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Research Paper

Water Quality Analysis of an Organically Polluted Lake by Investigating Different Physical and Chemical Parameters

***Verma Pradeep, Chandawat Deepika, Gupta Urvi and Solanki Hitesh**
Department of Botany, School of Sciences,
Gujarat University, Ahmedabad, Gujarat, 380009, INDIA

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Abstract - *Chandola is the largest lake of Ahmedabad city. This lake is surrounded by large number of small scale industries and slums. The waste from the industries and surrounding localities is directly discarded into the lake. To evaluate the water quality of this lake, study was carried out for the period of one year (March 2009 to February 2010). Monthly water samples were collected to analyze different physical and chemical parameters and obtained results were compared with standard values [4-5]. The pollution status was investigated on the basis of obtained results of physical and chemical parameters of water [1-3]. High level of variation was recorded during analysis which was as a result of human activity and discharge of waste water to the lake. Very soon Chandola Lake will become biologically inactive if the similar condition will be continued for longer period of time.*

Keywords: Polluted, Chandola Lake, Ahmedabad, Physico-chemical and Investigation.

Introduction

Ashaval, Karnavati, Ahmedabad, Amdavad… the largest city of Gujarat state is known by all these different names since its foundation on 4th March, 1411. Today Ahmedabad is the commercial capital of the Gujarat state and the 7th largest city of India has its own indefinable charm, combining many traditional elements and the latest international blend. The present city is divided by the river Sabarmati into two parts, eastern and western Ahmedabad. The old city – eastern Ahmedabad – reflects a superb social & architectural combination of Muslim, Hindu and Jain. Later the newer areas – western Ahmedabad – developed with more contemporary design of all on the other bank of river.

Development has brought many undesirable modifications to environment with increased number of industries and population. Aquatic environment of water bodies also disturbed due to somewhat mismanagement and unawareness of people. The development of new environment problems as a result of this has given rise to new ideas in the field of monitoring and assessment of aquatic ecosystem.

Monitoring and assessment provide the basic information on the condition of a water bodies. Chandola Lake is biggest lake of Ahmedabad city. It is located in the eastern part of Ahmedabad. The lake cover an area of 6, 18,100 m^2. And its exact latitude and longitude are $22^0$59'03.33" N and $72^0$35'24.19" E. One side of the Chandola Lake is covered by Dhobis, where the washing and colouring of cloths are carried out, whereas remaining part of lake is covered by slums area and small scale industries. The water in Chandola Lake is supplied through kharikat canal. The lake also receives influx of polluted water from the surrounding slum area. The coloured water containing chemical was also released by the dhobis, small scale industries also released their waste directly into the lake.

Material and Methods

The present study was carried out for Chandola Lake, located in Ahmadabad city. In the present study the sampling was done during morning hour. The water samples were collected in the polyethylene bottles. The closed bottle was dipped in the lake at the depth of 0.5 to 0.7 m, and then a bottle was opened inside and was closed again to bring it out at the surface. The samples were collected from five different points and were mixed together to prepare an integrated sample. From the time of sample collection to the time of actually analyses, many physical and chemical reactions would change the quality of the water sample; therefore to minimize this change the sample were preserved

soon after the collection. The water samples were preserved by adding chemical preservatives and by lowering the temperature. The water temperature, pH, DO, EC and TDS were analyzed immediately on the spot after the collection, whereas the analyses of remaining parameters were done in the laboratory.

The study was carried for a period of 1 year (March 2009 to February 2010). Monthly data was collected, but results were represented season wise. Four month make one season [March to June summer season, July to October monsoon season, and November to February winter season].The collected water samples were brought to the laboratory and relevant analysis was performed. pH was determined electrometrically using digital pH meter, electrical conductivity was measured by conductivity meter, dissolved oxygen is measured by DO meter, total dissolve solid was measured by using TDS meter and similarly turbidity is measured by Nepthalo turbidity meter. Alkalinity, chloride, TDS, calcium, magnesium, total hardness, nitrate and phosphate were determined by method suggested by [1-3]. Estimation of sodium was done by Flame Photometric method. The mean value of the monthly data was calculated as season wise and standard error was also calculated by using following formula

Standard deviation

$$\sigma = \sqrt{\frac{\sum (x_i - m)^2}{n-1}}$$

Standard error

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

Results and Discussion

Temperature: Temperature is an important factor, which regulates the biogeochemical activities in the aquatic environment. The temperature of Chandola Lake ranges between 17 ± 0.71 ^{o}C to 30 ± 1.47 ^{o}C (Figure 1). The maximum temperature was recorded during the summer season and the minimum was recorded during winter season. The maximum temperature during summer was due to greater solar radiation, low water level, clear atmosphere and higher atmospheric temperature. Similar observation was found in the studies of Banjara lake, Dahikhura reservoirs, and in lake at Nainital[6-8]. Generally water temperature correspond with air temperature indicating that the samples collected from shallow zone has a direct relevance with air temperature, shallow water reacts quickly with changes in atmospheric temperature. This type of observations was made in freshwater hill stream at Nandadevi and in Sruinsar lake of Jammu [9-10].

