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Pollution Monitoring Study of Sediments Collected along Bhavan's College Lake of Andheri - Assessment of Physico-Chemical Parameters

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ABSTRACT

The present investigation is a study of physico-chemical parameters of sediment along the Bhavan's College Lake of Andheri, Mumbai. The parameters monitored include pH, alkalinity, chloride, sulphate and phosphate contents. The annual average values of above parameters where found to be 5.75, 239 ppm, 236 ppm, 40 ppm and 0.62 ppm respectively. The weakly acidic pH of the sediment might reduce the pH of lake water below the recommended limit of 6.5 to 8.5 set by CPCB which is necessary for propagation of wild life fishery. It was observed that the excess of accumulated chlorides in the lake sediments have affected the plants growth and biological life of the lake. It was also observed that at some places of the lake, the plants shows suppressed growth and flowering, leaf necrosis, black and flaccid roots, root decay which might be due to accumulation of sulphates in the sediment. Also the formation of dense blue-green algal blooms was observed along the lake which might be due to accumulation of phosphates in the lake sediments. From the overall results of the present investigation it seems that the present condition if neglected might create irreparable damage to the lake ecosystem. It is expected that such type of systematic and continuous monitoring will help to assess the extent and severity of sediment contamination, to evaluate the effects of contaminated sediments on freshwater and marine environment, and to prepare a plan for appropriate remedial action.

Keywords: Environmental Pollution, Bhavan's College Lake, Sediments, Physico-chemical Properties, Andheri, Mumbai.

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INTRODUCTION

Sediments of lakes, rivers and other water bodies are important habitat as well as a main source of nutrient for aquatic organisms as well as vegetation. Sediment is also the major site for organic matter decomposition which is largely carried out by bacteria. Sediments form a natural buffer and filter system in the material cycles of waters. Important macro-nutrients are continuously being interchanged between sediment and over-lying water [1]. Furthermore, sediments have an impact on ecological quality because of their quality, or their quantity, or both [2]. It is observed that continuous accumulation of pollutants due to biological and geochemical mechanisms cause toxic effect on sediment dwelling organisms and fish, resulting in decrease survival, reduced growth, or impaired reproduction and lowered species diversity [3, 4]. As compared to the usual water testing, sediment testing reflects the long term quality situation which is independent of current inputs [5, 6]. 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 [7-9]. 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 [10-19].

Therefore we carried out the present investigation to understand the physico-chemical properties of sediments samples collected along lake of the Bhavan’s College campus of Andheri Mumbai which is subjected to pollution load due to discharge of sewage and due to seepage of effluents from nearby laboratories. It is expected that the pollution data generated from such regular scientific study will help to implement compatitable policies and programs to gauge the extent of pollution. The pollution data of the present study is also expected to help in rational planning of pollution control strategies and their prioritization; assessment of nature and extent of pollution control needed; evaluation of effectiveness of pollution control measures already is existence; evaluation of water quality trend over a period of time; assessment of assimilative capacity of a water body thereby reducing cost on pollution control.

MATERIALS AND METHODS

Area of study

The study was performed at Bhavan’s College Lake, located at Andheri, Mumbai city which is one of the most heavily populated and industrialized cities of Maharashtra. It is situated between 18° 96’ north latitude and 72° 81' east longitude. The average elevation ranges from 10 meters to 15 meters. The major portion of the city is at the sea level while the maximum height of the city is at 450 meters. It covers a total area of 603.4 km^2.Climate is subtropical, with mild winters and warm summers. The weather is typical coastal sultry and humid. The average rainfall records from 1500 mm to 2000 mm. The place experiences the onset of the monsoon in the month of June and experiences monsoon till the end of September. The average temperature recorded varies from 25 to 37 degrees.

Requirements

The chemicals and reagent used for analysis were of analytical reagent grade. The laboratory apparatus were soaked in nitric acid before analysis and then rinsed thoroughly with tap water and deionised distilled water to ensure any traces of cleaning reagents were removed. The pipettes and burette were rinsed with the same solution before final use.

