Water Quality Indices and Plankton Diversity in Two Lakes of Mysore City

Swetha D[1] Dr. Udayashankara T.H[2]
[1]P.G Scholar [2]Professor
[1,2]Department of Environmental Engineering
[1,2]SJ college of Engineering, Mysore -570006

Abstract— The water quality index is a single number that expresses the quality of water by integrating the water quality variables. Its purpose is to provide a simple and concise method for expressing the water quality for different usage. The present work deals with the monitoring of variation of seasonal water quality index of some strategically selected surface water bodies. The index improves the comprehension of general water quality issues, communicates water quality status and illustrates the need for and the effectiveness of protective practices. The study deals with physico-chemical properties of Hebbal and Lingambudi lakes of Mysuru city and its impact on phytoplankton population. Several limnological parameters were evaluated during the period from December 2014 to July 2015 from four sampling stations sited along both lakes of Hebbal and Lingambudi. In order for the policy makers and general public to understand the extent of pollution in these lakes, water quality indices have been formulated. In this study, water quality indices which have been used are Canadian Council of Ministers of Environment (CCME) and National Sanitation Foundation (NSF). CCME provides information on quality for all designated purposes of a lake, while NSF provides the quality level, if the lake is being used, or is to be used for drinking purposes. The physical parameters included were temperature, turbidity and chemical parameters included were pH, temperature, dissolved oxygen, BOD, COD, nitrate, phosphate . A total 20 species were observed during the study period, maximum number of sp observed were in the Lingambudi lake i.e. 20 sp. There were 5 species observed from the class Chlorophyceae, 7 species of the class Cynophyceae, 8 of the class Bacillariophyceae,. The Microcystis species was observed in Lingambudi Lake indicates the signs of eutrophication of lake. The physico-chemical parameters such as nitrates, phosphate, temperature and TSS are favorable for the growth of phytoplankton. Maximum species of the class Bacillariophyceae were observed during study period.

Key words: Eutrophication, Physico-Chemical, Lakes, Phytoplankton

I. INTRODUCTION

Along with the pressures from direct consumption and use of water by humans, freshwater face many stress related factors which enhance degrading process in the form of pollution from point and non point sources. These factors increase in spatial scale by cumulative impacts and enhanced anthropogenic activities in the water body. Along with these pressures it is not only difficult to protect and maintain the diverse biota of fresh water but also to conserve the water resources of lakes. Regular environmental monitoring allows detection, assessment and management of the negative effects on fresh water ecosystems (Karthick, 2010). Fresh water ecosystems vary in size and composition and contain a wide range of organisms, which interact with each other and with the environment. The dynamic and heterogeneous relationship gains varied physical, chemical and biological elements in the aquatic ecosystem, which can be recorded by regular monitoring to maintain the integrity and conserve the ecosystem (Ramachandran et al., 2002). Biological

Monitoring, especially species richness will allow detection of disturbances that might otherwise be missed (Eckhout et al., 1996). Bioindicators can be evaluated through their presence or absence, reproductive success, community structure and function (trophic state) (Hellawell, 1986, Landres et al., 1998). Biological indicators are sensitive to nutrient concentration changes (Pan et al., 1996) and robust statistical and multi unit procedures can be used to analyze assemblages of data (Dixit et al., 1992). In an era of human impact on natural ecosystem a major challenge for ecosystems is to understand the structure and dynamics of biological communities in relation to environmental variability (Gaston and Blackburn 2000). Community diversity and the population abundance of species are controlled by immediate environment (Ricklefs, 1987; Kotliar and Wiens, 1990; Levins, 1992 and Wiens et al.1993). During an extensive survey of lakes of Mysuru city, great fluctuation in water quality variables and the distribution of algae were recorded. In Hebbal and Lingambudi lake 9 physico-chemical and 4 algal groups were analyzed. In order to trace relationship between the variables the data was subjected to statistical analysis. Water quality programmes involved in traditional physicochemical measurements for assessing nutrients are an important guide for monitoring environmental changes. The Canadian Council of Ministers of the Environment (CCME) and NSF (National sanitation Foundation Water Quality Index) was designed to evaluate surface water quality for the purpose of protecting aquatic life aided with specific guidelines. The number of parameters to be measured can be determined by the water quality monitoring agency. The sampling protocol requires at least four parameters sampled at least four times. The finding must reflect the water quality in a given water area as accurately as possible. Water quality guidelines are numerical values that define physical, chemical or biological characteristics of the water that cannot be exceeded without causing harmful effect (CEQG, 1999). The indices are among the most effective ways to communicate the information on water quality trends to the general public and in water quality management. In the present study an attempt has been made to assess the surface water quality of Hebbal and Lingambudi lake, a major lake of Mysuru city. This paper explores the insights for bio assessment and ecological studies, focusing on the physical, chemical and algal communities in Hebbal and Lingambudi lake at Mysuru city.

