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Trophic status assessment of Nigeen Lake, Kashmir (India)

Amardeep Kaur, Adnan Abubakr and Syed Shabih Hassan

Abstract
The purpose of the study was to evaluate the trophic status of Nigeen Lake, through the interaction of nutrient concentration based on Carlson's TSI. In order to determine the trophic status of Nigeen Lake, surface water samples from six different sites of the lake were collected from December 2015 to May 2016. Monthly as well as seasonal variation among different parameters was observed during the study period. Highest temperature was recorded during spring season along with higher values of depth, conductivity, ortho-phosphate, total phosphorous and chlorophyll-a during this season. However, dissolved oxygen, transparency and pH values were minimum during spring and maximum in winter season. The data analysis from Carlson's TSI indicates that the average TSI(SD) value was in the range of 47.19 to 56.26, TSI(TP) ranged from 84.63 to 85.6 and TSI (Chl-a) was in the range of 58.24 to 61.37. The overall results of the study showed that the Carlson's TSI (Total) of Nigeen Lake ranged from 65.7 to 67.7 indicating that the lake is in hyper-eutrophic condition. The myriad ways in which people use the lake along with the numerous pollutant-generating activities have stressed the lake ecosystem in diverse ways. The study suggests that managers and policy makers should take action to slow down or halt eutrophication by applying best management practices for the conservation of Nigeen Lake.

Keywords: Nigeen Lake, Carlson's trophic state index (TSI), hyper-eutrophic

Introduction
The valley of Kashmir is known for its natural beauty and has often been referred to as the 'Switzerland of the East' and "Paradise on Earth". The land of sparkling rivers and sleepy lakes, of starling gardens and regal Chinar trees, Kashmir boasts of some of the beautiful flowering meadows and snowcapped peaks it is mesmerizing to see how this endless beauty never fails to charm the viewers with its from changing scenes dazzling white snow of winters to blooming fragrance of spring. However, the most fascinating character that nature has gifted is its water resources, which are not only important for ecological, socio-economic and cultural heritage of the state but also serve as primary source for the upliftment of local economy [1]. The valley of Kashmir is blessed with a number of lakes with different hydrological settings such as Dal lake, Wular Lake, Manasbal lake, Nagin Lake, Anchar Lake, etc [2]. Nigeen Lake, one of the basins of Dal Lake, (Lat. 34º06´N and Long. 74º45´) situated in the heart of Srinagar, the summer capital of Jammu & Kashmir, covering an area of 4.5 sq. km is a narrow stretch of water, making it an ideal place for stationary houseboats and conducting aquatic sports [3]. During recent times the rapidly increasing population has resulted in the establishment of new human settlement around the lakes which has resulted in the deterioration of water quality. As a result, the Nigeen Lake ecosystem is under tremendous anthropogenic pressure since more than three decades [4].

The assessment of trophic condition of lake is valuable scientific step in the determination of lake ecological status which describes the abiotic and biotic condition of water bodies, relations between chemical and biological features and lake condition in relation to human needs [5,6]. The examination of several diverse criteria viz; concentration of nutrients, productivity, faunal and floral quantity and quality, oxygen availability, and Lake Morphometry have been made for the trophic states description. Multi-parameter trophy index is not in use, now a days. Therefore, Carlson [7] formulated the trophic state indices (TSIs) as a quantitative measure of the degree of Lake Eutrophication. Traditional systems of classification of lake on the basis of trophic status divide the continuum into three classes: oligotrophic, mesotrophic and eutrophic [8]. Carlson [7] pointed out that there is often no clear delineation of these divisions, some lakes may be considered oligotrophic by one criterion and eutrophic by

Another; this problem is sometimes circumvented by classifying lakes that show characteristics of both oligotrophy and eutrophy as mesotrophic. Carlson [7] proposed using a trophic state index (TSI) to predict the status of lakes. The TSI correlates relationship among phosphorous, algal blooms, chlorophyll-a and secchi disc transparencies. The index has been used to classify waters, to predict trophic changes and as a lake management tool. Trophic State of Index proposed by Carlson which is an index method for determining the trophic state of lake based on secchi depth, chlorophyll-a concentration and total phosphorous concentration [7]. This system was designed in order to simplify some of the more complex multi-parametered models that are sometimes used in the fields. While these models are beneficial, they are sometimes avoided due to a number of parameters that must be measured. His model was tried and tested on many lakes located in Minnesota [7].

