Kalmar ECO-TECH '05 and
The Second Baltic Symposium on Environmental Chemistry
KALMAR, SWEDEN, November 28-30, 2005

PHYSICO-CHEMICAL STUDIES OF WATER QUALITY OF SINGANALLUR LAKE, COIMBATORE, SOUTH INDIA

Mathan Ramesh
Bharathiar University, India

ABSTRACT

Water pollution is a major environmental problem in India, especially pollution of rivers, lakes and ponds caused by people's daily activities but also by industry. The growing population and the contaminated growth in agriculture, rapid urbanization and industrialization, have led to an increasing demand for water. In India, pollution from various sources is seriously degrading freshwater sources. Coimbatore is the second largest city in TamilNadu, South India. There are more than 25,000 small, medium, large and tiny industries and textile mills. The unplanned and uncontrolled expansion of Coimbatore has brought in its wake serious pressures on its natural resources.

Singanallur Lake (major source for irrigation) is situated between 10°, 56' 46' latitude and 77° 01' 11" longitudes at Southwest of Coimbatore city, South India. The lake with an area of 835 m^2 is divided into two equal halves having a connection for water in between. The south half of the lake receives freshwater only during rainy reason from Noyyal River (highly polluted river) through a canal and north half receives urban, domestic and industrial wastewater. During rainy season storm water and road runoff enters the lake through Sanganoor pallam. The catchment area is 125 km^2 comprising a part of Coimbatore urban and suburban areas. The present study was carried out over a period of January 2004 – December 2004 and the sample was collected at 30 days interval in two zones namely, middle zone and sewage mixing zone.

The study depicts high level of pollution at sampling station near sewage mixing zone. The physico chemical parameters like BOD, COD, DO, solids, chlorides, carbonates etc., are exceeding safe limits. The lake with such high level of pollutants is unfit for irrigation.

KEYWORDS

Water quality; Singanallur; Coimbatore; South India

1. INTRODUCTION

India has a predominately agriculture economy and water and land are among its most valuable natural resources. Due to increasing industrialization, urbanization and other developmental activities, most of our water bodies such as ponds, lakes, streams and rivers have become polluted. Shortages of freshwater and its pollution threaten the quality of life of many Indians. There is an urgent need for action to maintain the health of our water systems. Coimbatore is the

https://doi.org/10.15626/Eco-Tech.2005.030

second largest city in Tamil Nadu, South India and there are more than 25, 000 small, medium and tiny industries and textile mills. The unplanned and uncontrolled expansion of Coimbatore has brought in its wake serious pressures on its natural resources. The city is developing very fast and waste water from industries as well as sewage of the city disposed of into lake, ponds, reservoirs etc. Its waters are used for irrigation, water supply and other public uses as bathing and industry. For evolving policies for the best use of water resources, it is important to make an assessment of their magnitude, distribution and scope of utilization. Singanallur Lake, located in Coimbatore, South India receives sewage and industrial effluents. Its waters are used for irrigation, water supply and other public uses as bathing and laundry.

2. MAERIALS AND METHODS

Singanallur Lake is situated between 10º 56' 46" latitude and 70º 01' 11" longitudes at south west of Coimbatore City, South India. The lake with an area of 835 m2 is divided into two equal halves having a connection for water in between with inhabitant of many freshwater fishes. The south half of the lake receives freshwater only during rainy season from Noyyal River through a canal and north half receives urban, domestic and industrial wastewater. During rainy season storm water and road runoff enters the lake through Sanganoorpallam. The catchment area is 125 km^2 comprising a part of Coimbatore urban and suburban areas.

During January 2004 – December 2004, a survey was undertaken for evaluating pollution load in the lake and 2 sampling stations were chosen to study various physico-chemical parameters. The two stations ***viz.***, Station A, Middle Zone, Station B – Sewage mixing zone were selected. The samples were collected from the above stations on monthly interval for one year and analyzed as per standard methods [1].