II. MATERIALS AND METHODS

A. *Study Area*

Hebbal lake is situated at latitude of 12° 21′31.32″N, longitude of 76° 36′ 42.20″E and elevation of 2463ft. it is located about 6 Km away from Mysore city. The Shape of the lake is irregular. The source of water to lake is rain water and industrial effluents. Anthropogenic activities are found and large numbers of industries are situated around the lake.

The geographical location of Lingambudi Lake is situtated at Latitude12° 16' 20" N Longitude 76° 31'E. It is a perennial freshwater lake situated in the basin of River Cauvery. The lake was serving as a source of drinking water, irrigation, and fish produce. It spread over 217 acres. The Domestic sewage from the surrounding areas has become a common source of water.

Surface water samples were collected from the Hebbal an Lingambudi lake during the period from December 2014 to July 2015 and analysed for 9 water quality parameters following the standard methods (APHA,1995). The water chemistry variables analysed are pH, water temperature, total suspended solids, turbidity, Dissolved Carbon-di-oxide, Dissolved Oxygen, Chemical Oxygen Demand, Nitrate, Phosphate and Biochemical Oxygen Demand. Collection, preservation, identification and enumeration of phytoplankton have been done as per the methods described by APHA 2005. Four samples per lake, one upstream, middle at two points and down stream were collected and analysed.

MONTH	DEC	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY
PARAMETER								
pH	7.43	7.9	8.3	8.4	7.9	7.8	8.7	8.5
NITRATE(mg/l)	0.27	0.083	0.0650	0.047	0.2135	0.0362	0.285	0.24
PHOSPHATE(mg/l)	0.0177	0.0158	0.0162	0.0380	0.0148	0.0193	0.0194	0.0167
TURBITIDITY(NTU)	39.25	37.75	8.82	40.03	22.87	21.75	17.78	18.16
TSS(mg/l)	128.5	104.75	95.62	142.37	92.25	90.25	46.78	44.15
COD(mg/l)	85.32	82.56	87.05	88.92	92.22	79.83	91.03	87.91
DO(mg/l)	0.84	1.14	0.708	0.69	0.69	0.13	1.6	1.61
BOD(mg/l)	2.83	2.88	2.56	3.01	3.02	1.83	2.47	2.35
CHLOROPHYLL-a(μg/L)	0.28	0.38	1.2	0.8	0.41	0.99	0.74	0.29

Table 1: Characteristics of Physico-chemical parameters of Hebbal Lake (December 2014- july 2015).

MONTH	**DEC**	**JAN**	**FEB**	**MAR**	**APRIL**	**MAY**	**JUNE**	**JULY**
PARAMETER								
pH	8.02	7.56	8.61	8.56	7.43	7.38	8.67	8.45
NITRATE(mg/l)	0.0891	0.0972	0.1841	0.1837	0.1890	0.1585	0.2575	0.2345
PHOSPHATE(mg/l)	0.2057	0.1430	0.142	0.139	0.163	0.115	0.148	0.129
TURBITIDITY(NTU)	219.5	218	228.2	210.5	227.75	215.2	212.2	199
TSS(mg/l)	322	298.37	301.74	262.25	284.12	284.87	282.5	268
COD(mg/l)	97.92	97.36	105.8	97.27	105.12	95.5	93.27	92
DO(mg/l)	2.72	2.72	2.92	3.01	2.72	2.14	2.42	2.55
BOD(mg/l)	5.58	5.60	5.45	5.55	5.78	5.38	5.10	5
CHLOROPHYLL-a(μg/L)	7.9	6.9	9.3	37.3	30	20.09	26.67	27.80

Table 2: Characteristics of Physico-chemical parameters of LingambudiLake (December 2014- july 2015).

