P: ISSN NO.: 2394-0344 RNI No.UPBIL/2016/67980 VOL-3* ISSUE-9*(Part-2) December- 2018
E: ISSN NO.: 2455-0817 Remarking An Analisation

Carlson's Trophic State Index (CTSI) Applied in the Water Quality Assessment of Hameer Pond, Kishangarh, Ajmer

Abstract

The present work is aimed to investigate trophic Status of Hameer pond using Carlson Trophic State Index (CTSI),which uses data like Secchi Disk Depth (SDD), Chlorophyll-a (Chl-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. Present study revealed the fact that the CTSI values are lesser during post monsoon (38.75 to 69.27) and higher during pre-monsoon (49.32 to 75.89) inspite of the fact that in summer environmental factors have a positive influence on eutrophication rate.

Keywords: Carlson Trophic State Index (CTSI), Secchi Disk Depth (SDD), Chlorophyll-A (Chl-a), Total Phosphorous (TP), Eutrophication.

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Introduction

'Water'- one of the "*five tatvas*", is the most important physical resource for all living beings (Pattanaik, 2015) and providing basis for social, cultural, political, economical and religious development. Fresh water bodies are very essential for existence of dynamic ecosystem contributing immensely in shaping and evolving the biotic and abiotic system. As a matter of fact water resources, one of the important life support system on the earth, cover about 70 percent of the planet, and glaciers ,ice-caps and clouds cover additional area(1.993%), but very limited quantity (0.00192%) is available and suitable for sustenance of fresh water dependent life (Sawyer et al. 1994,Kibona et al. 2009; Lui et al. 2011,Cassardo and Jones, 2011). On a global scale, total water quantity is not the problem; the main problem is of water availability in the right place at the right time in the right form. Although we as human recognize this fact, we disregard it by polluting our water resources. Subsequently, we are steadily ruining this wealth to the point where the sustenance of life becomes doubtful. If honestly speaking, every large body of water in world has been tainted and "polluted" by man's presence, in one way or another (Gleick, 1998).Stagnant water bodies have more complex and frail ecosystems in comparison to running water bodies as they lack self cleaning ability and hence, readily accumulate greater quantities of pollutants (Patel and Patel, 2012). That's why in order to combat water pollution; we must understand the problems and become part of the solution.

In India, sustainable and equitable use of water in the past has been ensured by cultural and social advocacy and adaptation to water availability through water conservation technologies, agricultural practices adapted to different climatic zones. But in last few decades, the consequences of population growth, progressive industrialization and urbanization, rehabilitation of arid areas, rising living standards, increasing food supply, drive for development and the associated consumerist culture have led to overuse, abuse and pollution of our vital water resources and disturbed the quality and the natural cleansing capacity of water.(Swaminathan and Manonmani, 1997 ,Ramakrishnaiah *et al*., 2009). Due to lack of community perception, irrational use, widespread negligence for conservation among various stakeholders, systematic encroachment of water bodies made them merely a dump yard for domestic and industrial waste. As comprehend the importance and scarcity of available freshwater planning, development, management and conservation of this most precious resource is necessary. To do so the materialization of concept of sustainable development is becoming the need of time. This concept implies development that meets the needs of present without compromising the ability of the future generations to meet their own needs. The sustainable development would ensure minimum adverse impacts on the quality of life supporting environmental entities in an integrated and environmentally sound frame considering the socio-economic arenas and needs of the society (Hardi et al. 1998). In the Ramsar Convention (2002), it was emphasized that wetlands should be the initial point for integrated water management strategies, since they are the source of fresh water, maintains the health of water course and water bodies, subsequently supply water to meet the human needs and are a key to future water security.

Therefore, characterization of physical, chemical and biological parameters serve as a good index in providing a comprehensive picture of the conditions prevailing in a water body (Mishra et al. 1999). As there is lack of consensus among different experts and end users regarding perceptions and interpretation of various parameters of water quality. Therefore it is necessary to translate water quality data in widely acceptable and unambiguous term. Water quality criteria that usually does not appear with definite conclusion is trophic status of the water body. Trophic state is the biological response for nutrient additions to the water bodies (Naumann, 1929). In traditional continuum of trophic status, which is a multidimensional aspect, there is no delineation among oligotrophy, mesotrophy and eutrophy (Beeton and Edmondson 1972). Hence, to understand the level of pollution and nutrient status of a water body, it is becoming necessary to not only analyze the physical, chemical and biological parameter but also to report these parameters in term of various indices. Carlson (1977) developed a Trophic State Index (TSI) which has goodness of these two approaches provide more complete and dynamic and consistent picture of nutrient status of water body. Carlson's trophic state index mainly uses algal biomass involving three variables namely chlorophyll-a (CA), Secchi disc depth (SD) and total phosphorus (TP). The Carlson's trophic state index for lakes incorporates lakes in a scale of 0 to 100. The average values of TSI of these three parameters will be considered in determining the Carlson's trophic state index. This index is widely used as an important tool in conservation of lakes and to assess trophic status monitoring. Therefore present study is carried out to achieve trophic status of Hameer pond by using Carlson's trophic state index.