3. RESULTS

The physico – chemical characteristics of the middle and sewage mixing zone of the Singanallur Lake was presented in the Table 1 & 2. In the present study, the color of the middle zone and sewage mixing zone of the lake was pale green and dark green, respectively. The temperature of the middle zone was 26.0 to 34.4 °C whereas in sewage mixing zone the temperature was 28.6 to 35. 8 °C. The turbidity in both the zones was more or less similar in nature (1.0 – 1.6 mg/l). The total dissolved solids of the sewage mixing zone was lower (1.2 – 2.8 mg/l) when compared to middle zone of the lake (4.4 – 5.5 mg/l). The pH of the middle zone shows normal (6.8 – 7.5) where as the pH of the sewage mixing zone was in acidic side (3.9- 5.7). The sewage mixing zone registered higher alkalinity (162-198 mg/l) when compared to middle zone (138-156 mg/l). The carbonates level in the sewage mixing zone was higher (1.2 -2.7mg/l) when compared to middle zone (7.6 – 10.0 mg/l). But the bicarbonate level was higher in sewage mixing zone (112-160) when compared to middle zone (94.0-120.0 mg/l). The dissolved oxygen level in the middle zone was 4.4 – 5.5 mg/l whereas in the sewage mixing zone it was 1.5- 2.8 mg/l. The sewage mixing zone registered high BOD content (4.6 – 8.4 mg/l) when compared to middle zone (1.8–4.2 mg/l) (*Table 1*).

The chemical oxygen demand of the middle zone of the lake was 3.6 – 5.4 mg/l, whereas in the sewage mixing zone of the lake it was 14.0 – 31.0 mg/l, which was higher than the middle zone. The total hardness of the middle zone of the lake was 124 -155 mg/l, which was lower than the

sewage mixing zone of the lake (215.0-312.0 mg/l). The chloride level of the middle registered 80.0 – 105.0 mg/l, which was lower than the sewage mixing zone (135.0 – 170.0 mg/l). The nitrite and nitrate level of the sewage mixing zone was higher (1.0 – 1.6 and 14.8 – 22.2 mg/l) when compared to middle zone of the lake (0.04 – 1.0 and 9.6 – 12.8 mg/l). The phosphate of the middle zone of the lake was minimum showing 0.3 – 1.4 mg/l, and of the sewage mixing zone of the lake it was 1.1- 2.3 mg/l. The calcium and magnesium content of the sewage mixing zone was higher (96.8 – 122.2 and 12.4 – 20.8 mg/l) when compared to middle zone of the lake (80.2 – 92.1 and 8.2 – 16.2 mg/l) (*Table 2*).

Table 1. Physico - chemical characteristics of Singanallur Lake, Coimbatore, South India.

Months 2004	Color		Temperature		TDS		Turbidity		pH		Total Alkalinity		Carbonates		Bicarbonates		Dissolved Oxygen	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	Pale green	Dark green	26.0	28.6	4.4.	1.2	1.6	1.2	6.9	5.7	140	162	10.00	1.2	99	129	4.4	2.1
February	Pale green	Dark green	28.0	30.8	5.3	2.4	1.4	1.1	7.1	4.8	138	168	9.05	1.7	98	117	5.3	2.0
March	Pale green	Dark green	29.0	30.4	5.5	1.5	1.4	1.2	7.2	3.9	142	172	8.25	1.5	98	109	5.5	1.5
April	Pale green	Dark green	33.5	35.0	4.8	1.6	1.5	1.0	7.4	3.0	148	174	9.29	1.9	94	112	4.8	1.8
May	Pale green	Dark green	34.4	35.8	5.0	1.8	1.2	1.1	7.5	4.7	150	180	9.42	2.7	102	120	5.0	2.8
June	Pale green	Dark green	32.6	35.2	4.8	2.8	1.4	1.2	7.0	4.9	138	184	10.20	2.4	110	128	4.8	2.2
July	Pale green	Dark green	31.4	31.5	4.6	2.2	1.6	1.0	6.9	4.8	146	170	9.84	1.9	112	132	4.8	1.9
August	Pale green	Dark green	31.4	33.0	5.1	1.9	1.2	1.2	7.0	4.5	140	182	8.8	2.0	116	124	5.1	2.0
September	Pale green	Dark green	30.5	32.0	5.2	2.0	1.4	1.2	6.8	4.6	144	192	7.6	2.4	118	148	5.2	2.2
October	Pale green	Dark green	30.2	31.2	4.9	2.2	1.4	1.0	6.8	4.7	152	198	8.0	1.8	110	150	4.9	2.0
November	Pale green	Dark green	28.0	30.8	5.0	2.0	1.6	1.4	6.9	4.6	156	186	8.3	2.2	112	152	5.0	1.8
December	Pale green	Dark green	29.0	30.6	5.4	2.3	1.4	1.0	7.0	8.4	148	189	8.2	2.0	120	160	5.4	2.0