Nigeen Lake witnessed tremendous changes with respect to increased nitrate and phosphate levels with concomitant decrease in dissolved oxygen levels in recent past. The major classes of stress, which still continue to degrade the Nigeen Lake water quality are excessive input of nutrients and organic matter from autochthonous and allochthonous sources, leading to eutrophication including changes in physico-chemical and hydro-biological characteristics of Nigeen Lake. Keeping in view the importance of trophic state of index (TSI), an attempt was made to obtain the baseline data on secchi disc transparency (SD), total phosphorus (TP) and chlorophyll-a (Chl-a) in various sites of Nigeen Lake in Kashmir to evaluate actual TSI condition (oligotrophic, mesotrophic, eutrophic, hyper-eutrophic) so that Nigeen Lake may be managed properly.

Materials and methods

Study area

One of the famous lake of Kashmir, Nigeen, a Himalyan urban lake located at a distance of 9 km to the North-East of the Srinagar city India and is situated between coordinates Lat. 34º07´ 13``N, 74º49´40`` E, at an altitude of 1584m a.m.s.l., covering an area of 4.5km² [9]. This lake is source of attraction for tourists and a number of houseboats reside within the lake that provide excellent residing station for tourist and a source of income for the lake dwellers. The houseboats are served by Shikaras for transport and leisure. The area of lake has got reduced to 0.65 km^2 in as recorded in 2004 from an area of 0.79 km^2 recorded in 1971 due to creation of floating gardens for vegetable cultivation, increased hotels and human habitation. The lake is known for its aquatic sports and has been the focal point of tourist attraction. It supports a rich and diverse macrophytic vegetation of both floating and submerged forms. Nigeen Lake has become drainage type which is fed by Dal Lake from Ashaibagh bridge, from the North-East and also connected to Khushal Sar and Gil Sar lakes on its North-West side via an exit channel known as Nallah Amir Khan. The panoramic view of Nigeen Lake including sampling sites are depicted in Map 1.

Morphometry and site selection

Nigeen Lake has maximum length of 2.7 km, maximum width of 0.82 km and surface elevation (1,584m a.m.s.l). The mean water depth of this lake is recorded to be 1.37m and the open water area is 0.89sq Km [10]. It has considered as the deepest basin of Dal lake with a maximum depth of 6 meters and post glacial lake of warm monomictic type with average depth of about 3 meters [11].

Site selection

Site 1st: This site is located near the sewage treatment plant, and acts as an outflow of Nigeen Lake, where from water drains into Gilsar and Khushalsar lakes. This site is recognized as rich in submerged and free-floating macrophytes.

Site 2nd: This site is located near Ashaibagh Bridge in the North-East side of Hazratbal basin. This site receives water from Dal Lake and act as an inlet source of Nigeen Lake. The site is marked with the presence of floating gardens on one side. Submerged and free-floating macrophytes are recorded to be abundant in this site.

Site 3rd: This site is situated at the Centre of the lake and has maximum depth. The site is investigated to become usually free from aquatic macrophytes, however, sometimes free floating macrophytes can be seen spread on the surface.

Site 4th: This site is marked by the presence of house boats and receives direct inflow of raw domestic sewage from houseboats into the lake. This site has rich growth of submerged and free-floating macrophytes.

Site 5th: This site is located near Saderbal area, which is inhabited by human habitation and few houseboats. The area is identified as relatively shallow and few surface drain discharge effluents directly at this site. This zone is usually dominated by submerged and floating macrophytes.

Site 6th: This site is situated near famous Nigeen ghat, which is usually dominated by submerged macrophytes. Shikara boats usually remain parked near this site.

The Carlson TSI is calculated by using three empirical equations, each based on one of the parameters listed above, and then taking the average of those three equations. The empirical equations used are defined below:

TSI_{SD}= 60-14.41 LN (SD)
TSI_{chla}= 9.81 LN (chla) + 30.6
TSI_{TP}= 14.42 LN (TP) + 4.15

$$TSItot = \frac{TSI(SD)+TSI(chla)+TSI(TP)}{3}$$

Where: chla = Chlorophyll-a concentration (µg/l)
SD = Secchi disc depth (meters)
TP = Total phosphorous concentration (µg/l)
TSI= Trophic state index

The Carlson model was implemented during the present study for all lake samples and TSI was determined based on TSI of trophic state classification (Table-1).

