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Assessment of Physico-Chemical Properties of Sediments collected along the Mahul Creek near Mumbai, India

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ABSTRACT

The present study was performed for the period of one year from January 2013 to December 2013 in order to understand the physico-chemical properties of sediments samples collected along the Mahul Creek of Mumbai. The annual average pH value of the creek sediments was recorded as 5.38. It is feared that such low pH value of sediment might increase the acidity of creek water thereby triggering the heavy metal toxicity which will further reduced survivorship in fish through chronic stress and affect the reproductive partner. The annual average salinity content of the sediment was recorded as 4601.17 *ppm*. It is important here to note that the high salinity of the sediment may increase the salinity level of creek water which is considered as a major stress factor for most freshwater organisms including crustaceans. The average annual concentration of phosphate in the creek sediment was found to 480.39 *ppm*. Such high concentration of phosphate in the creek sediments might accelerate the process of eutrophication. From the results it appears that as India moves towards stricter regulation of industrial effluents to control water pollution, greater efforts are required to reduce the risk due to the toxic pollutants which are released into the ecosystems.

***Keywords*:** industrial effluents; physico-chemical properties; sediments; Mahul Creek; Mumbai

1. INTRODUCTION

Although all industries in India function under the strict guidelines of the Central Pollution Control Board *(CPCB)* but still the environmental situation is far from satisfactory. Different norms and guidelines are given for all the industries depending upon their pollution potentials. Most major industries have treatment facilities for industrial effluents. But this is not the case with small scale industries, which cannot afford enormous investments in pollution control equipment as their profit margin is very slender.

Consequently, at the end of each time period the pollution problem takes menacing concern. As a result in India there are sufficient evidences available related with the mismanagement of industrial wastes [1-16]. The industrial wastes often contain a wide range of contaminants such as petroleum hydrocarbons, chlorinated hydrocarbons and heavy metals, various acids, alkalis, dyes and other chemicals which greatly change the pH of water. The waste also includes detergents that create a mass of white foam in the river waters. All these chemicals are quite harmful or even fatally toxic to fish [17-19] and other aquatic populations [20]. These wastes also include various toxic chemicals, acids, alkalis, dyes, detergents, pesticides and agrochemicals which greatly affect the physico-chemical properties of water bodies.

Therefore, a better understanding of physico-chemical properties like pH, conductivity, alkalinity, salinity, hardness, Chemical Oxygen Demand *(C.O.D)* etc. in the water bodies seem to be particularly important issues of present day research on pollution assessments. As compared to the usual water testing, sediment testing reflects the long term quality situation which is independent of current inputs [21,22]. The suspended and precipitated non-floating substances and organic substances in waters are capable of adhering pollutant particles by adsorption. The sediments, both suspended and precipitated substances stored on the water bottom, form a reservoir for many pollutants and trace substances of low solubility and low degree of degradability [23-25]. Pollutants are conserved in sediments over long periods of time according to their chemical persistence and the physical-chemical and biochemical characteristics of the substrata. This can allow conclusions to be drawn regarding sources of contamination. Since sediments act as a sinks and sources of contaminants in aquatic systems, chemical analysis for characterization of sediments also provides environmentally significant information about natural and anthropogenic influence on the water bodies [26-37]. The present study was therefore carried out to understand the physico-chemical properties of the sediment samples collected along the Mahul Creek of Mumbai. The results of our study is expected to provide valuable information about the trend in pollution level along the creek which receives heavy pollution load from the surrounding refineries, agrochemical and other industries and also domestic effluent from the surrounding slum areas.

2. EXPERIMENTAL

2. 1. Study Area

Mahul creek (19°01’N &72°53’E) lying on the east coast of Mumbai along the Arabian sea, is situated in Chembur suburban the north eastern corner of Mumbai about 15 km from Victoria Terminus (presently known as Chhatrapati Shivaji Terminus). The temperature of the area ranges between 13 °C to 39 °C. The south west monsoon (June to mid-October) brings rain to the area which is recorded maximum 747 mm during July. The climate is humid and relative humidity ranges between 29 to 96 % [38].

2. 2. Sediment sampling and sample preparation

The study on pollution status along the Mahul creek of Mumbai was performed for the period of one year from January 2013 to December 2013. Sediment sampling was done along different locations of the creek by hand-pushing plastic core tubes with an intention to avoid metallic contamination. Samples so collected were kept in polythene bags which were free from heavy metals and organic impurities. The samples collected in the field were well covered while transporting to the laboratory to avoid contamination from the environment. The samples thus collected from different locations were mixed together to give gross sample. The samples collected were air dried, ground using agate mortar and sieved with a 0.5 mm mesh size sieve to uniform particle size. The thoroughly mixed sediment samples were packed in polythene bags and kept in a dry place until analysis. The samples were analyzed every month for their physico-chemical parameters so as to get the seasonal variation in pollution level along the Mahul Creek.

