Kjerfve et al. 1981) suggested the connection between coastal and marine ecosystems through nutrient and material exchanges making them among the most productive natural habitats worldwide.

The chemical composition of the brackish water can influence the existence of mangrove vegetation to the greater extent. Currently most of these ecosystems are under severe anthropogenic stress. The degree of pollution in water depends on the physical and chemical nature of the material discharged, water depth and hydrographic conditions (Cairns, 1992). According to Chitmanat (2010), the release of municipal and industrial effluents might deteriorate the quality of water. Also the activities like
logging, road construction, river channelization, and development in watersheds leads to poor water quality (Kehoe, 1982). These might result in increased estuarine sedimentation and turbidity, reduced productivity and biodiversity (Clark, 1996). Therefore, it is crucial to determine various changes that occur due to impact of anthropogenic activities, which might serve as baseline data to form any strategy for conservation of ecosystem from deterioration.

In estuaries and creeks the inflow and outflow of water during tides play an crucial role in maintaining the biodiversity. Therefore, in order to understand the present status of the creek, several physico-chemical parameters of water such as temperature, pH, turbidity, suspended solids, free CO₂, dissolved oxygen, salinity, and nutrient dynamics were studied.

Due to spatial and temporal variations in water chemistry a monitoring program that will provide a representative and reliable estimation of the quality of surface waters is necessary and this leads to generation of large data matrix, which needs a complex data interpretation (Chapman, 1992). The application of different multivariate approaches (cluster analysis (CA),) for the interpretation of these complex data matrices offers a better understanding of water quality. The ecological status of the studied systems, allows the identification of the possible factors/sources that influence the water systems and offers a valuable tool for reliable management of water resources as well as rapid solutions on pollution problems (Morales et al 1999 ; Reghunath et al, 2002 ; Wunderlin et al 2001)

The present hydrological studies were carried out towards the riverine end of creek with sampling locations as described in the ‘materials and methods’.

MATERIALS AND METHODS

Site description

Location

Thane Creek (Lat. 19° 00’N to 19° 13’N and Long. 72° 57’ E to 73° 00’E) is an inlet in the shoreline of the Arabian Sea that isolates the city of Mumbai from the Indian mainland. The creek is divided into two parts, its first part lies between Ghodbunder and Thane city, a section from where the Ulhas river flows from the north of Mumbai Island to meet the Arabian Sea on the west. The second part of the waterway lies between the city of Thane and the Arabian Sea at Trombay.

The climate on the western coastal plains of Thane is tropical, very humid, and warm. In the coastal area, the average daily maximum temperature in summer is 32.9°C and in winter average mean daily minimum temperature is 16.8°C. The average annual rainfall in the Thane district is 2293.4 mm. The creek being tropical in location, winter is not severe and three seasons can be distinguished viz., monsoon (June to September), post monsoon (October to February) and pre monsoon (March to May).
Area of study

Thane creek is a 26 km long stretch, which joins Ulhas river on its north by a minor connection near Thane city. The creek is tidally influenced with dominance of neritic waters. The substratum of the creek in the mid-stream is made up of consolidated and unconsolidated boulders intermingled with loose rocks and rarely with sand and gravel. Extensive mudflats are formed along the banks of the creek which are characterized by the growth of mangroves.

During the present study, four sites were selected which were located on West and East bank of the creek (refer fig 1.) of which, the first two sites are situated on the West bank near Bhandup village. One site is adjacent to the Bhandup pumping station, from where the treated sewage water is released into the creek and the second site is located approx. 1.5 km away from here. These sites have lesser impact of sewage water.

Fig 1. Map showing location of Thane creek and study locations.

The next two sites are located on the East bank near Airoli village, approximately 1.5 km apart and showed higher impact of human interference. One site is used by the villagers as Duspinda (a site where daskriya vidhi takes place, ten days after cremation according to Hindu culture) while the other consists of active aquaculture fishing ponds. The study was conducted for 18 months, from November 2009 to April 2011.

The methodology used for studying all these parameters is as mentioned in the International standard methods suggested by APHA, AWWA, WPCF (1981); Trivedi and Goel (1984). All the results obtained are represented in the form of cluster analysis. Cluster analysis is a multivariate analysis that seeks to organize information about variables so that relatively homogenous groups or clusters can be formed. Cluster analysis is proved to be an efficient mean to recognize groups of samples that have similar chemical and physical characteristics Guler et al. (2002). It results into a tree diagram dendrogram, which represents the amalgamation of variable into clusters.
The objective of cluster analysis is to identify the complex nature of multivariate relationships (by searching groups) among the data under investigation, so as to foster further hypothesis developed about the phenomena being studied (Zeng and Rasmussen, 2005).

