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Comparative Assessment of Water Quality in Selected Rural and Urban Lakes of Karnataka

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Abstract

Lake ecosystems vital functions such as recycling of nutrients, purification of water, recharge of ground water, augmenting and maintaince of stream flow and habitat provision for a wide variety of flora and fauna along with their recreation values necessities their sustainable management through appropriate conservation mechanisms. The results of the water quality analysis showed that Gotakanapura Lake, maximum BOD was recorded as 9.87 mg/liter in summer season and minimum was recorded as 7.5 mg/liter in monsoon season and in Muduganukunte Lake, the maximum was recorded as 9.4 mg/liter in winter season and minimum was recorded as 6.9 mg/liter in monsoon season. The results reveal the need and importance for restoration and management of rural and urban lakes. Restoration can be brought about in many ways, the important ones being pollution abatement, desilting of the tank and educating the stake-holders and the local population on the importance for restoring the lake ecosystem.
Key words : Urban lakes, Rural lakes, Water quality, Pollution.

Lake have more complex and fragile ecosystem as they do not have a self cleaning ability and therefore readily accumulate pollutants, the increasing anthropogenic activities in recent years in and around aquatic systems and their catchment areas have contributed to a large extent to be deterioration of water quality and dwindling number of water bodies, leading to their accelerated eutrophication. Karnataka state has about 2,000 perennial and about 30,000 seasonal tanks with a total spread area of 30 lakh hectares (1). Urban lakes and tanks all over the country and in the state of Karnataka are in various degrees of environmental degradation (2). The degradation is due to encroachments, eutrophication loads (from domestic and industrial effluents) and silt. The main causes for the deterioration of water quality in tanks are entry of pollutants due to discharge of untreated or partially treated waste water from municipal sewage, domestic effluents and discharge of organic, inorganic and toxic pollutants of industrial effluents. Ponds in rural areas are most easily accessible sources of water for various human needs such as bathing, washing, irrigation, aquaculture. Large numbers of ponds in the villages occupy a unique position in limnology and help in maintaining water table. Being open lentic water bodies, ponds are more easily susceptible to pollution due to various factors such as the industrial, municipal domestic waters and surface run off from adjoining areas (3). Ponds form the life lines in Indian villagers. The lake water systems of the region are characterized by the seasonal fluctuations in water levels. Lake water resources are deteriorating factor day-by-day and water quality is affected (4). This highlight needs for appropriate conservation, restoration and management measures. The study was made to assess the water quality of two rural and urban lakes.

Methods

A study was conducted to investigate the water quality status of selected rural and urban lakes. Rural lakes comprises of Gotakanapura and Muduganukunte, located near Gouribidanur Taluk, Chikkaballapur district. Urban lakes of Hebbal and Puttenahalli located in and around Bangalore. Important parameters like pH, EC, BOD, COD, Carbonate and bicarbonate were recorded. The procedure was followed from the standard methods APHA (5).

Rural Lakes

Gotakanapura Lake is located 5 km from

Gouribidanur. It situated between 13^{0}37′ 12.55′′ N latitude and 77^{0}32′ 19.92′′ E longitude. It covers an area of 29.63 hectare at full water level and is a 2 meters deep at the middle of the tank. The lake is man made, rain fed and often used by people for anthropogenic and agricultural purpose. The catchments area is 10.64 sq km and the lake receives run off material from surrounding agricultural fields.

Muduganukunte Lake is located eight Km from Gouribidanur and is situated between 13^{0}36′ 39.95′′ N latitude and 77^{0}33′ 53.60′′ E longitude. It covers an area of 28.77 hectare when full and is 1.5 meters deep at the middle of the tank. The lake is man made, rain fed and used by people for anthropogenic and agricultural purpose, the catchments area is 18.30 sq km.