MONTH	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**
PHYTO PLANKTON							
BACILLARIOPHYCEAE							
Nitzschia raiosa	100	50	55	60	80	100	90
Nitzschia obtusa	150	55	60	70	75	110	100
Syndera ulna	800	200	200	100	120	150	100
Amphiplrura sp	300	100	90	80	65	110	100
Cymbella cymbiformis	100	85	70	100	150	110	95
CYANOPHYCEAE							
Oscillatoria protrida	0	300	200	100	150	200	100
Oscillatoria amphibia	0	280	180	110	165	180	100
Oscillatoria subbrrevis	0	250	260	150	130	160	110
Merismopedia elegans	100	150	100	100	200	200	150
Merismopedia tenussima lemermanin	100	135	100	100	200	180	140
Glococapsa minuta	100	150	160	200	250	350	280
Navicula rhomboidus	100	200	150	250	300	300	180
Ananbena macrospora	200	150	170	200	250	250	200
Ananbena circularis	150	135	150	175	200	230	190
CHLOROPHYCEAE							

Cymbella aspera	100	150	200	250	180	170	160
Chromolina ovalis	120	135	170	210	230	200	180
Closterium strigosum	170	185	160	170	200	210	230
Closterium turpini	175	185	160	170	185	195	200
Pediastrum duplex	200	180	150	200	250	210	190
Scenedesmus dimorphus	70	150	170	200	250	190	175

Table 3: Analysis of Phytoplankton's in Hebbal Lake

MONTH	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**
PHYTO PLANKTON							
BACILLARIOPHYCEAE							
Navicula rhomboidus	90	100	250	300	250	150	200
Navicula anglica	80	95	180	270	240	110	180
Syndera ulna	20	50	60	100	110	160	180
Synedra acus	25	45	50	130	90	150	200
Gomphonema gracela	100	120	110	160	150	180	200
Amphiplrura sp	80	90	70	80	65	90	100
Gyrosigma sp	100	110	140	180	175	200	350
Nitzschia obtusa	50	60	70	90	180	140	200
CYANOPHYCEAE							
Oscillatoria subbrevis	20	55	80	125	180	135	200
Oscillatora putrid	30	60	70	100	160	170	210
Spirulina sp	100	110	90	70	100	120	100
nostoc	100	150	125	135	150	200	210
Microcystis aeruginosa	200	200	250	350	360	370	350
Microcystis crassa	150	180	260	270	290	350	280
Lepocinclis ovum	75	100	90	100	135	120	110
CHLOROPHYCEAE							
Cholorococcus bijugatus	200	210	140	200	180	200	170
Eudorina sp	50	75	90	110	120	160	130
Scenedesmus bijugatus	200	180	160	150	180	200	180
Eunotia monodon	40	35	65	80	95	120	135
Spirogyra	65	75	100	120	130	180	200

Table 4: Analysis of Phytoplankton's in Lingambudi Lake

The water Quality Index (WQI) using the above parameters were calculated by feeding the data to CCME-WQI software -1.0. The index involves scope (F1), the number of parameters that are not compliance with water quality guidelines; frequency (F2), number of times that the guidelines are not respected and amplitude (F3), the difference between non compliance measurements and the corresponding guidelines. The square of each term and the square root of the sum are divided by 1.732, which is based on the fact that each of the three factors contributing to the index can reach a value of 100. The final value is subtracted from 100. The index produces values from 0-100 and based on the values the water quality index is characterized as shown in Table1and 2. Standard values of WHO and ISI are used for calculation of WQI.

Rating	**CCME-WQI**	**Characterization of the water**
Excellent	95.0-100	Water quality intact, conditions close to natural levels
Good	80.0-94.9	Water quality is protected with only a minor degree of threat or impairment, conditions rarely depart from natural desirable levels
Fair	65.0-79.9	Water quality usually intact,but occasionally endangered, conditions often deviate from natural levels
Marginal	45.0-64.9	Water quality frequently endangered, conditions very often deviate from natural levels
Poor	0.0-44.9	Water quality almost always endangered, conditions regularly deviate from normal levels.

