Volume : 3 | Issue : 2 | February 2014 • ISSN No 2277 - 8179

Research Paper

Studies on Water Quality With Special Reference to Limnological Characteristics of Kalyani Lake, West Bengal, India

Biology

KEYWORDS : limnological parameter, water quality, pollution, Kalyani lake. limnological parameter, water quality, pollution, Kalyani lake

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ABSTRACT

The present study deals with some limnological parameters of water of Kalyani lake in district Nadia, West Bengal to determine whether the water quality is suitable for fish culture or not. A total of nine physico-chemical parameters were measured for a period of one year (March'2011- February'2012) in three different seasons to assess the pollution load and present status of the lake following the standard method of APHA'1995. The parameters showed distinct temporal or seasonal variation. The low DO level and high level of nutrient values indicate the poor water quality of the lake for human consumption and fish culture also. The depletion of water quality is mainly due to the daily assemblage of huge amount of raw sewages from neighbouring sites, bathing of human and cattle, washing of cloths and utensils, dumping of solid wastes etc. This survey reflects the higher degree of pollution in Kalyani lake.

A lake is a low-lying part of the earth's surface in which rainwater, surface water run-off, outflow from a river and water from various sources accumulates. Lakes on the earth are of different kinds; there are freshwater lakes and saltwater lakes, ranging in size from small fish-ponds to huge waterbodies. Wetlands such as lakes constitute a unique ecosystem and considered not only as one of the most productive ecosystem but they also play a very crucial role in maintaining the socio-economic condition of the concerned region through fisheries activities.

In recent years almost half of the world's lakes are polluted, degraded and contaminated by various anthropological activities. The main causes of such pollution are influsk of domestic sewages, agricultural run-off, inflow of untreated effluents from different industries, habitat degradation, over-fishing, rapid rate of urbanisation etc. Kalyani lake of district Nadia is a shallow type of freshwater lake and is used for carp culture (especially Indian major carps or IMCs). Kalyani is a small industrial town of the state West Bengal, so usually there have some pollution problems due to rapid rate of industrialisation and urbanisation. The aforesaid lake is being polluted by a number of human activities such as bathing, washing their clothes, utensils etc. Moreover a huge amount of solid wastes and household sewages from the surroundings also reduce the water quality of the lake, which will be detrimental to the fisheries activities in near future of this area.

STUDY AREA

Kalyani lake is a shallow freshwater lake, located in the town Kalyani of district Nadia, West Bengal. It is positioned on 22º58' N latitude and 88º26' E longitude at an elevation of 8m. The total area of the lake is approximately 5 acres (Bala and Mukherjee, 2010) and the average depth is 2-5m.

MATERIALS AND METHODS

Collection of water samples: Water samples were collected fortnightly in a 500 ml. Glass stopper sterilised bottle at a depth of 5 cm. from March 2011 to February 2012 from two selected sampling sites for analysing different physico-chemical parameters of water. Preservation of water samples were done at 4ºC temperature.

Analysis of different limnological parameters: Different limnological parameters are taken into consideration during this work. These were- water temperature, pH, DO (Dissolved oxygen), BOD (Biological oxygen demand), total alkalinity, total hardness, nitrate, phosphate and sulphate of the sample water. These parameters not only serve as the indicators of water quality but these have a crucial role in maintaining the productivity of the lake ecosystem as well as in fish culture also. Among these parameters water temperature and pH were measured in the field with the help of mercury glass thermometer and portable digital pen pH meter (pHep Tester, Hanna instrument, Romania) respectively immediately after collection. Rest of the parameters were tested within 8 hrs. of collection in the laboratory using the standard methods of APHA (1995, 19th edition).

Samplings were done fortnightly from the month of March-2011 to February-2012. The study was conducted throughout different seasons of the year, *viz.* Pre-monsoon (from March to June), Monsoon(from July to October) and Post-monsoon(from November to February). After analysis, the mean value of each parameter from different months of a season was taken into consideration.

RESULTS AND DISCUSSION

The limnological properties of water of Kalyani lake during study period [From March-2011 to February-2012] is tabulated in the *table no.1*; S^1 and S^2 represent the first and second sampling sites respectively.

The interpretation of the tabulated results in Table 1 is written in the following paragraphs.

Water temperature of this lake during study period showed the normal tropical characteristics. Temperature showed the diurnal as well as seasonal variations. In the pre-monsoon the mean highest temperature was recorded from S^1 (32.03ºC) and the mean lowest was seen in S^2 (31.86ºC). whereas in monsoon the average temperature was more or less same in two different sampling sites with a little fluctuation (in S^1- 33.36ºC and that of in S^2- 33.50ºC).in post-monsoon period the average temperature of S^1 was recorded as 27.03ºC and that of S^2 was 26.80ºC. Indian major carps (IMC) thrive well in the temperature ranging from 18.3ºC to 37.8ºC (Jhingran, 1991). Temperature below 16.7ºC and 39.5ºC prove fatal to them (Jhingran, 1991).