Urban Lakes

Hebbal Lake is situated on 13^{0}02′ 48.18′′ N latitude and 77^{0}35′ 13.44′′ E longitude and is one of the large lakes of Bangalore and is located at Hebbal along the Bangalore-Bellary road in the northern part of Bengaluru. The lake is about 8 km from the heart of Bangalore city. It is one of the land marks of north Bangalore ; it has been used and is still being used for irrigation, fish culture and recreation. This seasonal lake used to be filled during the monsoon and invariably is dry in summer. It has a variety of aquatic vegetation and a large number of birds inhabit it.

Puttenahalli Lake is located on 13^{0}06′ 42.45′′ latitude and 77^{0}34′ 35.75′′ E longitude is near BTS bus depot, Yelahanka and is fourteen km north of Bangalore. The lake is prominent because of various species of birds sighted during the breeding season. The 'avifauna' of this lake also includes some of the endangered and migratory birds from the Northern Himalayas and Siberia. The lake receives sewage effluents from catchments areas of Yelahanka, Yelahanka new town, and wheel and axil industry and near by hotels.

Sampling of Water

The water samples were collected during three different seasons, VIZ., monsoon, winter and summer of 2008-2009. All the samples were collected in dilute acid washed polythene bottles. The samples were brought to the laboratory on the day of collection and were analyzed for pH and electrical conductivity. Thereafter the samples were acidified to pH 2 with analytical grade HNO_3 and stored at 4C for further analysis.

Table 1. Seasonal variation of Gotakanapura Lake water during 2008-2009.

	Parameters	Units	Monsoon	Winter	Summer
1	pH	-	7.50	7.64	7.65
2	EC	d S/M	0.047	0.054	0.062
3	BOD	mg/l	7.50	9.50	9.87
4	COD	mg/l	28.8	29.00	30.00
5	Carbonate (CO_3)	mg/l	7.22	8.80	9.50
6	Bicarbonate (HCO_3)	mg/l	269.5	290.8	293.8

Results and Discussion

The seasonal variations of selected rural and urban lakes are given in Tables 1—4.

pH

The pH represents the effective concentration (activity) of hydrogen ions (H +). In the present study pH of all the rural and urban lakes like Gotakanapura, maximum was recorded as 7.65 in summer season and minimum was recorded as 7.5 in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 7.6 in summer season and minimum was recorded as 7.45 in monsoon season (Table 2). In Hebbal Lake, the maximum was recorded as 7.8 in summer season and minimum was recorded as 7.27 in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 8.1 in summer season and minimum was recorded as 7.3 in monsoon season (Table 4).

The rural lake pollution was due to intensive ag-

Table 2. Seasonal variation of Muduganukunte Lake water during 2008-2009.

	Parameters	Units	Monsoon	Winter	Summer
1	pH	-	7.45	7.53	7.60
2	EC	d S/m	0.03	0.033	0.04
3	BOD	mg/l	6.90	7.67	9.40
4	COD	mg/l	25.20	26.60	27.60
5	Carbonate (CO_3)	mg/l	7.20	7.50	11.27
6	Bicarbonate (HCO_3)	mg/	281.0	282.8	285.4

Table 3. Seasonal variation of Hebbal Lake water during 2008-2009.

	Parameters	Units	Monsoon	Winter	Summer
1	pH	-	7.27	7.68	7.80
2	EC	d S/m	0.80	0.84	0.89
3	BOD	mg/l	10.90	27.03	36.70
4	COD	mg/l	130.94	109.70	160.0
5	Carbonate (CO_3)	mg/l	6.93	7.82	11.45
6	Bicarbonate (HCO_3)	mg/l	321.8	323.87	331.3

Table 4. Seasonal variation of Puttenahalli Lake water during 2008-2009.