Table 1: Trophic State Classification based on Carlson`s TSI

Classification	Sub-Classification	TROPHIC STATE INDEX
Oligotrophic	Strongly-oligotrophic	0-25
	Oligotrophic	26-32
	Slightly-oligotrophic	33-37
Mesotrophic	Slightly –mesotrophic	38-42
	mesotrophic	43-48
	Strongly- mesotrophic	49-53
Eutrophic	Slightly –eutrophic	54-57
	eutrophic	58-61
	Strongly- eutrophic	62-64
Hyper-Eutrophic	Hyper-Eutrophic	65+

(Source: Alexander, 2013)

Result and discussion

During the present study six different sites of Nigeen Lake were selected to assess the overall trophic status of Nigeen Lake. The parameters such as Secchi disc depth (SD), total phosphorous (TP) and chlorophyll-a (chl-a) at six different sites were monitored/evaluated and analyzed their values. The average values of TSI for the above parameters at different sampling point are presented in Table 2 to 6 and Figure 1 to 4. Trophic State of Index was developed based on the relationship among phosphorous, chlorophyll-a and secchi disc depth. The TSI was computed from any of the three parameters and investigated to be approximately the same regardless of the parameter chosen. Carlson generated a single number to fit into a numerical scale ranging from 0 to 100 with major trophic divisions at 10 unit increments.

The average monthly TSI Secchi disc transparency (SD) value of Nigeen Lake ranged from a minimum 47.19 in December (winter) to a maximum of 56.26 in the month of April during the study period. However, the average value of TSI(SD) fluctuation in different sites of Nigeen Lake was recorded to be 58.7, 53.8, 43.3, 58.01, 57.4, and 59.9 in site1, site2, site3, site4, site5 and site6 respectively (Table 2). No significant variation in TSI (SD) value was observed in the present study. However, the slight changes in water depth from winter to spring season are attributed to precipitation received in the form of rain and runoff from the catchment areas. The mean TSI (SD) of Nigeen Lake was found to be 53.96 based on this value, the lake is classified under eutrophic category. Similar observations have been made previously by some workers [12]. Alexander [13] studied trophic analysis of 46 lakes testing, out of which 5 lakes was classified as slightly oligotrophic, 19 mesotrophic and 14 eutrophic in Yellowstone National Park. During the present study Nigeen Lake was evaluated to be eutrophic which is in conformity with the lake classification proposed by Alexander. Depth of an aquatic body plays an important role in concentrating ions in water mass, besides being an important factor for growth of various life forms of vegetation [14]. Mean depth is regarded as the best single index of morphometric conditions and clearly shows a general inverse correlation to productivity at all trophic levels among large lakes [15].

The month-wise average TSI Total phosphorus (TP) value of Nigeen Lake ranged from a minimum 84.63 in the month of December (winter) to a maximum of 85.6 (March) during the study period. However, the average value of TSI(TP) fluctuation in different sites of Nigeen Lake was recorded to be 86.15, 79.77, 84.79, 85.28, 88.71, and 86.58 in site1, site2, site3, site4, site5 and site6 respectively (Table 3). Although there was not much difference between the average total phosphorous values, yet some seasonal fluctuations were observed with lower values during winter and higher during spring season. These fluctuations can be related to precipitation in the form of rain, sewage runoff and discharge of untreated human waste directly to the lake. The low values of total phosphorous observed during winters may be due to decreased runoff combined by utilization of phosphorous by phytoplankton.

Total phosphorous is considered as the most important element for determining the biological productivity in aquatic ecosystem. It acts as valuable nutrient for plant growth and fundamental element in the metabolic reactions of plants and animals. It is also considered as an important factor affecting the trophic status of lakes [16, 17]. Any change in phosphorous concentration of fresh water can alter its trophic status. Decline in inflow of nutrients reduces phosphorous concentration. It is also considered as the most limiting nutrient for plant growth in natural lakes [18]. Higher phosphorus levels in water were recognized as indicative of freshwater pollution [19] and also linked to the use of detergents and dyes in adjoining locations, which finally find their way into lake [12]. Nigeen Lake need remedial as well as restoration measures due to its highly eutrophic conditions. Higher phosphorus level in lake is related to the direct discharge of untreated human wastes from houseboats, sewage disposal and illegal settlements adjoining the lake [20, 22].

The mean TSI (TP) value during the study period recorded from Carlson's TSI was 85.21, resulting in the eutrophic condition of lake. While studying the trophic status of Kashmir lakes, Zutshi and Wanganeo [21] reported that in lakes of Kashmir, phosphorous is the limiting factor for phytoplankton in lakes. Sharma *et al.* [22] while studying the limnology of Dal and Nigeen Lake, linked higher phosphorous values of Nigeen Lake to direct discharge of untreated human wastes from houseboats and illegal settlement adjoining the lake.