During winter the temperature remain low due to cold low ambient temperature and shorter photoperiod [11-13].

Electrical Conductivity: EC is a measure of water capability to transmit electric current and also it is a tool to assess the purity of water [14]. Electrical conductivity recorded in chandola lake ranges between 3.25 ± 0.26 mhos/cm to 4.16 ± 0.14 mhos/ cm (Figure 2). The high value of conductivity was recorded during the summer season were as low value was recorded during monsoon season. The relative high conductivity recorded during study may be attributed to the predominance of non leached substratum and the large size of the catchments area [15]. A high level of conductivity reflects the pollution status as well as tropic levels of the aquatic body [16]. Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolve solid content. Seasonal variation in the conductivity is mostly due to increased concentration of salt because of evaporation. Similar result was observed in Sursagar lake of Baroda [17]. Dilution of water during the monsoon season causes a decrease in electrical conductance due to the addition of rain water. Similar result was observed in Jamwa Rangarh wetland [18].

Turbidity: Turbidity of water is actually the expression of optical property in which the light is scattered by the particles present in the water. Clay, slit, organic matter, phytoplankton and other microscopic organisms cause turbidity in lake water [19]. High turbidity shows presence of large amount of suspended solids [20].Turbidity in Chandola lake recorded ranges between 19 ± 0.41 NTU to 24 ± 1.08 NTU (Figure-3). The maximum turbidity in water was recorded during summer season whereas minimum turbidity was recorded during winter season. The high turbidity during summer season may be due to addition of large amount of sewage waste and pollutant from the surrounding slums area. The increase in turbidity might also be due to the growing of aquatic vegetation and also by lowering the volume of water. Higher turbidity affects the life indirectly, as its cut of light to be utilized by the plants for photosynthesis there by lowering the rate of primary productivity [21-22].

Total Dissolve Solid : Total dissolved solids denote mainly the various kinds of mineral present in the water. The amount of total dissolve solid in Chandola lake ranges between 828 ± 6.48 ppm to 1014 ± 32.1 ppm (Figure-4). The maximum amount of total dissolve solid was recorded during summer season and minimum was recorded during monsoon. Due to contamination of domestic waste water, garbage, fertilizer, etc in the natural surface water body the value of TDS was reported to be high. Indeed, high concentration of TDS enriches the nutrient status of water body which were resulted into eutrophication of aquatic ecosystem Similar result was observed in the fresh water reservoir of Ajmer city [23].

pH: Generally in India many small confined water pockets particularly, are alkaline in nature [22-24]. The water was alkaline in nature which could be due to solutes, which may show a buffering action i.e. H^{+} ions are compensated with OH^{1-} ions [25]. The pH value recorded ranges between 8.7 ± 0.11 to 9.5 ± 0.27 (Figure 5). The maximum pH was recorded during summer season and the minimum pH was recorded during winter season. Alkaline state of pH might

be due to the chemical buffering and release of bicarbonate and carbonate ions or salts [26]. High pH in summer is due to high decomposition activities. Similar result was observed in Yammuna river at Faridabad and in mini Mahi river [27-28]. The factors like photosynthesis, respiratory activity, temperature exposure to air, disposal of industries wastes etc bring out changes in the pH [29].

The low value of pH could be due to accumulated organic matters and decomposition of vegetation which on biological oxidation gives up CO_2 which ultimately reduces the pH. Similar result was observed in Malyanta pond of Laxmisagar and in Kolar lake of Bhopal [30-31].

Total Alkalinity: Total Alkalinity in water is due to salts of weak acids and bicarbonates of highly alkaline water [32].The amount of total alkalinity recorded in Chandola lake ranges between 198 ± 8.12 ppm to 228 ± 8.12 ppm (Figure-6). The minimum value of alkalinity was recorded during winter season and the maximum value of alkalinity was recorded during summer season. During summer the water level in many number of lake decreases resulting the death and decay of plants and living organism. Thus during decomposition of this CO_2 is released resulting in the addition of carbonate and bicarbonate, this might also be one of the reason for the increase in alkalinity value. Similar result was observed in ponds and lakes of Dharwad, Karnataka [33].