A – Sample collected from middle zone of the lake, B- Sample collected from sewage mixing zone of the lake.

Values are means of ± S.E. of five individual observations. All values are calculated in mg/l.

Table 2. Physico - chemical characteristics of Singanallur Lake, Coimbatore, South India.

Months 2004	BOD		COD		Total Hardness		Chloride		Nitrite		Nitrate		Phosphates		Calcium		Magnesium	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
January	2.2	4.6	3.6	14.0	132	250	85	152	0.1	1.2	11.2	17.3	0.6	1.2	80.2	97.2	8.2	12.4
February	1.8	6.2	3.8	24.2	124	251	80	143	0.8	1.0	12.4	14.8	0.4	1.4	80.4	98.3	8.8	18.2
March	3.2	8.4	3.2	31.0	128	247	93	137	0.6	1.4	11.8	16.2	0.7	1.6	82.0	112.0	10.0	16.4
April	3.0	7.2	4.6	29.4	130	215	102	135	0.08	1.4	11.6	17.2	0.4	1.1	84.0	106.8	9.2	12.0
May	3.4	7.6	5.2	22.0	133	268	98	148	0.06	1.0	10.8	18.2	0.3	1.5	82.8	114.3	9.8	14.4
June	2.2	8.0	5.4	20.9	148	312	92	152	0.6	1.0	12.4	18.0	0.4	1.3	80.2	110.0	10.2	18.4
July	2.4	7.8	4.6	21.2	155	230	90	138	0.04	1.2	12.8	20.2	0.6	2.0	82.6	98.8	12.2	18.4
August	3.8	7.4	4.6	18.0	150	240	96	142	1.0	1.4	10.8	19.4	0.9	2.1	83.2	96.8	14.8	20.2
September	4.2	8.2	5.0	22.2	145	222	87	150	0.80	1.6	9.40	19.8	1.4	1.5	84.6	117.4	16.2	18.4
October	4.0	8.4	4.4	24.0	130	218	94	168	0.04	1.2	10.6	18.4	1.2	2.3	85.0	118.6	13.0	16.8
November	3.8	7.9	5.2	18.2	147	220	96	170	0.06	1.0	9.6	22.2	1.0	2.1	88.8	120.0	12.9	17.6
December	3.4	6.8	5.4	20.8	144	218	92	156	0.09	1.0	9.8	20.8	0.8	1.9	92.1	122.2	13.4	20.8

A – Sample collected from middle zone of the lake, B- Sample collected from sewage mixing zone of the lake.

Values are means of ± S.E. of five individual observations. All values are calculated in mg/l.

4. DISCUSSION

The rapid increased rate of human population and industrialization in India, has created problems of disposal of wastes products which are indiscriminately discharged into the nearby ponds, reservoirs, lakes and tanks and even in the adjoining fields with almost no pretreatment [2]. Due to the lake of treatment and improper mode of disposal of the industrial wastes, municipal sewage and domestic wastes the ponds and lakes are highly polluted in India. This impairs the water quality and the suitability for domestic purpose, recreation; irrigation, and aquaculture etc., Natural water bodies like ponds and lakes are now shrinking under various types of anthropogenic influences. The problem of water scarcity is becoming acute in the urban as well as rural areas of India.

