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Assessment of Trophic State of Lakes in Terms of Carlson's Trophic State Index

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ABSTRACT: The present work has been carried out in pre-monsoon and post-monsoon from December 2013 to May 2014 to determine the trophic State of five lakes of Haveri town using Carlson Trophic State Index (CTSI) which uses minimum data like Secchi Disk Depth (SDD),Chlorophyll-a (Chlo-a) and Total Phosphorous (TP) and provides information of these data in a single number. The CTSI value ranges from 0 to 100, the higher the score the higher will be the productivity. The present study reveals that Akkamahadevi (AK), Neharuhalankere (NHK) and Heggere(HG) lakes are moderately eutrophic followed by Dundibasaweshwar (DB) and Mullankere (MK) lakes are highly eutrophic because of discharge of untreated sewage.

KEY WORDS-Carlson Trophic State Index (CTSI) ,Secchi Disk Depth (SDD) ,Chlorophyll(Chlo-a) ,Total phosphorous (TP),Eutrophic.

I. INTRODUCTION

Lakes are considered to be as critical element in the hydrological cycle. Lakes are not only a significant source of precious water but also provide valuable habitats to the biological world [1]. Lakes are also known to recharge the ground water, channelize water flow to prevent water logging and flooding. Lakes are also host to a wide variety of flora and fauna, especially birds. Lakes can provide us with prime opportunities for recreation, tourism, and cottage or residential living [2].It needs to take an immediate attention to restore, conserve, manage and maintain the lakes as it is a precious part of the whole ecosystem and if ignored could be dangerous in the future. If there is a proper management and conservation plan the balance will be maintained between socio-economic and recreational use and ecological health of the lake.
Scientists have classified lakes on the basis of its trophic state. It is the state which defines how much nutrient does lake contains. It has been divided into three types-Oligotrophic, Mesotrophic and Eutrophic lake. Oligotrophic lakes are called as healthier lakes and considered to be well mineralized with transparency is good as well, Mesotrophic lakes are moderately enriched with nutrients, Eutrophic lakes are highly enriched with nutrients.

II.RELATED WORK

Robert E. Carlson [1977] has developed a numerical trophic state index for lakes that incorporates most lakes in a scale of 0 to 100. Each major division [10,20,30, etc] represents a doubling in algal biomass. The index number can be calculated from any of several parameters, including Secchi disk transparency, chlorophyll and total phosphorus

G.Panduranga Murthy explained that application of TSI to the lake under study reveals that Alanahalli lake,Dalvoi lake ,Devikere lake,Lingambudhi lake have an index above 60 and are considered to be hypereutrophic. There is a dominance of blue green algae,formation of algal scum's and extensive macrophytic problems.This can be overcome by removal of macrophytes and introduction of warm water fish.Mandakalli lake has an index of 47 (mesotrophic) where, the water is

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moderately clear,Karanji,Marase and varua lakes have an index ranging between 52 and 57.Here the lower boundary of lakes are classical eutrophic.Thus the trophic state state index (TSI) can sever as an important tool in conservation of lakes. M.Rajashekar and K.Vijaykumar have adopted various methods for classification of lakes and to indicate their trophic status. The most commonly and widely used method is based on productivity, while the frequently used biomass related trophic state index is that of Carlson (1977). Three variables like Chlorophyll pigments (CHL), Secchi's depth (SD) and Total Phosphorus (TP) were carried out in Sharanabasaveshwara Lake from February 2006 to January 2007. During the study period the Secchi's depth (SD) was recorded in the range of 0.4 to 0.6 meters where as Chlorophyll pigments (CHL) and Phosphate (P) were recorded between 79.2 µg/l to 305 µg/l, 198 µg/l to 337 µg /l. The trophic state index calculated by using TSI= TSI (TP) + TSI (CHL) + TSI (SD) / 3 formula. Seasonal changes of trophic state index were also observed. The lake was found to highly eutrophic condition.