Hydrogen ion concentration (pH) in water is one of the important parameter for lake ecosystem as well as fish culture. The pH values of Kalyani lake during study period ranged from 7.16 to 8.37 showing little alkaline nature of its water. Swingle (1967) showed that in the pH range of 6.5 to 9.0 recorded before daybreak are most suitable for pond culture. Low pH indicates high levels of dissolved carbon-di-oxide and pH more than 9 is stressful for carp culture, moreover Fish dies at about pH 11(Jhingran, 1991).

Volume : 3 | Issue : 2 | February 2014 • ISSN No 2277 - 8179

All of the gases, Dissolved oxygen (DO) is most important in lake ecosystems for the life in water. In the study period the range of DO varies between 2.76 mg/l to 6.10 mg/l from the both sampling sites. The mean value of DO remained high in the post-monsoon months and its mean value remained comparatively low in the pre-monsoon months. The recommended range of DO for carp culture is from 4 mg/l. Very low and very high values of DO have an adverse effect over fish production and other faunal communities (Jhingran, 1991).

The Biological oxygen demand (BOD) value of Kalyani lake showed its range from 1.75 mg/l to 4.90 mg/l. Its average peak value (4.29 mg/l) was seen in S^1 during post-monsoon and its average lowest value (2.50 mg/l) was recorded from S^2 during monsoon months. The recommended BIS standard for BOD value of water is 5 mg/l .

Mainly bicarbonates are responsible for the alkalinity of waterbodies. For fish culture the overall ranges of alkalinity should be between 40 – 240 mg/l (Jhingran, 1991). The value of total alkalinity in Kalyani lake ranged from 27.05 mg/l to 53.58 mg/l with its mean highest value (45.76 mg/l) in S^2 during monsoon and the mean lowest value (30.22 mg/l) was recorded in post-monsoon months from S^1. The increase in total alkalinity during summer and rainy season was due to the concentration of nutrients in the lake water and in winter the values remained low due to slow decomposition of organic matters, CO_2 production was less (Patra *et. al*., 2010).

Total hardness in principle is the total of soluble Ca and Mg salts present in the water, expressed as its $CaCO_3$ equivalent. Total hardness above 60 ppm is desirable for fish culture (Jhingran,1991). The maximum values of total hardness(with mean peak value 117.94 mg/l in S^1) were recorded during pre-monsoon months in Kalyani lake, which had a decreasing trend in monsoon months and in post-monsoon the total hardness value reached its lowest value (mean lowest value-100.54 mg/l in S^1). Studies revealed that the dilution of hardness depends with the introduction of monsoon (Chakraborty *et.al*.,1959; Goldman and Wetzel,1963) and its value increases with the decrease in water levels (Subho Rao and Govind,1964).

Fillos and Swanson (1975) pointed out that nitrates are the prime index of immediate fertility of water. The values of nitrates ranged between 0.75 mg/l and 1.79 mg/l throughout the year in the study area. Nitrate values were low in summer months and remain high in rainy season in both sampling sites. The high values were due to the activities of denitrifying bacteria which break up nitrates into nitrites and ammonia (Hutchinson,1967). For fish production in the Kalyani lake, the values of nitrates are much higher than its limit. Super saturation of nitrogen can occur at the air-water interface, which at times causes 'gas-bubble disease' to fishes (Jhingran,1991).

Phosphate is one of the major nutrients in waterbody. The main supply of phosphate in natural water is mainly from the leaching of soils of catchment area by rain. Cattle dung and raw sewages add phosphates to the water. The total phosphate in natural water varies from less than 1 mg/m^3 to a very high value as in a few closed saline lakes (Jhingran, 1991). In Kalyani lake the phosphate ranged from 0.20 mg/l to 0.63 mg/l with its high and low values during monsoon and pre-monsoon respectively. Thomas (1969); Niswander and Mitsch (1995) had shown that high level of phosphate is responsible for eutrophication of waterbodies by increasing the bacterial activities, increase in oxygen demand and increase in algal growth.

Lakes receive sulphates dissolved in rain water and through the dissolution of sulphate compounds present in the sedimentary rocks of catchment area. In lakes sulphate values have been found to vary from >1 mg/l to 30 mg/l depending upon the geology of the drainage (Jhingran, 1991). In Kalyani lake the values of sulphate ranged from 9.72 mg/l to 18.72 mg/l with its average lowest (13.61 mg/l in S^1) and average highest (16.70 mg/l in S^2) value during summer and winter months respectively.