Review of Literature

Sandeep (2008) used Carlson's Trophic Index and found that TSI is an important tool to measure trophic state where biomass is involved.

Elmaci et al. (2009) studied Uluabat Lake in Turkey (a Ramsar site) and revealed the eutrophication of the lake on the basis of Carlson's trophic state index values, based on TP, SD and Chl-a. They also suggested that phosphorus was the limiting nutrient in lake water.

Sharma, M. P., et al. (2010) studied Mansi Ganga Lake in Mathura to review the work done on the development of TSI for assessment of trophic state of lakes and applicability of most important TSI methods for Indian lakes and found that the lake was oligotrophic to mesotrophic in the study period showed increase in pollution.

G. Devi Prasad and Siddaraju (2012) studied two lakes of Mandya using Carlson's Trophic State Index (CTSI) and found CTSI of these lakes ranged between 35-53 indicated that they were mesotrophic in study period.

Upadhyay et al. (2013) studied Upper Lake, Bhopal using Palmer pollution index and found total index value of 27 indicated eutrophy of the lake due to high nutrient intake.

Keshre and Mudgal (2013) studied trophic status of Moghat Reservoir at Khandwa (MP) and found absence of volvocales as an indicator of mesotrophic status of the lake.

Ramesh and Krishnaiah (2014) studied Bellandur Lake of Bangalore using Carlson's Trophic State Index and found that the lake score 85, which indicated hypertrophic state of the Lake.

Manderia et al. (2014) evaluated the water quality status of Anchar Lake, Kashmir and found nutrient enrichment of the lake was due to anthropogenic pressure, siltation and the effluent released from Sheri-Kashmir Institute of Medical Sciences (SKIMS).

Jindal, R., et al. (2014) studied Prashar Lake, in Himachal Pradesh using CTSI and found Prashar Lake was oligotrophic with TSI values from 17.085 to 14.57 during study period.

Deepa N.Barki, Pradeepkumar Singa (2014) studied five lakes of Haveri town using Carlson Trophic State Index (CTSI) and found lessor CTSI in Akkamahadevi (AK), Neharuhalankere (NHK) and Heggere(HG) lakes and revealed that Dundibasaweshwar (DB) and Mullankere (MK) lakes were highly eutrophic because of discharge of untreated sewage.

Deshmukh and Tarar (2015) studied trophic status of the freshwater resources of the Bhandara District of the central India and found that majority of lakes in the Bhandara District face severe nutrient pollution and are at risk of becoming Eutrophic in near future.

Fuller and Jodoin (2016) studied more than 11,000 inland lakes of Michigan (U.S.) for 15 year estimated Trophic State Index (eTSI) and found that Southern Michigan/Northern Indiana Drift Plains eco-region also had predominantly mesotrophic class lakes, but had a higher percentage of eutrophic lakes and fewer oligotrophic lakes than the Northern Lakes and Forests and North Central Hardwood Forests ecoregions of Michigan state.