Sediment sampling and preservation

The study on pollution status along the Bhavan's College campus of Andheri, Mumbai, was performed to study the level of pollution in sediments. The sampling was done daily in morning and evening sessions along different locations of the college campus for the period of twelve months from June 2011 to May 2012. Sediment samples were collected by hand-pushing plastic core tubes (7 cm diameter) as far as possible into the sediment. The sediment cores retrieved in the field were sliced on arrival at the lab at 1-cm depth intervals for the first 15 cm, 2-cm depth intervals from 15–25 cm, and then every 5 cm for the deeper sections of the cores. The sediments were kept cool in icebox during the transportation to the laboratory [20, 21]. They were then ground manually to a fine powder in an alumina mortar; and passed through a 2-mm mesh screen and stored in polyethylene bags based on method used by for further analysis.

Physico-Chemical Study

The sediment samples collected were analyzed for pH, Chlorides, Sulphate, Phosphates and alkalinity. The standard techniques and methods were followed for physical and chemical analysis of soil samples [22, 23].

RESULTS AND DISCUSSION

The experimental data on physico-chemical properties of sediments samples collected along the Bhavan's College Lake of Andheri, Mumbai from the month of June 2011 to May 2012 are presented in Table-1

pH of the sediments is a measure of their acidity or alkalinity and is one of the stable measurements. pH is a simple parameter but is extremely important, since most of the chemical reactions in aquatic environment are controlled by any change in its value. In the present investigation, the yearly average pH values of sediment samples collected from different sampling locations of the lake each month vary between minimum 5.02 to maximum of 6.54 the average pH being 5.75 which is towards the weakly acidic side. The weakly acidic pH of sediment may lower the water pH below the recommended limit of 6.5 to 8.5 set by CPCB for propagation of wild life fishery. Surface waters having a pH values below six can be hazardous to aquatic life. Acidic waters can mobilise metals that can be toxic to aquatic species by reducing survivorship in fish through chronic stress, which impairs health and decreases the reproductive partners [24]. Fish, shellfish and aquatic insects have different tolerances to acidic medium and species diversity will decrease along with increased acidification. Young organisms tend to be more sensitive to acidic medium: for example, at a pH of 5, most fish eggs cannot hatch, while only some adult fish will be affected. Thus, pH is having primary importance in deciding the quality of sediments

Alkaline sediments may impart alkalinity to the water which is responsible for determining the amenability of water to biological treatment [25]. In the present investigation it observed that average alkalinity of sediment samples was in the range 90-400 ppm, with an annual average value of 239 ppm. The alkalinity of sediment samples increases gradually from winter season and was high during the summer season in May followed by steep fall in the monsoon periods from July to September.

The monthly chloride content in the lake sediments were found to vary in the range of 95-506 ppm, with an annual average value of 236 ppm. The chlorinity level of the sediment samples which was high during the winter and summer period was observed to fall sharply during rainy season. Munawar [26], observed a direct correlation between Cl^- concentration and pollution level in fresh water ponds of Hyderabad. Govindan and Sundaresan [27] and Jana [28], observed that concentration of higher Cl^- in the summer period could be also due to sewage mixing and increased temperature and evaporation by water.Chloride occurs in all natural waters in widely varying concentrations. The excess of chlorides in lake water accumulates in the sediments, under certain conditions they may be released back into water and may affect the plants growth and biological life in the lake. Plants do not thrive as well on chlorinated as on unchlorinated water; wild animals develop atherosclerosis by consumption of chlorinated water [29]. The presence of chlorides in markable amount (> 250 mg/L) may impart slightly salty taste to the lake water making it unfit for drinking and people who are not accustomed to high chlorides may be subjected to laxative effects.