CONCLUSION

As we know that the wetlands such as lakes are one of the most productive ecosystem and they play an important role to maintain the socio-economic condition of concerned region through various fisheries activities. On the other hand the lakes contain a huge amount of floral and faunal communities, thus they also play a vital role in maintaining this enormous biodiversity. On the basis of above findings it may be concluded that the water of Kalyani lake is not good enough for human consumption, irrigation more over the lake water is very much prone to eutrophication, as it receives massive amount of raw sewages from the neighbouring sites and various human activities. The nutrient levels become very high which is unsuitable for fish culture also. So we should take some effective measures immediately to control this aquatic pollution, to restore the biodiversity and to enhance the production potentials in this lake, otherwise there

Table 1: **Seasonal changes (mean ± S.D) in the physico-chemical conditions with minimum and maximum values given in parentheses of Kalyani Lake, Nadia District, West Bengal, India, for the period March-2011 to February-2012. [PRM: Pre-monsoon, MON: Monsoon, POM: Post-monsoon; S^1-First sampling site, S^2-Second sampling site; S.E- Standard Error**

Limnological parameters	S^1			S^2		
	PRM Mean±SD (Upper limit-Lower limit) SE	MON Mean±SD (Upper limit-Lower limit) SE	POM Mean±SD (Upper limit-Lower limit) SE	PRM Mean±SD (Upper limit-Lower limit) SE	MON Mean±SD (Upper limit-Lower limit) SE	POM Mean±SD (Upper limit-Lower limit) SE
Water temperature(ºC)	32.03±1.52 (30.2-34.2) S.E 0.53	33.36±0.59 (32.6-34.2) S.E 0.20	27.03±1.85 (24.9-29.9) S.E 0.65	31.86±1.37 (30.3-33.9) S.E 0.48	33.5±0.53 (32.7-34.2) S.E 0.18	26.8±1.89 (24.5-29.8) S.E 0.67
pH	8.07±0.22 (7.85-8.37) S.E 0.07	7.41±0.26 (7.16-7.83) S.E 0.09	7.91±0.15 (7.76-8.14) S.E 0.05	8.08±0.21 (7.87-8.35) S.E 0.07	7.45±0.24 (7.25-7.85) S.E 0.08	7.86±0.17 (7.70-8.11) S.E 0.06
DO(mg/l)	3.75±0.89 (2.76-4.65) S.E 0.31	3.96±0.63 (2.96-4.59) S.E 0.22	5.61±0.33 (5.25-5.95) S.E 0.11	3.73±0.85 (2.79-4.57) S.E 0.30	4.01±0.67 (3.12-5.00) S.E 0.23	5.69±0.31 (5.35-6.10) S.E 0.10
BOD (mg/l)	2.57±0.58 (1.75-3.51) S.E 0.20	2.51±0.50 (1.95-3.14) S.E 0.17	4.29±0.51 (3.71-4.90) S.E 0.18	2.68±0.59 (1.86-3.45) S.E 0.20	2.50±0.42 (2.07-3.15) S.E 0.14	4.21±0.46 (3.77-4.87) S.E 0.16

Total alkalinity(mg/l)	38.03±6.15 (30.82-48.02) S.E 2.18	43.84±6.50 (34.71-51.75) S.E 2.30	30.22±2.07 (27.05-33.58) S.E 0.73	37.28±4.61 (31.25-43.00) S.E 1.63	45.76±5.96 (35.91-53.58) S.E 2.11	31.43±1.91 (28.09-33.08) S.E 0.67
Total hardness(mg/l)	117.94±6.44 (108.28-125.91) S.E 2.28	110.89±7.94 (100.95-123.31) S.E 2.81	100.54±3 (96.74-105.53) S.E 1.06	117.04±6.95 (106.57-124.04) S.E 2.46	110.92±8.18 (100.02-123.01) S.E 2.90	101.87±3.39 (97.51-107.38) S.E 1.20
Nitrate(mg/l)	0.87±0.14 (0.75-1.12) S.E 0.04	1.55±0.23 (1.20-1.79) S.E 0.08	1.03±0.19 (0.80-1.31) S.E 0.06	0.86±0.11 (0.77-1.07) S.E 0.03	1.52±0.22 (1.19-1.78) S.E 0.07	1.12±0.21 (0.90-1.42) S.E 0.07
Phosphate(mg/l)	0.33±0.11 (0.20-0.51) S.E 0.03	0.59±0.02 (0.55-0.62) S.E 0.007	0.35±0.05 (0.30-0.43) S.E 0.01	0.35±0.09 (0.25-0.50) S.E 0.03	0.59±0.02 (0.56-0.63) S.E -0.007	0.40±0.07 (0.32-0.51) S.E 0.02
Sulphate(mg/l)	13.61±1.67 (12.02-16.28) S.E 0.59	14.46±3.76 (9.72-18.21) S.E 1.33	16.49±1.66 (14.28-18.72) S.E 0.58	13.87±1.29 (12.00-15.35) S.E 0.45	14.30±3.57 (10.09-18.25) S.E 1.26	16.70±1.23 (14.87-18.29) S.E 0.43

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