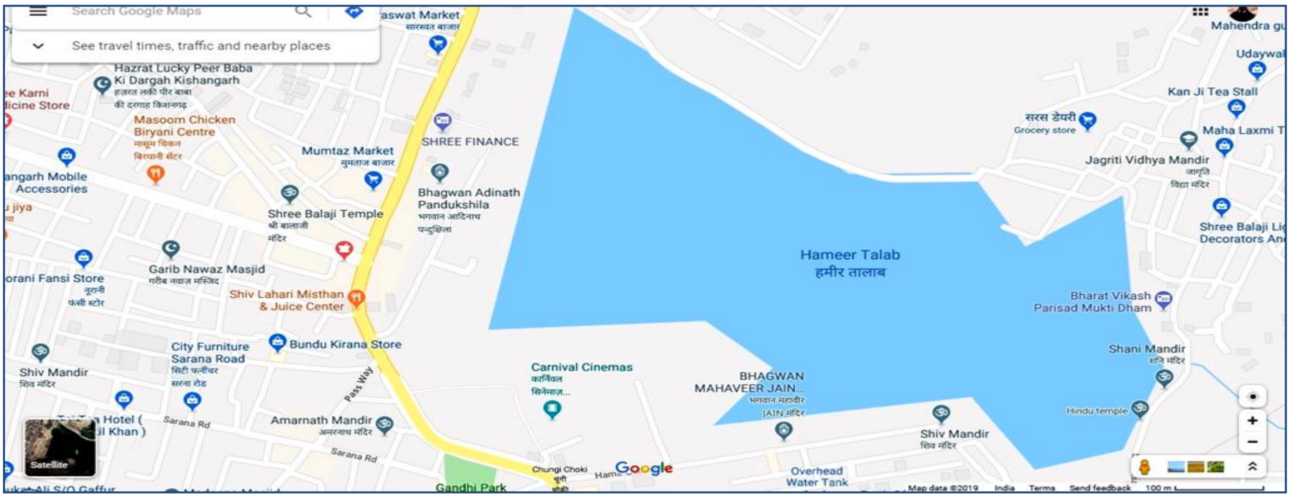
From the above literature, it is seen that Carlson's Index has largely been used to assess the trophic status of Water bodies in almost all the countries including India. Therefore, present study is carried out to estimate Carlson's trophic state index of Hameer pond, Kishangarh, Ajmer.

Aim of the Study

The study aimed to investigate the trophic Status of Hameer Pond, Kishangarh, Ajmer. It is expected that the proposed study will contribute to a more informed evaluation and response to water quality deterioration and negligence of surface water systems and is relevant to present day interest in pollution control and environmental concerns; comprising a logical, scientific approach.

Study Site

study area Hameer pond is one of the many perennial shallow water bodies around Kishangarh, of which Santolav pond, Gundolav pond are important. Totally rain-fed Hameer pond is a manmade pond amidst low hills erected on almost plain surface of eastern semiarid agro-climatic zone, located at $26^0$35'24 to $26^0$35'44 North latitude and $74^0$51'04 to $74^0$51'34 East longitude at 500 m above MSL in the center of Kishangarh near Railway station of Madanganj -Kishangarh (Rajasthan). Hameer Rao the resident of old Kishangarh city, laid the foundation of pond, amidst beautiful surroundings of hills and panoramic environment (Source: Kishangarh Tavarikh). The area experience moderate climate with all four seasons. Here soil is sandy loam to sand clay in texture and low fertile as low in nitrogen and moderate in phosphorous and potassium. The total catchment area of the lake is 13.44 sq. km. and the terrain is semi hilly and rocky. Pond is surrounded by the human habitation and it receives sewage and wastewater through number of unlined drains, disposal of domestic wastewater from surrounding residential and commercial area, and indiscriminate disposal of solid wastes deteriorating the water quality of the pond day-by-day.



Pictures Showing Study Sites and Geographic Location

Materials and Methodology

Samples were collected for the analysis of three parameters Secchi depth (SD), total phosphate (TP),and chlorophyll-a (Chl-a) to explore trophic status of ecological subsystem by using Carlson's Trophic State Index (CTSI) (Carlson, 1977). Secchi depth was determined using a 20 cm black and white metal disk and the values are expressed in meters. The maximum depth at which the Secchi disc can be seen when lowered in to the water is marked and measured. Total phosphorus was analyzed by colorimetric method and chlorophyll-a were estimated by acetone method and measured using a spectrometer.

The total amount of TSI is the mean of these three parameters, and the value of TSI varies between 1 and 100. Then Carlson's trophic state indices (TSI_{TP}, $TSI_{Chl\text{-}a}$ and TSI_{SD}) was calculated from the mean values of TP, Chl-a, and SD using the following equations.

$$TSI\ (SD) = 10\left(6 - \frac{\ln SD}{\ln 2}\right),$$

$$TSI\ (C\square l) = 10\left(6 - \right. 2.04{-}0.68\ln Ch\ l \ln 2,$$

$$TSI\ (TP) = 10\left(6 - \frac{\ln \frac{48}{TP}}{\ln 2}\right)$$

Based on Carlson's Trophic State Index, the state of the water body is characterized to oligotrophic, meso-trophic, eutrophic and hyper-eutrophic. The higher the values of Carlson index, the worse the state of water quality.