Table 5: Characterization of the water Quality Index (CCME-WQI, 1991)

III. NSFWQI

Water quality index (WQI) is a number to express the overall water quality of a certain location and transforms the complex physico chemical parameters into information that is usable and understandable by general public. It is one of the most effective tools to communicate the water quality information between policy makers and general public. National Sanitation Foundation Water Quality Index (NSFWQI) of USA is one of the most acceptable and convenient WQI, proposed by Horton in 1965. The NSFWQI, which is used for the assessment of water quality of Hebbal and Lingambudi Lake, is expressed as following equation:

$$WQI = \sum_{i}^{n} = W_i Q_i$$

Where Qi: Sub index for ith water quality parameter;
Wi: Weight associated with water quality parameter;
n: Number of water quality parameters**.**

90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very Bad

Table 6: Water quality index rating of lakes

IV. RESULTS AND DISCUSSIONS

Data Summary	**Over all**	**Aqua tic**	**Recreat ion**	**drinki ng**	**Livesto ck**
CWQI	38	37	3	30	100
Categoriza tion	**Poor**	**Poor**	**Poor**	**Poor**	**Excelle nt**
F1(Scope)	33	50	100	50	0
F2 (Frequenc y)	33	50	100	50	0
F3 (Amplitud e)	97	83	91	98	0

Table 7: Calculated Values of CCME WQI for Hebbal Lake

Data Summary	**Over all**	**Aqua tic**	**Recreat ion**	**Livesto ck**	**drinki ng**
CWQI	38	37	3	100	30
Categoriza tion	**Poor**	**Poor**	**Poor**	**Excelle nt**	**Poor**
F1(Scope)	33	50	100	0	50
F2 (Frequenc y)	33	50	100	0	50
F3 (Amplitud e)	97	83	91	0	98

Table 8: L Calculated Values of CCME WQI for Lingambudi Lake

The CCME Water quality index for lakes of Mysuru has been studied by Hosmani et al., (2011) The Canadian Water Quality Index for Hebbal lake and Lingambudi lake for various purposes indicates that it is poor for overall purpose,drinking, aquatic and recreation with index values ranging between a minimum of 3 for recreation in both lakes, 37 for aquatic.The index is 100 for livestock indicating an excellent quality. The number of variables tested for the overall quality was 9 out of which 5 did not meet the requirements. Similarly 7 were tested for drinking water among which 3 were failures. 3 for aquatic out of which 2 failed. 1 for recreation and there was a failure and no failures among the 2 tested for irrigation and 2 out of 4 failed to meet live stock requirements. Parameters of failing data were TSS for overall, drinking and livestock, TSS being very low in all cases. Salinity for overall and drinking, Turbidity for overall and aquatic. Maximum parameters of failing data were TSS, Salinity. Parameters of passing the test were pH in all cases, turbidity in two instances ie., overall and aquatic, TSS in overall, drinking and livestock, nitrate in overall, irrigation and drinking, Phosphate in overall, drinking, aquatic , irrigation and livestock.

Survey	**Hebbal Lake**		**Linggambudi Lake**	
	Water Quality Index	**Water Quality Rating**	**Water Quality Index**	**Water Quality Rating**
1	40.97	BAD	30.91	BAD
2	40.80	BAD	32.29	BAD
3	42.50	BAD	30.07	BAD
4	38.97	BAD	30.26	BAD
5	41.43	BAD	31.89	BAD
6	42.61	BAD	32.79	BAD
7	46.48	BAD	29.97	BAD
8	40.70	BAD	31.01	BAD

Table 9: Calculated Values of NSF WQI

The calculated values of the NSF WQI Hebbal and Lingambudi lakes are presented in Table 9 respectively. According to the NSF WQI, both Hebbal and Lingambudi lakes lakes are rated as bad. In Hebbal Lake, the water quality has been maximum rated 'bad' in the months of June and minimum rated in the month of March while it has been rated 'bad' during the rest of the sampling period. In Lingambudi Lake, the water quality remained 'bad' throughout the sampling period. The deteriorating water quality trend from January onwards was may be due to the low flow conditions accompanied by high rate of organic decomposition.

V. DIVERSITY INDICES

The diversity indices were calculated using the PAST (Hammer *et al*., 2001) software program. The diversity index includes ten different indices. However, only three indices namely; Dominance index, Shannon's diversity index and Buzas and Gibson's evenness index were considered since they were more appropriate for the present study. The results of diversity indices for Hebbal and Lingambudi lakes are presented in Table 10and 11 respectively.