The addition of large amount of sewage waste and organic pollutant in the lake also effect photosynthesis rate, which also result in death of plants and living organism. The degradation of plants, living organism and organic waste might also be one of the reasons for increase in a carbonate and bicarbonate, resulting an increase in alkalinity value [34-36].

Total Hardness: Hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. It is caused by dissolved polyvalent-metallic ions. In water, the principle hardness causing ions are calcium and magnesium. The total hardness recorded in the water of Chandola lake ranges between 320 ± 4.83 ppm to 368 ± 18.1 ppm (Figure-7). The maximum amount of total hardness in the water of Chandola lake was recorded during summer season and the minimum amount of total hardness was recorded during winter season. The high value of hardness during summer may be due to evaporation of water and addition of calcium and magnesium salts by mean of plants and living organism. Similar result was observed in J.N.U lake in Delhi and in various water bodies of Tamilnadu [37-38]. High values of hardness are probably due to regular addition of large quantities of sewage and detergent into lakes from the nearby residential localities [39-40].

Calcium: Calcium is most abundant ions in freshwater and is important in shell construction, bone building and plant precipitation of lime [41]. The amount of calcium in the water of Chandola lake ranges between 72 ± 1.83 ppm to 102 ± 2.8 ppm (Figure 8). The maximum amount of calcium recorded in water was during summer season, whereas the minimum amount of calcium in water was recorded during winter season. The amount of calcium increases during summer season due to rapid oxidation /decomposition of organic matter [42]. Relatively higher proportion of calcium in the surrounding rocks and soils might have also contributed to the rich calcium level in lake water. Calcium is present in water naturally, but the addition of sewage waste might also be responsible for the increase in amount of calcium. Similar result was observed in Papnash pond of Karnataka [43]. The decrease may be due to calcium being absorbed by living organisms in winter.

Magnesium: The considerable amount of magnesium influence water quality [44]. The amount of magnesium recorded in the water of Chandola lake ranges between 25 ± 1.29 ppm to 34 ± 1.58 (Figure-9) ppm the maximum amount of magnesium in the water was recorded during winter season where as the minimum value was recorded during monsoon season. Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium [45]. Magnesium is essential for chlorophyll growth and it also acts as a limiting factor for the growth of phytoplankton [46].

Dissolved oxygen: Measurement of dissolved oxygen is a primary parameter in all pollution studies. Dissolve oxygen value is higher in those lake where there was good aquatic life [47]. The amount of dissolved oxygen recorded in the water of Chandola lake ranges between 2.10 ± 0.17 ppm to 4.12 ± 0.41 ppm (Figure-10). The minimum amount of dissolved oxygen in the water of Chandola lake was recorded during summer season, whereas the maximum amount of dissolved in the water of Chandola lake was recorded during monsoon season. Dissolved oxygen in water is often attributed to the fact that the oxygen is dissolved more during the period of active photosynthesis [48-49].

The high temperature and addition of sewage and other waste might be responsible for low value of DO [50-51]. Depletion of dissolve oxygen in water is due to high temperature and increased microbial activity [32].

Biochemical Oxygen Demand: Biochemical oxygen demand depends on aquatic life,variation in BOD indicates dynamism in aquatic life present in the pond. BOD refers the oxygen used by the microorganism in the aerobic oxidation of organic matter. Therefore with the increase in the amount of organic matter in the water the BOD increases. The BOD value in Chandola lake ranges between 1.12 ± 0.08 ppm to 2.04 ± 0.2 ppm (Figure 11). The minimum demand of oxygen in the water was recorded during summer season, whereas the maximum demand was recorded during winter season. The higher value of BOD during winter was due to input of organic wastes and enhanced bacterial activity. Similar result was observed in certain freshwater ecosystem of Santal Pargana, (Jharkhand) [52].

Chloride: The greater source of chlorides in lake water is disposal of sewage and industrial waste [53]. Human body release very high quantity of chlorides through urine and fasces. The amount of chloride recorded in the water of

Chandola lake ranges between 116 ± 3.16 ppm to 133 ± 4.22 ppm (Figure 12). The minimum amount of chloride in lake water was recorded during the winter season and the maximum amount was recorded during summer season. The high chloride concentration of the lake water may be due to high rate of evaporation or due to organic waste of animal origin [54-55].