Hypothesis

H_o: The pollution load in Hameer Pond remains within its natural resilience limit and does not affect the nutrient level to a considerable level spatially as well as temporally within the pond system.

H_a: The pollution load in Hameer Pond is variable beyond it's natural resilience limit and affect the nutrient level to a considerable level spatially as well as temporally within the pond system

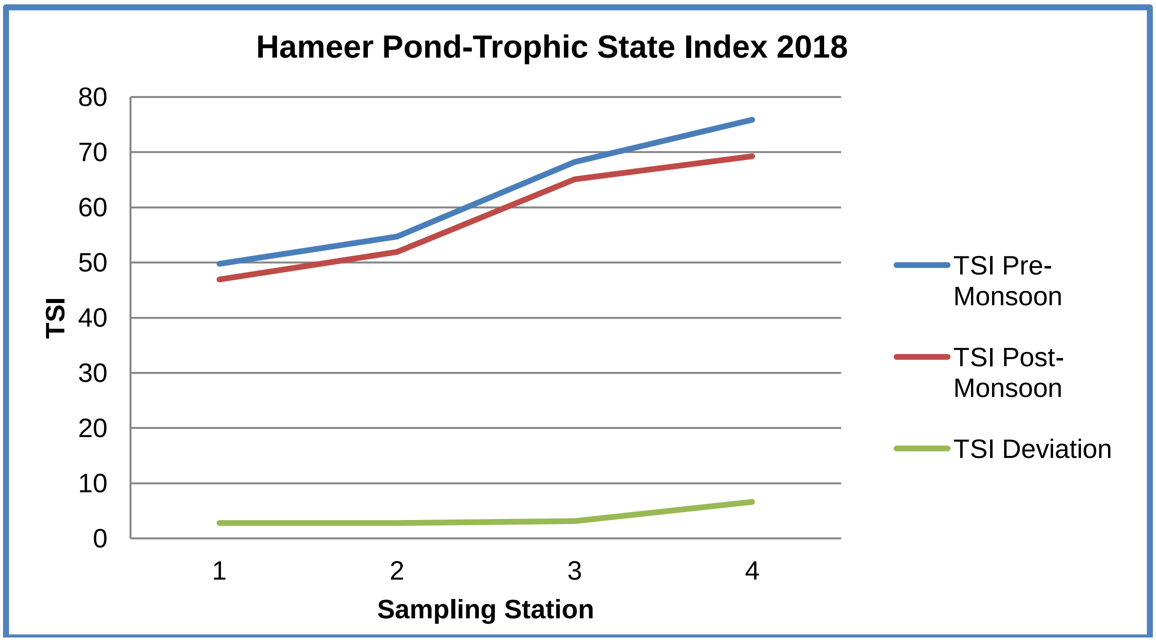
Result and Dicussion

Table-1

Pre-monsoon 2018							
Station No.	**Total Phosphorus (Mg/L)**	**Total Chlorophyll (Mg/L)**	**Secchi Depth (Mtr.)**	**TSI-TP**	**TSI Chl**	**TSI SD**	**TSI**
1	5.48	46.21	1.7	28.6799	68.204	52.36	49.75
2	5.93	73.89	0.9	29.8179	72.808	61.52	54.71
3	9.18	190.18	0.16	36.1195	82.083	86.39	68.20
4	9.26	258.28	0.04	36.2447	85.085	106.4	75.89

Table-2

Post-monsoon 2018								TSI Change
Station No.	**Total Phosphorus (Mg/L)**	**Total Chlorophyll (Mg/L)**	**Secchi Depth (Mtr.)**	**TSI-TP**	**TSI Chl**	**TSI SD**	**TSI**	
1	3.62	39.38	1.8	22.701	66.635	51.536	49.75	2.793
2	4.82	57.29	1.1	26.829	70.312	58.628	54.71	2.787
3	9.04	153.11	0.26	35.898	79.956	79.398	68.20	3.116
4	9.16	218.23	0.14	36.088	83.432	88.312	75.89	6.613



Carlson's Trophic State Index (CTSI) for each of the parameters and their attributes for Hameer pond over a period of two seasons are presented in the tables 1 and 2. Present study revealed the fact that the CTSI values are lesser during post- monsoon and higher during pre-monsoon seasons due to the effect of high temperature in summer. The above table and graph indicate the range of the Carlson's trophic state index values and classification of water body as per scale if the pond has CTSI values are within 30 then it is oligotrophic pond, if it is within the range of 30-40 then it is Mesotophic pond, if the values ranges between 40-80 or above 80 then it is eutrophic pond.