Gopal [3] reported that the major source of aquatic pollution in freshwater system is domestic and industrial organic wastes, although toxic metals are also a concern in some areas. Knowledge on the physico-chemical characters of the effluent and the receiving water body is very important because of the former influences/ alters the immediate environment of aquatic fauna and flora in the receiving water body. The physio-chemical parameters of the water may influence the toxicity present in the water, which may affect the quality of water which may affect the aquatic organisms, or the distribution of the organisms.

The color of the lake was observed as pale green and dark green in the zone of middle zone and sewage mixing zone, respectively. The dark color of the water in the sewage zone may be due to varieties of materials which are being discharged by domestic and industrial use in to the lake by small scale industries [4].

Temperature is one of the most important ecological factors which control the physiological behavior of the aquatic system and distribution of the organisms. It is one of the most important biologically significant factors and plays an important role in the metabolic activities of the organisms. The higher range of temperature (April to August) may be also due to clear atmosphere, greater solar radiation, and due to low water level as reported by Swaranlatha and Narsing Rai [5]. The minimum temperature in the present may be due to a change in the climatic conditions and also due to high humidity, current velocity, water level and rain during the months particularly from September to December.

The amount of total solids was minimum in sewage mixing zone which may be due to stagnant condition of the water and also due to lack of rainfall through the study period. Generally suspended solids greatly influence the turbidity of the water bodies which in turn affects the light penetration resulting in reduced photosynthesis. The turbidity in the both the zones more or less similar in nature. Higher sediments during rainy season may increase the turbidity (middle zone) and decrease the transparency. Measurement of pH is one of the most important and frequently used tests in water chemistry. Decreasing volume of water due to evaporation is often accompanied by progressive changes in pH [6]. Changes in pH of a water body can indicate the presence of certain pollutants when it is continuously monitored. In the present study the pH value was minimum in the sewage mixing zone which may be due to mixing of industrial effluents.

Alkalinity is governed in natural waters by photosynthesis and microbial decomposition.. Alkalinity may be used as important measure to determine the quality of water. Alkalinity also

may be due to the contamination by leaching process through surface water. Excess alkalinity gives a bitter taste to water. The slight excess of alkalinity in the sewage mixing zone may be due to seasonal effect, planktonic population, bottom deposits rocky bed and water current in the lake. The alkalinity in both the zones are tolerable range. In the present study the carbonate level was lower where as bicarbonates level in the sewage mixing zone was higher which may be due to usage of the lake water by dhobis for washing clothes and bathing by public and discharge of waste water from the small scale industries that are nearby.

Dissolved oxygen is the most important parameter of the lakes and reservoirs. It is obviously essential to the metabolism of all aquatic organisms that possess aerobic respiratory biochemistry. The low dissolved oxygen in sewage mixing zone in the present study indicate high rate of biodegradation of organic matter and also due to presence of domestic sewage and industrial waste. High temperature also affects the decreasing oxygen. The phenomenon of oxygen depletion in various months may be due to involvement of aquatic plants or activity of sediment surfaces as an active site of oxygen consumption. Low level of dissolved oxygen greatly threatens the survival of aquatic organisms except anaerobic micro organisms [7].

BOD is an important parameter to evaluate the water quality with respect to the presence of organic and inorganic pollutants. The high BOD in the sewage mixing zone may be due to less light penetration and more turbidity in the lake.

COD is a reliable parameter in judging the extent of organic pollution. The high COD values in sewage mixing zone in the present study indicate that some degree of non- biodegradable oxygen demanding pollutants were present in the water. The high COD may be due to higher rate of oxidation [8]. Ellis [9] observed that high BOD and COD levels in the effluent might reduce the DO levels in the receiving water, leading to conversion of sulphate to sulphite, which is toxic to fishes. Water hardness is understood as a measure of the capacity of water to precipitate soap. A low water level and flushing rate lead to increase in hardness. The high total hardness in the present study may be due to heavy rainfall and discharge of waste water from the near by towns, small scale industries, municipal sewages, etc. The high level of total hardness in both the zones may be due to weathering of rocks during which minute fragments are carried out and settle in the lake.