The average monthly TSI (Chlorophyl-a) value of Nigeen Lake ranged from a minimum 58.24 (December) during winter to a maximum of 61.37 (May) in spring season during the study period. However, the site-wise average value of TSI(Chl-a) fluctuation of Nigeen Lake was evaluated to be 62.42, 58.70, 60.51, 59.98, 62.10, and 55.31 in site1, site2, site3, site4, site5 and site6 respectively (Table 4). Low concentration of chlorophyll-a in winters could be explained by low primary productivity, which is further related to low temperature, less nutrient concentration and less photo-synthetically active radiations (PAR). While higher concentration of chlorophyll-a during spring season may be due to phytoplankton activity and lower water levels in lake ecosystem. The mean TSI (chl-a) value of Nigeen Lake was reported as 59.84, hence the lake falls under eutrophic category based on this value. TSI chl-a value was

significantly higher in spring while lowest in winter season. It is evident that photosynthetic activities are pronounced during spring due to higher atmospheric temperature, nutrients supply and increased photoperiod. These factors become conducive for the algal growth including enhanced biomass. Lower productivity during colder climatic conditions suggested lower values during winter.

Chlorophyll-a is the major photosynthetic pigment of phytoplankton and a trophy index in aquatic ecosystem [16, 23]. So a method for the estimation of the growth and development of phytoplankton community is to perform an analysis of photosynthetic pigments, even though the content of chlorophyll in the cells changes with the availability of light [6] and thus with depth and trophic gradient [24]. Lakes having chlorophyll-a values in the range of 3.0 and 78.0 µg.L-1 are classified as eutrophic [25]. High values have also been linked to the greater abundance of phytoplankton in water bodies [26]. Similar observation was recorded during the present study.

Overall the mean value of TSI (TP) were found to be higher than TSI (chl-a) followed by TSI (SD) (Table-6) which indicates the increasing phosphorous surplus in the lake water. The increase in phosphorous concentration in lake may be on account of anthropogenic activities in the catchment leading to direct discharge of wastewater from the point source including houseboats. A strong relationship between chlorophyll-a and total phosphorous has been described by many scientist [7, 27, 28, 29].

The average monthly fluctuation in TSI (Total) value of Nigeen Lake noticed 65.7 in the month of December where as 67.7 in April which revealed that the lake is in hyper-eutrophic condition (Table-5). The trophic status of Nigeen Lake in terms of mean TSI (Total) during different month was evaluated to be 63.35, 65.92, 66.68, 66.84, 67.63 and 67.59 during the month of December, January, February, March, April, and May, respectively (Table 6). It was concluded that Nigeen Lake fall under the category of strongly- eutrophic during December and under hyper-eutrophic category from January to May. It was observed that there was increase in eutrophic condition of the lake as the temperature increases. These observations are in agreement with the reports of many workers [7, 12, 16, 22, 30,]. Earlier investigator described direct relationship between total phosphorous and chlorophyll-a as the higher the concentration of phosphorous in water, more is the primary productivity resulting in higher chlorophyll-a concentration [31]. The relationship between secchi disc transparency and chlorophyll-a has been proposed by many investigators [7, 30, 32].

Carlson found that the trophic state indices calculated from secchi disc transparency usually approximated those calculated from chlorophyll-a. The author recognized that secchi disc transparency could give false values in highly colored lakes but concluded that its advantages over-weighted its disadvantages. The relationship among secchi disc transparency, chlorophyll-a and total phosphorous relate well and proved valuable to assess the trophic status of Nigeen Lake.

Table 2: Monthly variations in TSI (SD) at different sites of Nigeen Lake

	Dec	Jan	Feb	March	Apr	May	Avg.
Site 1	57.3	57.3	60	57.3	60	60	58.7
Site2	52.35	52.35	53.22	52.35	56.21	56.21	53.8
Site3	42.79	42.36	43.69	41.94	44.16	44.65	43.3
Site4	57.3	57.3	57.3	60	60	56.21	58.01
Site5	56.21	56.21	57.3	57.3	58.62	58.62	57.4
Site6	60	61.04	60.73	57.3	58.62	61.51	59.9
Avg.	47.19	54.42	55.36	54.35	56.26	56.18	