The CTSI values ranged from 49.75 to 75.89 during pre-monsoon while during post-monsoon, it varied between 46.95 to 69.27 at various sampling stations. Sampling station near inlet of *Gandhi Nagar Nalla, Chamda Ghar Nalla* (sampling station 4) have high CTSI due to nutrient enrichment by waste water rich organic waste. From the obtained results it is clear that the present status of Hameer Pond is Eutrophic at all stations due to indiscriminate disposal of domestic waste water from surrounding residential and commercial area except Station 4, which is highly eutrophic due to continuous inflow of nutrients from surroundings industrial area. This finding is also in line with Prasad and Siddaraju (2012) who studied Arakerelake and Thaggahalli Lake and found higher CTSI values in summer season. The findings of the present study is also consistent with the results of a study conducted on Gilarlo Reservoir Dam (northeast of Iran), in which the researchers concluded that it was mesotrophic in August and eutrophic in October (Shamlou A, Naseri S, Nadafi K. 2004). Moreover, the TSI change as the difference of pre-monsoon and post-monsoon period is showing increasing trend suggesting high magnitude changes in pollution level at the sampling sites under study in which station 4 is depicting high TSI and high TSI change.

T Test

Variables	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
TSI-PrM* - TSI-PoM**	4.000	2.000	1.000	.818	7.182	4.000	3	.028

*TSI-PrM-Pre-monsoon TSI

**TSI-PoM-Post-monsoon TSI

Means of TSI Values of Pre-monsoon and Post-monsoon were compared using t-test and found the t-value of 4 which was significant with significance value of 0.028 at 96% level of significance. Therefore, the null hypothesis that the pollution load in Hameer Pond remains within its natural resilience limit and does not affect the nutrient level to a considerable level spatially as well as temporally within the pond system, is rejected.

Overall it was found that TSI (TP) is a key parameter in deciding the trophic status of the lake. Any change in phosphorus concentration of fresh water ecosystem can also alter its trophic status.

Conclusion

In essence the trophic status of the pond reveals that it is tending, fast towards “eutrophism” particularly at station 4 (*Chamda Ghar Nalla*). The quality of water is deteriorating day by day due to inflow of domestic sewage, municipal waste and effluents of organic waste of animal and human origin into the pond. Deterioration of water quality and eutrophication are assuming alarming state in pond due to casual attitude of people concerned with development of urban population. If waste input is not checked then it will severely impair water dynamics and will cause eutrophication of the entire system. In nutshell, the results depict that the pond is eutrophic in different stations during pre-monsoon while it was moderately eutrophic for all points during Post-monsoon. Based on the findings, the stations located at the entrance of the pollutants showed nutrient enrichment throughout the study period. Moreover, phosphorous acted as a limiting factor in this system. Obviously the eutrophication is becoming a serious problem for this water body because of discharge of untreated sewage, rich in organic waste, both from point sources (viz. *Chamda Ghar Nalla, Sanwatsar Nalla, Gandhi Nagar Nalla etc.*), and non point sources.

Recommendations

In order to assist recuperation of the pond and to explore it in sustainable manner; immediate priority should be given to identification and abatement of lacuna in existing information and tools failing to conserve the pond and catchment area. It is necessary to identify the grounds of pollution-source expansion and to check them, to strengthen administrative coordination and explore possibilities of Public Private Partnership (PPP). It is also necessary to prepare action plan on pond restoration providing sufficient space to beautification in order to develop economic subsystem. Aforestation in catchment area, prohibition of construction and garbage disposal near pond should be enforced. Sewer network and sewage treatment plant should be materialized to limit nutrient entry in the pond system. Besides source control, some palliative actions should be commenced with prime importance in order to cope up the problem of eutrophication in the pond system. Community based indigenous knowledge system for water harvesting should be materialized to aware and insures involvement of community in efforts for conservation of this natural wealth. Therefore, coordinated efforts of various stakeholders and proper community involvement are the primary needs to restore the ecological subsystem of the pond and to make it useful for further social and economic exploration.

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