	Parameters	Units	Monsoon	Winter	Summer
1	pH	-	7.3	7.62	8.10
2	EC	d S/m	0.33	0.58	1.16
3	BOD	mg/l	13.00	28.5	39.5
4	COD	mg/l	128.13	129.9	162.15
5	Carbonate (CO_3)	mg/l	8.81	10.85	16.17
6	Bicarbonate (HCO_3)	mg/l	360.7	389.6	388.6

riculture practices using heavy doses of NPK fertilizer in and around the lakes. Krishna Ram et al. (6) noted that the pH range of 6.7 to 8.4 is considered to be safe for aquatic life and to maintain productivity. However, pH below 4.0 and above 9.6 was hazardous to most of life forms. Results revealed that the urban lakes recorded more pH than the rural lake water because of pollutants such as domestic and industrial effluents entering the water body. Dash et al. (3), reported that the pH gives an idea of the type and intensity of pollution, which influences aquatic production in rural areas.

Electrical Conductivity

EC is a numerical expression of the ability of an aqueous solution to conduct electric current. This ability depends on the presence of ions, their total concentration, mobility, valence and relative concentrations. Value expressed in desi siemens per meter. In Gotakanapura Lake, maximum was recorded as 0.062 dS/m in summer season and minimum was recorded as 0.047 dS/m in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 0.04 dS/m in summer season and minimum was recorded as 0.03 dS/m in monsoon season (Table 2). In Hebbal Lake, the maximum was recorded as 0.89 dS/m in summer season and minimum was recorded as 0.8 dS/m in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 1.16 dS/m in summer season and minimum was recorded as 0.33 dS/m in monsoon season (Table 4).

The urban lakes showed higher EC than the rural lakes. This was mainly due to, presence of higher quantity of dissolved solids, greater the amount of ions in urban and rural lake water and discharge of domestic and industrial effluents to the lake water. It also contains large quantities of suspended inorganic wastes and dissolved materials including heavy metals. These results corroborated with the findings of Krishna Ram et al. (7) who reported that high levels of conductivity indicate pollution status and tropic levels of the aquatic body. Krishna Ram et al. (8) noted that the conductivity of the common bicarbonate type of lake water is closely proportional to concentration of the major ions.

Biochemical Oxygen Demand (BOD)

BOD refers to the quantity of oxygen required to oxidize organic matter present in water. Expressed in mg/liter, in Gotakanapura Lake, maximum was recorded as 9.87 mg/l in summer season and minimum was recorded as 7.5 mg/l in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 9.4 mg/l in winter season and minimum was recorded as 6.9 mg/l in monsoon season (Table 2). In Hebbal Lake, the maximum was recorded as 36.7 mg/l in summer season and minimum was recorded as 10.9 mg/l in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 39.5 mg/l in summer and minimum was recorded as 13.0 mg/l in monsoon season (Table 4).

BOD values of 9.87 and 39.50 mg/l were recorded during summer season in Gotakanapura (rural lake) and Puttenahalli (urban lake) this was comparatively higher than other seasons. The urban lakes recorded higher BOD as compared to rural lakes. The higher BOD value of rural and urban lake was because of chemical substance entering into the lake (from agricultural wastes and cloth washing). Similar results were observed by Anitha Devi and Singaracharya (9). According to them the pollutants entering the water body mainly constitute treated and untreated domestic and industrial effluents which have rendered the water frothy foul smelling and turbid.

Chemical Oxygen Demand (COD)

COD measures the oxygen equivalent of the organic and inorganic matter in a water sample that is susceptible to oxidation. Too much organic matter addition to the lentic and lotic systems increases the level of COD and changes the composition of oxygen requiring organisms. Expressed in mg/liter, in Gotakanapura Lake, maximum was recorded as 30 mg/l in summer season and minimum was recorded as 28.8 mg/l in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 27.6 mg/l in winter season and minimum was recorded as 25.2 mg/l in monsoon season (Table 2). In Hebbal Lake, the maximum was recorded as 160 mg/l in summer season and minimum was recorded as 130.64 mg/l in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 162.15 mg/l in summer season and minimum was recorded as 128.13 mg/l in monsoon season (Table 4).