Sodium: Sodium is a natural constituent of raw water, but its concentration is increased by pollutional sources such as rock salt, precipitation runoff, soapy solution and detergent. The amount of sodium recorded in the water of Chandola lake ranges between 54 ± 2.58 ppm to 68 ± 4.24 ppm (Figure-13). The minimum amount of sodium in the water of Chandola lake was recorded during monsoon season and the maximum amount was recorded during summer season. The addition of waste water containing soap solution and detergent from the surrounding slummy area are also responsible for the increase in sodium level in the water bodies [56]. The addition of sewage waste and organic pollutant are also responsible for the increase in the value of sodium in the water bodies [40, 57].

Nitrate: Nitrates are contributed to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields.The amount of nitrate recorded in the water of Chandola lake ranges between 8.72 ± 0.29 ppm to 11.14 ± 0.65 ppm (Figure-14). The minimum amount of nitrate in the water of Chandola lake was recorded during summer season, whereas the maximum amount of nitrate in water was recorded during monsoon season. The high nitrate concentration during monsoon might be due to influx nitrogen rich flood water that brings about large amount of contaminated sewage water. The monsoon season was the period with the highest nitrate-nitrogen concentration which is known to support the formation of blooms [58-59].

Phosphate: Phosphate is one of the limiting factor for phytoplankton productivity because of geochemical shortage of phosphate in drainage basin. The amount of phosphate recorded in the water of Chandola lake ranges between 1.18 ± 0.02 ppm to 2.12 ± 0.06 ppm (Figure-15). The minimum amount of phosphate recorded in the water of the lake was during winter season and the maximum amount was recorded during summer season. The washing of large amount of clothes by dhobis and laundry worker, as well as continuous entry of domestic sewage in some area are responsible for increase in amount of phosphate [60]. During the multiplication of plankton, concentration of phosphate decrease automatically [61].

Conclusion

The result obtained during study was compared with [4-5] standards and it was found that maximum number of parameters in Chandola lake were above desirable limit in all the three season. This result shows that the Chandola lake receives very high amount of pollution from the surrounding. And the water of lake is highly contaminated and If the similar condition continue for the longer period, Chandola lake may soon become ecological inactive.

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Table 1.

S. No.	Parameters	YEAR 2009 - 20010		
		Summer Mean ± S.E.	**Monsoon Mean ± S.E.**	**Winter Mean ± S.E.**
1.	Temperature in ^{0}C	30 ± 1.47	23 ± 1.29	17 ± 0.71
2.	Electrical conductivity in mhos/cm	4.16 ± 0.14	3.25 ± 0.26	3.78 ± 0.15
3.	Turbidity in NTU	24 ± 1.08	22 ± 1.08	19 ± 0.41
4.	Total Dissolve Solid in ppm	828 ± 6.48	1014 ± 32.1	978 ± 6.12
5.	pH	9.5 ± 0.27	9.1 ± 0.09	8.7 ± 0.11
6.	Alkalinity in ppm	228 ± 8.12	210 ± 6.98	198 ± 8.12
7.	Total Hardness in ppm	368 ± 18.1	336 ± 11.8	320 ± 4.83
8.	Calcium in ppm	102 ± 2.8	93 ± 4.43	72 ± 1.83
9.	Magnesium in ppm	28 ± 1.83	25 ± 1.29	34 ± 1.58
10.	Dissolved Oxygen in ppm	2.10 ± 0.17	4.12 ± 0.41	3.10 ± 0.2
11.	Biochemical Oxygen Demand in ppm	1.12 ± 0.08	1.78 ± 0.19	2.04 ± 0.2
12.	Chloride in ppm	133 ± 4.22	124 ± 2.83	116 ± 3.16
13.	Sodium in ppm	68 ± 4.24	54 ± 2.58	62 ± 2.08
14.	Nitrate in ppm	8.72 ± 0.29	11.14 ± 0.65	9.28 ± 0.09
15.	Phosphate in ppm	2.12 ± 0.06	1.54 ± 0.14	1.18 ± 0.02