During the present study for the cluster analysis of physicochemical parameters, 50% similarity level was taken into consideration as it depicts better picture. The cluster analysis was carried out for all selected study location.

The data was presented in comparison of Station 1 and station 2 as they are located near Bhandup and of station 3 and station 4 located on east bank near Airoli.

RESULT AND DISCUSSIONS

Cluster Analysis for Station 1 and Station 2

![Dendrogram of physico-chemical parameters at Station 1](image1)

**Fig 1. Dendrogram of physico-chemical parameters at Station 1**

<table>
<thead>
<tr>
<th>Final Partition</th>
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<tbody>
<tr>
<td>Cluster 1</td>
</tr>
<tr>
<td>Temp C pH</td>
</tr>
<tr>
<td>Cluster 2</td>
</tr>
<tr>
<td>Free CO₂ (mg/l)</td>
</tr>
<tr>
<td>Sus.Solids (g/l)</td>
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<tr>
<td>DO (mg/l)</td>
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<tr>
<td>Cluster 3</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
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<tr>
<td>PO₄-P (mg/l)</td>
</tr>
<tr>
<td>SiO₃-3 (mg/l)</td>
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<tr>
<td>Cluster 4</td>
</tr>
<tr>
<td>NO₃-N (mg/l)</td>
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</tbody>
</table>

Total-4 clusters were obtained in dendrogram each of station 1 and station 2.

Temperature and pH of water showed strong correlation at both stations with 66.7% similarity at station 1 and 77.7% similarity at station 2. This indicates that change in temperature might have effect on pH of water.

Free CO₂ was found to have correlation with suspended solids and dissolved oxygen at station 1 and with nutrients like phosphates and silicates at station 2.

As station one is located near Bhandup pumping station which releases treated waste water to the creek may lead to changing load of suspended solids thereby causing increase or decrease in dissolved oxygen content.
At station 2, free CO$_2$ showed relation with nutrients like phosphates, silicates and also nitrates, as cluster 4 showed nitrates linked with cluster 2. This might be attributed to increased effluent discharge having high concentration of nutrients. Increase in free CO$_2$ can also increase the uptake of nutrients like phosphates and nitrates (Conroy et al., 1992). At station 2 maximum correlation with 71% similarity was observed in dissolved oxygen and nitrates. This indicates good biological productivity as dissolved oxygen content increase the productivity of the ecosystem and thus nitrate accumulation may increase. 50% similarity was noted in suspended solids and salinity.

**Cluster analysis for Station 3 and Station 4**

![Dendrogram](image1)

**Fig 3. Dendrogram of physico-chemical parameters at Station 3**

**Final Partition**

Cluster 1
Temp

Cluster 2
pH DO Salinity PO4-P (mg/l)

Cluster 3
Free CO2 Sus.Solids SiO3-Si (mg/l)

Cluster 4
NO3-N (mg/l)

Station 3 and station 4 revealed most of the parameter related to each other showing three major clusters at station 3 and two clusters at station 4. Cluster 2 showed maximum similarity in pH, Dissolved Oxygen, Salinity and phosphate at both stations. Temperature and nitrates in cluster 1 and cluster 4 showed least relation with any other parameter (fig 3) and free CO$_2$ showed correlation with suspended solids and silicates at station 3.

At station 4 maximum similarity between parameters such as suspended solids, silicates, temperature, nitrates and free CO$_2$ was found to have separate cluster but showed linkage with temperature, suspended solids, silicates and nitrates.

**CONCLUSION**

In the present study physico-chemical analysis were studied for parameters such as temperature, pH, suspended solids and chemical analysis, free CO$_2$, salinity, dissolved oxygen and nutrients like phosphates, silicates and nitrates.
Overall cluster analysis revealed profound impact of effluent discharge from Bhandup pumping station at station 1, as the physico-chemical parameters at station one and station two were found less similar. On the other hand, station 3 and station 4 showed maximum similarity in the physico-chemical parameter studied at both stations. All the parameters studied revealed more of anthropogenic stress to the creek than natural and serious management actions need to be taken to improve the quality of environment of the creek.

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REFERENCES