2. 3. Physico-Chemical Parameters studied

The sediment samples collected were analyzed for Total Dissolved Solid (*TDS*), Total Suspended Solids (*TSS*), Total Solids (*TS*), Chemical Oxygen Demand (*COD)*, phosphates, temperature, pH, electrical conductivity, salinity, cyanide, total hardness, fluoride and total alkalinity. The techniques and methods followed for analysis and interpretation were according to the standard procedures [39-43].

3. RESULTS AND DISCUSSION

The experimental data on physico-chemical properties of the sediment samples collected along the Mahul Creek of Mumbai is presented in Table 1. The annual average values of various physico-chemical properties of the sediment samples are graphically represented in Figures 1 and 2.

Table 1. Physico-Chemical Properties of Mahul Creek Sediments.

Sampling Months/Year ➡ / Physico-Chemical Parameters ⬇	January 2013	February 2013	March 2013	April 2013	May 2913	June 2013	July 2013	August 2013	September 2013	October 2013	November 2013	December 2013
pH value	5.56	5.79	5.63	6.10	6.25	4.98	4.72	4.30	4.66	5.95	5.11	5.53
Salinity (ppm)	35.80	353.11	289.50	332.64	300.83	12010.00	13452.00	13897.00	14322.00	75.12	80.21	65.87
Fluoride (ppm)	10.90	3.80	3.60	2.90	1.30	7.70	6.90	5.70	7.40	1.80	2.20	3.40

Total Alkalinity (ppm)	3103.60	1249.80	1308.60	1175.20	1269.50	956.40	997.10	1002.50	901.90	2563.80	2991.60	3023.80
PO_4^{2-} (ppm)	379.75	91.03	126.89	109.11	63.75	777.28	918.89	984.17	1019.11	460.06	405.19	429.41

The creek sediment was having minimum pH value of 4.30 in the month of August and maximum pH of 6.25 in the month of May, with an annual average value of 5.38. The acidic pH value of the sediments may results in making the water acidic. Acidic waters also mobilise metals that can be toxic to aquatic species (e.g., aluminium).

Metal toxicity can cause reduced survivorship in fish through chronic stress, which impairs health and decreases the affected individual's ability to secure food; shelter, or reproductive partners [44].

The concentration of phosphate in the creek sediment was found to vary in the range of 63.75 to 1019.11 *ppm*, having the average annual concentration of 480.39 *ppm*. The high concentration of phosphate in the creek sediments may increase the level of phosphorous in water thereby accelerating a process called eutrophication, which is essentially the process of a Creeks biological death due to depleted bioavailable oxygen.

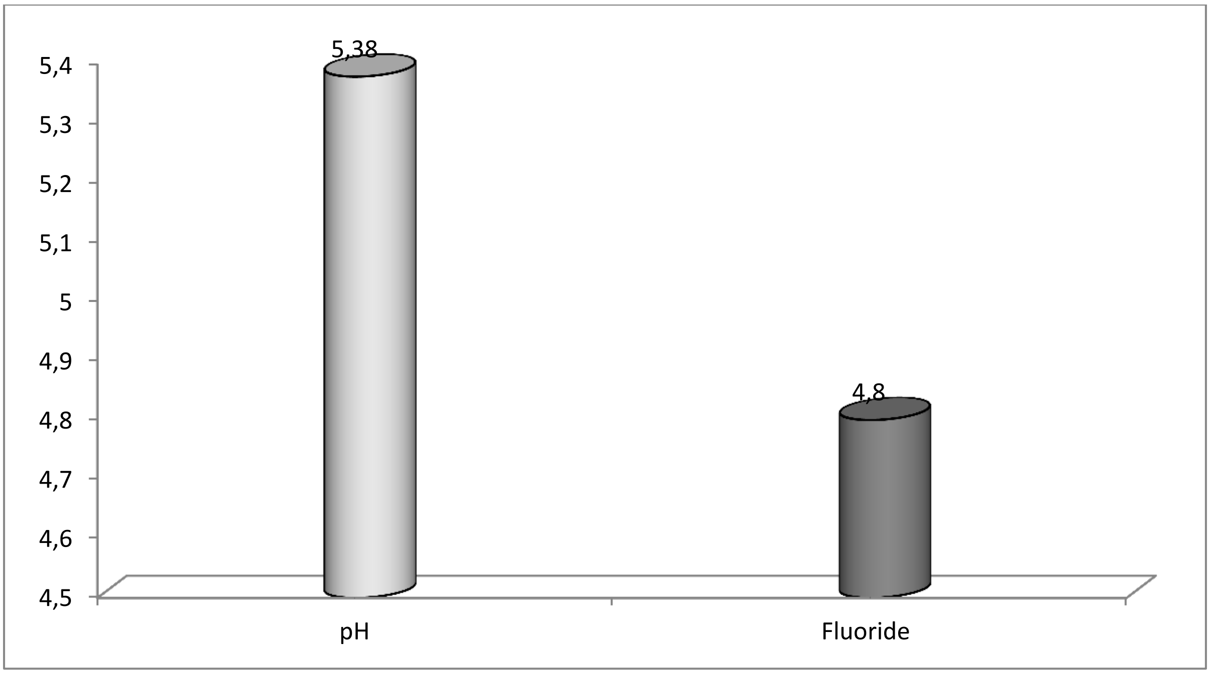

Figure 1. Annual average pH and fluoride content in the sediments of Mahul Creek. *(Fluoride concentration expressed in ppm).*