CHANDOLA LAKE

FIGURE-1

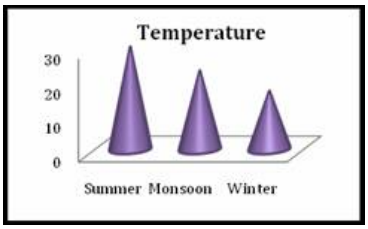


FIGURE-2

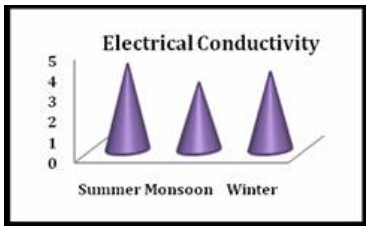


FIGURE-3

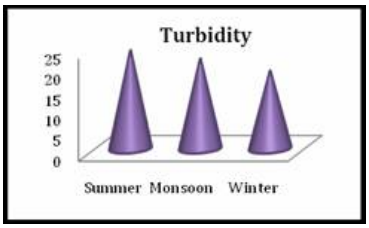


FIGURE-4

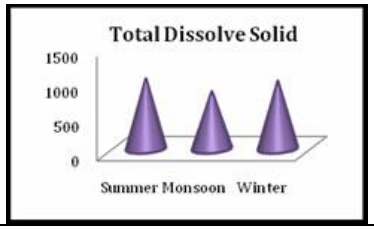


FIGURE-5

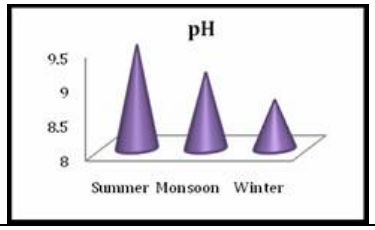
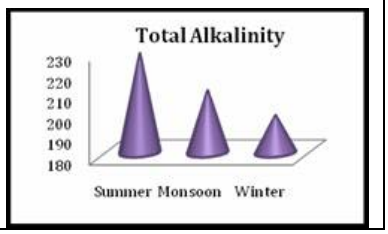
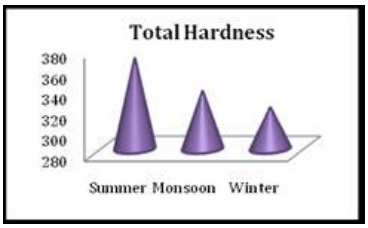


FIGURE-6



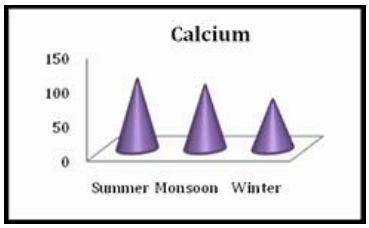
CHANDOLA LAKE

FIGURE-7



[TEMPERATURE in ^{0}C] [E.C. in mhos/cm] [WHILE ALL OTHER in ppm]

FIGURE-8



[TURBIDITY in NTU]

FIGURE-9

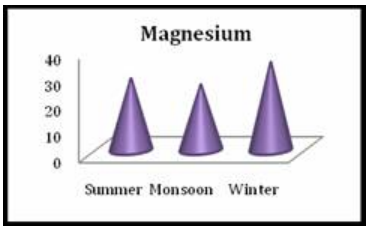


FIGURE-10

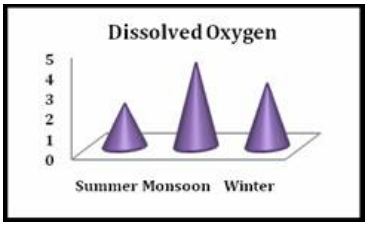


FIGURE-11

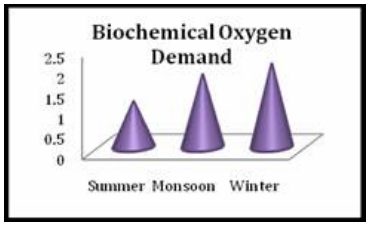


FIGURE-12

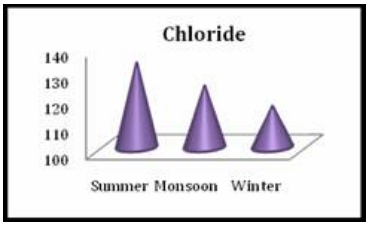


FIGURE-13

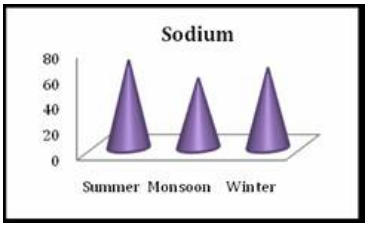


FIGURE-14

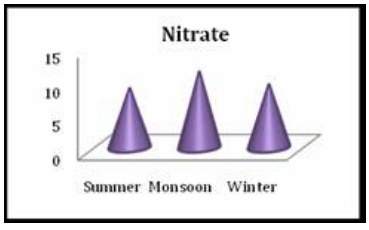


FIGURE-15