III.MATERIALS AND METHODOLOGY

A . Study Area

Haveri is situated in the center of Karnataka, Haveri is the head quarter of Haveri District, which was declared as City Municipal Council on 05/12/2003 . It is situated along Pune Bangalore National Highway (NH4) , it is 335kms away from Bangalore by road and 394 Kms away by rail as well equidistant from Bidar in the far north to Kollegal in the far south.

Fig 1: Index map of the study Area

Status Of Lakes In Haveri

Akkamahadevi ,Dundibasaweshwar ,Mullankere ,Neharuhalankere and Heggere lakes are few among the many lakes in Haveri. Most of the lakes mentioned are man –made and are directly used as a source of domestic supply, some of them are used as reservoirs to conserve rainwater but human activities are responsible for the degradation of the lake as lake water is used for bathing and washing clothes, during washing large amount of detergents directly goes into the lake which increases the phosphate content of the lake water and becomes unfit for potable use.. As there is no Sewage- Treatment Plant (STP) in some areas so all the untreated wastes directly goes into the lake and changes the parameters of the lake,solid waste is also dumped close to the lakes,open defecation is also a common practice to the banks of the lake.The main conclusion is that majority of lakes in Haveri are becoming detrimental to humans day-by-day, it is a major concern for the local administrative bodies to look after the solution of the problems related to the lake otherwise it will have serious threat for the future.

B. Sampling and analyses

In present study lakes are monitored by using conventional method (i.e. samples were collected manually) for pre-monsoon and post-monsoon (Dec 2013 to May 2014). After conducting reconnaissance survey, sampling spots were chosen in lakes. Grab water samples were collected twice in every month between 8:00 am to 10:00 am in stopperd polyethylene bottle and transported to laboratory for the examination of water using standard methods as prescribed in American Public health association (APHA),American Water Works Association (AWWA).Water clarity is determined by using Secchi disk and the values are expressed in meters. The maximum depth at which the disc can be seen when lowered in to the water is

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marked and measured. Total phosphorus was analyzed by colorimetric method and Chlorophyll-a was estimated by Acetone method and measured using a spectrometer.

Fig 2: General view of Akkamahadevi Lake ,Haveri

Major problems of Akkamahadevi lake include the disposal of domestic wastewater from surrounding residential and commercial area, washing and bathing, wallowing of animals, and indiscriminate disposal of solid wastes.

Fig 3: General view of Dundibasaweshwar Lake ,Haveri

This lake is surrounded by the human habitation and it receives sewage and wastewater through number of unlined drains. The water quality of the lake is deteriorating on account of untreated sewage inflow, siltation, encroachment, excessive growth of weeds

Fig 4: General view of Mullankere lake

This lake is surrounded by human habitation and like other lakes it receives untreated sewage inflow and siltation, encroachment and weeds growth are the major constraints for the detoriation of water quality.

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Fig 5:General view of Neharuhalankere lake

This lake water is not suitable for drinking instead it is being used by large number of people living near or around the lake for daily needs of bathing, washing clothes & vehicle

Fig 6:General view Heggere lake

The water quality of this lake is deteriorating day by day by agricultural runoff, siltation, washing of clothes and vehicles and dumping of solid wastes.

Carlson Trophic State Index (CTSI) was calculated using the following formulae

a. Trophic State Index for Chlorophyll-a (TSI Chlo-a) = 9.81In Chlorophyll-a(µg/L)+30.6
b. Trophic State Index for for Secchi disk depth (TSI SDD) = 60-14.41In Secchi depth(meters)
c. Trophic State Index for for Total phosphorus (TSI TP) = 14.42 In Total phosphorous (mg/l) +4.15
where In is Natural logarithm.
Carlson's Trophic State Index (CTSI) = [TSI (TP)+TSI(CA)+TSI(SD)]/3
Based on the values of CTSI the lakes are classified as oligotrophic (low productive), mesotrophic (moderately productive) and eutrophic (highly productive). The range of the Carlson's trophic state index values and classification of lakes are presented in the Table:1

IV.RESULTS AND DISCUSSIONS

Carlson's Trophic State Index (CTSI) for each of the parameters and their attributes for five lakes over a period of two seasons are presented in the tables 2 and 3,present study revealed the fact that the CTSI values are lesser during post-monsoon and higher during pre-monsoon due to the effect of high temperature.