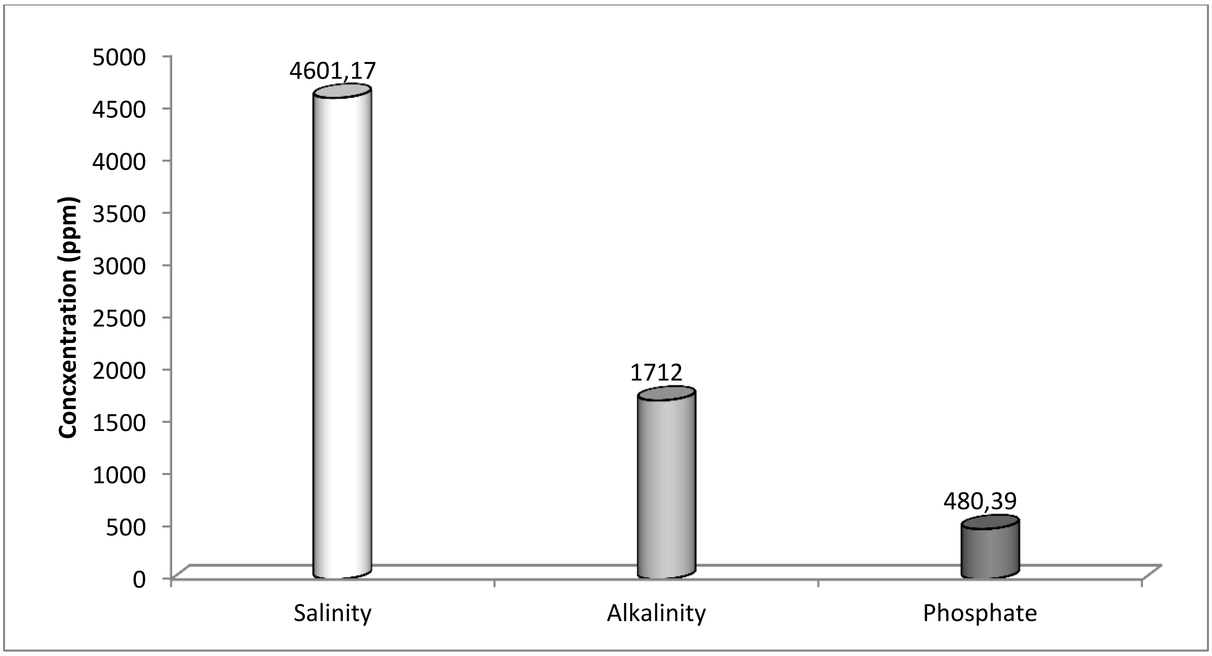

Figure 2. Annual average salinity, alkalinity and phosphate content in the sediments of Mahul Creek.

The salinity content of the creek sediment was found to be minimum of 35.8 *ppm* in the month of January and maximum of 14322 *ppm* in the month of September, having the annual average salinity content of 4601.17 *ppm*. The high salinity of the sediment may result in increase in salinity of creek water which is considered as a major stress factor for most freshwater organisms including crustaceans [45-53]. The fluoride content of the sediment was in the range of 1.3 *ppm* in the month of May to 10.9 *ppm* in the month of January. The annual average fluoride content was calculated as 4.80 *ppm*. The creek sediment was found to exhibit high alkalinity of 3103.6 *ppm* in the month of January, while the alkalinity level was low (901.9 *ppm*) in the month of September. The average annual alkalinity content was calculated as 1711.98 *ppm*.

4. CONCLUSION

With the rapid industrialization in the country, environment pollution by industrial waste has increased tremendously. The discharge of waste water from industries such as tanneries, pulp and paper, textile, petroleum, fine chemical industries etc. pollute water bodies. Nature has an amazing ability to cope up with small amount of water wastes and pollution, but it would be hazardous or harmful if billions of gallons of waste water produced everyday are not treated before releasing them back to the environment. It is therefore recommended that the careless disposal of industrial wastes without pretreatment should be discouraged. Here the right way forward will be to empower the local communities to ensure their right to a healthy environment and ultimately their survival. Hence there is a need that each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise ‘Polluter pays’ principle should be implemented. The existing situation if mishandled can cause irreparable ecological harm in the long term well masked by short term economic prosperity due to extensive industrial growth.

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