In the present investigation, the monthly concentration of sulfate in the sediment samples was found to vary in the range of 0.1 to 234.0 ppm, with an average value of 40 ppm. The sulfate pollution can be the result of prolonged high atmospheric deposition, sulfate containing fertilizers, and, probably the most important cause at many locations, oxidation of pyrite deposits in the deeper subsoil [30, 31]. Sulfates can interfere with the disinfection efficiency by scavenging residual chlorine in the distribution system [32]. Sulfate reducing bacteria produce hydrogen sulfide and lower the aesthetic quality of the water by imparting an unpleasant taste and odour and increases corrosion of metal and concrete pipes [33]. High amount of sulfates in wastewater may lead to problems due to the formation of hydrogen sulfide gas [34]. High sulfate loads in polluted rivers and groundwater have led to increased sulphur fluxes and concentrations in fens and marshes, e.g. in New York [35]. In freshwater wetland systems, it may lead to suppressed growth and development, iron chlorosis, leaf necrosis, suppressed flowering, black and flaccid roots, root decay and even the death of the whole plant [36, 37]. Phosphorus pollution accelerates a process called eutrophication, which is essentially the process of biological death of any aquatic ecosystem due to depleted bioavailable oxygen. Algal blooms caused by excess phosphorus impact fisheries because the blooms favour the survival of less desirable fish over more desirable commercial and recreation species. Phosphorus pollution caused enormous blooms of the Blue-Green Algae, a form of cyanobacteria, which produces toxins that damage aquatic ecosystems, fisheries, and water quality. Excess amounts of phosphorus can cause rapid growth of phytoplankton, creating dense populations of blooms. These blooms become so dense that they reduce the amount of sunlight available to submerged aquatic vegetation. Without sufficient light, plants cannot photo-synthesize and produce the food they need to survive. The loss of sunlight can kill aquatic grasses. The result of present study indicates that the monthly phosphate level lies in the range of 0.10 - 0.99 ppm, with an average annual concentration of 0.62 ppm.

CONCLUSION

Thorough study, wide surveillance, monitoring, and research activities are required to assess the extent and severity of sediment contamination, to evaluate the effects of contaminated sediments on aquatic environment, and to prepare a plan for proper action. The environments of land and water bodies are interdependent, linked by complex atmospheric, geological, physical, chemical and biological interactions.

Table 1: Physico-Chemical Properties of sediments samples Collected from the lake

Months	Physico-Chemical Properties				
	pH	Alkalinity (as$CaCO_3$) ppm	Chlorides (as Cl^-) ppm	Sulphate (as SO_4^{2-}) ppm	Posphates (as PO_4^{3-}) ppm
June 2011	6.26	400	287	0.2	0.10
July 2011	6.02	111	110	0.5	0.80
August 2011	6.30	90	100	105.8	0.30
September 2011	6.54	100	95	0.8	0.40
October 2011	6.47	124	177	0.1	0.70
November 2011	6.43	211	196	45.6	0.78
December 2011	5.11	161	231	234.0	0.66
January 2012	5.38	269	300	0.1	0.54
February 2012	5.02	322	246	91.3	0.35
March 2012	5.11	322	220	0.5	0.90
April 2012	5.19	360	360	0.7	0.99
May 2012	5.17	400	506	0.6	0.87
Range	5.02-6.54	90-400	95-506	0.1-234.0	0.10-0.99
Median	5.78	245	300.5	117.1	0.55
Average	5.75	239	236	40.0	0.62

The human activities that effect, and arise from this environment also depend on economic and social factors. The problem is beyond the limits of physical and institutional bodies, and therefore, there is a need to set common objectives and implement compatitable policies and programs. Today it is realized that solution to environmental problem can only be achieved through a comprehensive, systematic and sustained approach. The present data on the physico-chemical properties of sediments collected along the Bhavan's College lake points out the need of regular monitoring of water resources and further improvement in the water treatment methodology. The existing situation if neglected can cause irreparable ecological damage to the lake in the long term.

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