The values of dominance, diversity, evenness and simpson indices varied between a maximum of 0.1 during January and a minimum of 0.05 during june, a minimum of 0.891 during January and a maximum of 0.9 during June and a minimum of 0.76 during January and a maximum of 0.95 during June and minimum of 0.93 in the month of January to maximum of 0.944 in the month of June in Hebbel Lake and a minimum of 0.05 during June and a maximum of 0.069 during January, a minimum of 2.808 during January and a maximum of 2.93 during June and a minimum of 0.82 during January and a maximum of 0.94 during June minimum of 0.89 in the month of January to maximum of 0.949 in the month of June in Lingmabudi Lake.

The reason for high value of dominance in the month of January in Hebbal Lake was the occurrence of bloom of the specie *Syndera ulna* (Refer Table 4.4) which suppressed the growth of other species. In Lingmabudi Lake, the reason for high value of dominance index in January was due to the dominance of Cyanophyceae and Bacillariophyceae. The results of dominance index and Shannon's diversity index were in line with each other in both the lakes since diversity of species was high when dominance was low and vice versa.

However, according to the results the diversity and evenness of species were relatively high in Lingmabudi Lake while diversity and evenness were low and dominance of species was high in Lingmabudi Lake which may be due to the dominance of *Microcystis aeruginosa*, since high dominance results in low diversity.

0	JAN	FEB	MAR	APR	MAY	JUNE	JULY
Taxa_S	17	20	20	20	20	20	20
Individuals	3035	3225	2955	2995	3630	3805	3070
Dominance_D	0.109	0.05785	0.05619	0.05764	0.05611	0.05514	0.05579
Simpson_1-D	0.891	0.9422	0.9438	0.9424	0.9439	0.9449	0.9442
Shannon_H	2.564	2.915	2.929	2.917	2.929	2.946	2.939
Evenness_e^H/S	0.7637	0.9222	0.9354	0.9244	0.9359	0.9512	0.9448

Table 10: Diversity Indices of Hebbal Lake

0	JAN	FEB	MAR	APR	MAY	JUNE	JULY
Taxa_S	20	20	20	20	20	20	20
Individuals	1740	2040	2450	3120	3340	3505	3885
Dominance_D	0.06916	0.06073	0.06385	0.06285	0.05895	0.05784	0.05598
Simpson_1-D	0.9308	0.9393	0.9362	0.9371	0.9411	0.9422	0.944
Shannon_H	2.808	2.89	2.87	2.88	2.912	2.928	2.939
Evenness_e^H/S	0.8286	0.8998	0.8817	0.8904	0.9199	0.9342	0.9445

Table 11: Diversity Indices of Lingambudi Lake

VI. CONCLUSIONS

Looking at the importance of the Hebbal and Lingambudi Lake, the water quality and biodiversity is studied for the assessment of lake water quality. The results indicated from that NSFWQI and CCME water quality is almost always endangered conditions.(eutrophic and hypo eutropic). Through NSFWQI and SDI, it can also be concluded that physicochemical and biological characteristic of Hebbal and Lingambudi lake water shows sign of further improvement somewhere between summer and monsoon. The Naviculla Species is found to be dominant among the investigated phytoplankton genera and has great impact on the lake water quality. Further, it is suggested to do an extensive study of Naviculla Species in summer and monsoon for further improvement of lake water quality in future.

ACKNOWLEDGEMENT

P.G scholar expresses their profound gratitude to Dr. shankar P. Hosmani Head of Biotechnology Department, SBRR college, Mysuru.

REFERENCES

[1] Udayashankara T.H, Anitha K.G, "Study of water quality and dynamic analysis of phytoplanktons in four freshwater lakes of Mysore, India" International Journal of Innovative Research in Science, Engineering and Technology vol. 2, July 2013.
[2] Shankar.P. Hosmani, T.B. Mruthunjaya "Impact of plankton diversity on the water quality index in a lake at Thirumakudal Narasipura Mysore district" International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, May 2013.
[3] Dr.Shankar hosmani "freshwater plankton ecology: a review" Abhinav International Monthly Refereed Journal of Research in Management & Technology, Volume 3, August, 2014.
[4] T. Rajagopal, A. Thangamani and G. Archunan "Comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu", Journal of Environmental Biology, vol 31(5) , 2010.
[5] Shankar P. Hosmani, Phytoplankton Diversity in Lakes of Mysore District, Karnataka, India, The Ecoscan, Vol. 4(1): 53-57, 2010.
[6] Shankar P. Hosmani, Nestedness Patterns Of Freshwater Diatom Assemblages In Lakes Of Mysore Online International Interdisciplinary Research Journal, Vol. 1(2) 2011.