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TSI Values	Trophic Status	Attributes
< 30	Ologotrophic	Clear water, oxygen throughout the year in the hypolimnion
30-40	Oligotrophic	A lake will still exhibit oligotrophy, but some shallower lakes will become anoxic during the summer
40-50	Mesotrophic	Water moderately clear, but increasing probability of anoxia during the summer
50-60	Eutrophic	Lower boundary of classical eutrophy: Decreased transparency, warm-water fisheries only
60-70	Eutrophic	Dominance of blue-green algae, algal scum probable, extensive macrophyte problems
70-80	Eutrophic	Heavy algal blooms possible throughout the summer, often hypereutrophic
>80	Eutrophic	Algal scum, summer fish kills, few macrophytes

Table.1 : Classification of lakes based on CTSI values

The above table 1 indicates the range of the Carlson's trophic state index values and classification of lakes as per scale if the lake has CTSI value s are within 30 then it is oligotrophic lake ,if it is within the range of 30-40 then it is Mesotophic lake,if the values ranges between 40-80 0r above 80 then it is eutrophic lake. As the number increases the productivity increases.

LAKES	SD	CHLO-a	TP	TSI (SD)	TSI(Chlo-a)	TSI(TP)	AVG TSI
AK Lake	0.37	19.26	8.26	74.21	59.62	34.56	56.1
DB lake	0.13	142.54	4.73	89.5	79.25	26.3	65
MK lake	0.21	155.88	8.94	85.26	80.13	35.64	67
NHK lake	0.28	53.66	4.20	78.07	69.66	24.73	57.5
HG Lake	0.33	52.09	3.04	76.17	69.33	19.73	55.1

Table.2 : Carlson Trophic State Index values during pre-monsoon

LAKES	SD	CHLO-a	TP	TSI (SD)	TSI(Chlo-a)	TSI (TP)	AVG TSI
AK Lake	0.55	20.69	6.68	68.43	60.3	31.41	53.4
DB Lake	0.12	144.35	3.68	90.5	79.38	22.9	64.3
MK Lake	0.1	152.66	4.99	93.18	79.93	27.25	66.8
.NHK Lake	0.26	48.11	3.81	79.14	68.6	23.43	57.1
HG Lake	0.3	49.30	2.15	77.35	68.84	15.22	53.8

Table.3 : Carlson Trophic State Index values during post-monsoon

Table 2 and 3 are the values obtained during pre and post-monsoon.From the obtained results it is clear that the present status of Akkamahadevi, Neharuhaalankere and Heggere lakes are moderatly Eutrophic, which has features like lower boundary of classical eutrophy, decreased transparency and warm water fisheries only due to the problems like indiscriminate disposal of domestic waste water from surrounding residential and commercial area,washing,bathing and, wolwing of animals whereas other two lakes Mullankere and Dundibasaweshwar are highly eutrophic condition, this may be due to continuous inflow of nutrients from surroundings, which in turn enhances the growth of phytoplankton in the lakes. The enhanced growth and decay of planktons may lead the lake towards anoxic and high eutrophic condition. Hence further control measures have to take in order to use the water for domestic purposes.

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V.CONCLUSION

In view of growing pollution stresses in lakes, the TSI of a lake can be assessed using Carlson's Trophic State Index methods. It can be an easy measure of trophic condition where in biomass is involved. The index can be used as a teaching tool as change in plant biomass affects oxygen and fish species and possible effects on food chain and recreational potential. The results indicated that the lake has approached to eutrophic state and conservation measures like control of point sources and in lakes treatment methods should be implemented to revive the lake.It is essential to modify the lake according to the user and not simply making the water clear.

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