Chloride had been a basic parameter for detecting pollution of water by sewage before the development of bacteriological procedure. Generally unpolluted water contains low concentrations of chloride. The low level of chloride level in middle zone indicate eutrophication has not taken place. The slight variation of chloride in sewage mixing zone may due to the discharge of effluents from the tanneries, dying, small scale industries. Washing down of organic matter from the surrounding catchments may be another reason. Phosphates and nitrates are the basic nutrients, which determine the productivity of the static waters. Phosphatates is an important nutrient and it is reported to be the limiting factor for algal growth. Phosphorous occurs in natural water almost as phosphates. It is essential to the growth of organisms and can be the nutrient that limits the primary productivity of a body of water and that stimulates the growth of photosynthetic aquatic micro and macro organisms. The sources of phosphate were agricultural runoff from surrounding fields, domestic and industrial effluents, and use of detergents in lake area, urban run-off and faeces of birds, which enter the lake.

Nitrates and phosphates were mostly contributed by the discharge of waste, fertilizer, leachates and runoff. The high amount of nitrates in the sewage mixing zone in the present study may be due to sewage water and surface runoff of the water and nitrification of ammonia. However the phosphates, carbonates and bicarbonates level was maximum, which supports the animal and plant life which indicate the absence of rain water during the study period. Calcium is very important element influencing the flora of ecosystem, which plays potential rate in metabolism and growth. It is dissolved from rocks and soil, which contribute to hardness in water thereby reducing the utility of water for domestic purpose. The high amount of calcium and magnesium in the present study may be due to discharge of small scale industrial effluent discharge, mixing of municipal sewage and washing of cloths. The concentration of magnesium in water is comparatively less than calcium possibly due to lesser occurrence of a laxative effect.

In the present study it is concluded that the physico – chemical characters of the water shows the value above ISI value and it has deleterious effect on all aquatic flora and fauna of the lake. It is necessary to create awareness among the local nearby residents regarding the use of lake water for irrigation, drinking and bathing. Further the discharge of industrial effluents in to the lake should be avoided or the effluents should be discharged after proper treatment.

REFERENCES

[1] APHA, AWWA, WPCF., 1989. Standard methods for the examination of water and waste water. American Public Health Association, Washington, 17th edition.

[2] Jhingran, V.G., 1971. The Problems of aquatic pollution in India. Proceedings of the seminar pollution and human environment. Bhabha Atomic Research Centre, Bombay, pp. 304-311.

[3] Gopal, B., 1997. Biodiversity in inland aquatic ecosystems in India an overview. *Int.J. Ecol. Environ. Sci.* 23, 305 -311.

[4] Hunt, G.S., 1971. Understanding of Environmental Pollution. A. Strobbe and C.V. Mos. Publishers, pp. 3-10.

[5] Swaranlatha, N., Narsing Rai, A., 1998. Ecobiological studies of Banjara Lake with references to water pollution. *J.Environ.Biol.* 19(2), 79-186.

[6] Adoni, A.D., 1975. Studies on microbiology of Sagar Lake. Ph.D thesis. Sagar Univ. Sagar. M.P., pp. 243.

[7] Chinmoy, C., 2000. Physico-chemical studies of water quality of the river Nunia at Asansol Industrial area. *J. Environ. Poll.* 7(4), 256-261.

[8] Parvateesam, M., 1994. Physico-chemical characteristics of a lake receiving effluents from textile mills in Rajestan. *Poll.Res.* 13 (4), 317-321.

[9] Ellis, A.E., 1973. The Leucocytes of fish – A Review. *J.Fish* 11, 453-491.