Urban lakes recorded higher COD during three seasons as compared to rural lake. This was mainly due to different human activities in and around the lake and subsequent consequences on degradation of lake structure. The variation in the organic matter in turn, changes the COD levels in the autotrophic and heterotrophic populations and decreases the productivity status. The energy budgets of the aquatic bodies are also directly related to the levels of chemical oxidation in prescribed periods. Similar results were reported by Anitha Devi and Singaracharya (9), who described that COD is a reliable comparison among several major and minor lakes relating to COD levels and concluded that all the minor lakes are highly eutrophicates, while major lakes are oligotrophic. Ravi Kumar et al. (10) and Krishna Ram et al. (8) opined that a continuous monitoring of lakes were necessary so that the direct disposal of organic matter into the lakes could be strictly prohibited.

Carbonate (CO_3)

Carbonate alkalinity is a measure of the buffering capacity of water or the capacity of bases to neutralize acids. Alkalinity is important in determining the lakes ability to neutralize acidic pollution from rainfall. Expressed in mg/liter, in Gotakanapura Lake, maximum was recorded as 9.5 mg/l in summer season and minimum was recorded as 7.22 mg/l in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 11.27 mg/l in winter season and minimum was recorded as 7.2 mg/l in monsoon season (Table 2). In Hebbal Lake, the maximum was recorded as 11.45 mg/l in summer season and minimum was recorded as 6.93 mg/l in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 16.17 mg/l in summer season and minimum was recorded as 8.81 mg/l in monsoon season (Table 4).

Alkalinity was favored by summer season in both rural and urban lakes. However, maximum carbonate value of (11.27 mg/l and 16.17 mg/l0 was recorded in Muduganukunte Lake (rural) and Puttenahalli Lake (urban) respectively. Urban lakes were found to be more alkaline compared to rural lakes. This was mainly due to rapid decomposition of organic matter which in turn liberates carbon-di-oxide which reacts with water to form carbonate in summer. The results corroborate the findings of Krishna Ram et al. (11) and Krishna Ram et al. (8).

Bicarbonate (HCO_3)

In general term pH above 8.3 alkalinity is mostly in the form of carbonate and below 8.3 alkalinity as bicarbonate. Expressed in mg/liter, in Gotakanapura Lake, maximum was recorded as 293.8 mg/liter in summer season and minimum was recorded as 269.5 mg/liter in monsoon season (Table 1). In Muduganukunte Lake, the maximum was recorded as 285.4 mg/liter in winter season and minimum was recorded as 281 mg/liter in monson season (Table 2). In Hebbal Lake, the maximum was recorded as 331.3 mg/liter in summer season and minimum was recorded as 321.8 mg/liter in monsoon season (Table 3). In Puttenahalli Lake, the maximum was recorded as 388.6 mg/liter in summer season and minimum was recorded as 360.7 mg/liter in monsoon season (Table 4).

Among rural and urban lakes Gotakanapura (293.8 mg/liter) and Puttenahalli lakes (388.6 mg/liter were recorded higher value of bicarbonate during summer season as compared to other season. However results showed that high bicarbonate was recorded in urban lakes in all the seasons as compared to rural lakes.These results were mainly attributed to increased rate of evaporation and decomposition which in turn liberated carbon-di-oxide which reacts with

water to form bicarbonate, and was favored by summer. Results were in accordance with those of Rathore and Puttaswami (12) and Krishna Ram et al. (8) who reported maximum bicarbonate during summer season.

Conclusion

On the basis of values of water quality parameters, its clearly found that both urban and rural lakes were polluted beyond acceptable levels. However, urban lakes (Hebbal and Puttenahalli) have recorded higher levels of pollutants compared to rural lakes (Gotakanapura and Muduganukunte). This may be due to, constant flow of domestic, industrial effluents and sewage water to the urban lakes. Raise in pollutant load in both rural and urban lakes is alarming. The periodic monitoring and preventive measures are requiring to save the lakes from pollution.

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