Table 3: Monthly variations in TSI (TP) at different sites of Nigeen Lake

	Dec	Jan	Feb	March	Apr	May	Avg.
Site 1	85.7	86.1	85.4	86.39	86.69	86.67	86.15
Site2	79.5	78.32	79.34	80.65	79.96	80.90	79.77
Site3	85.2	82.47	86.16	85.28	85.6	84.08	84.79
Site4	86.08	85.75	85.4	85.75	85.24	83.47	85.28
Site5	89.98	89.6	89.66	88.11	87.32	87.59	88.71
Site6	81.32	86.63	87.05	87.49	88.37	88.62	86.58
Avg.	84.63	84.8	85.5	85.6	85.53	85.22	

Table 4: Monthly variations in TSI (Chl-a) at different sites of Nigeen Lake

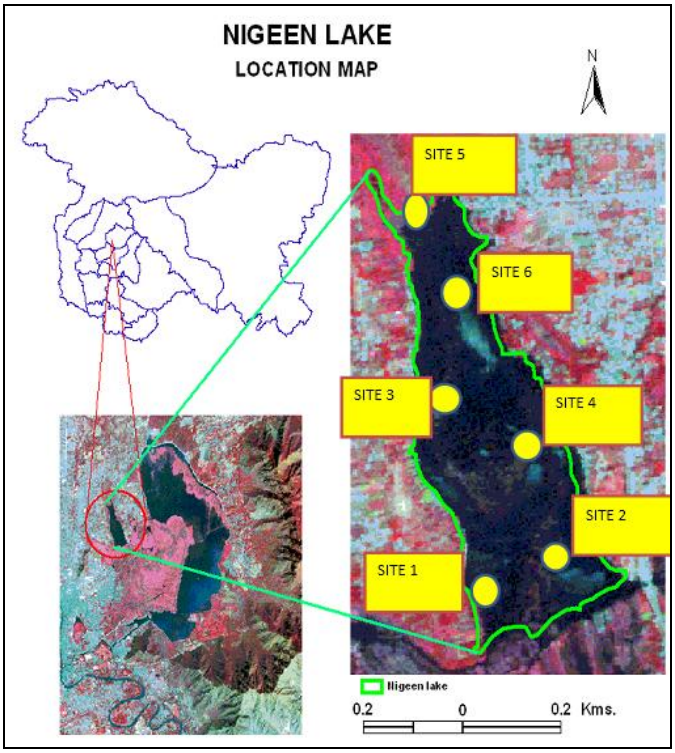
	Dec	Jan	Feb	March	Apr	May	Avg.
Site 1	59.97	60.37	59.01	64.69	65.19	65.33	62.42
Site2	58.10	57.73	57.79	59.38	59.48	59.73	58.70
Site3	59.48	59.99	61.57	60.69	60.92	60.46	60.51
Site4	59	59.15	59.15	59.64	61.27	61.69	59.98
Site5	60.23	61.27	62.59	63.04	62.59	62.93	62.10
Site6	52.67	52.86	55.13	55.99	57.16	58.10	55.31
Avg.	58.24	58.56	59.20	60.57	61.10	61.37	

Table 5: Monthly variations in TSI (Total) at different sites of Nigeen Lake

	Dec	Jan	Feb	March	Apr	May	Avg
Site 1	67.62	67.92	68.13	69.46	70.62	70.66	69.06
Site2	63.31	62.8	63.45	64.12	65.21	65.61	64.08
Site3	62.49	61.6	63.8	62.63	63.56	63.06	62.85
Site4	67.46	67.4	67.28	68.46	68.83	67.12	67.75
Site5	68.8	69.02	69.8	69.48	69.51	69.71	69.38
Site6	64.66	66.84	67.6	66.92	68.05	69.41	67.24
Avg	65.7	65.9	66.7	66.8	67.7	67.6	

Table 6: Trophic status of Nigeen Lake during different months

	TSI(SD)	TSI(TP)	TSI(Chl-a)	TSI(Total)	Trophic Status
Dec.	47.19	84.63	58.24	63.35	Strongly eutrophic
Jan.	54.42	84.8	58.56	65.92	Hyper-eutrophic
Feb.	55.36	85.5	59.20	66.68	Hyper-eutrophic
March	54.35	85.6	60.57	66.84	Hyper-eutrophic
April	56.26	85.53	61.10	67.63	Hyper-eutrophic
May	56.18	85.22	61.37	67.59	Hyper-eutrophic



SITE 1: Exit Gate, SITE 2: Ashaibagh Bridge
SITE 3: Central Site, SITE 4: House Boats Area
SITE 5: Saderbal Area, SITE 6: Nigeen Ghat

Map 1: Panoramic view of Nigeen Lake and sampling sites

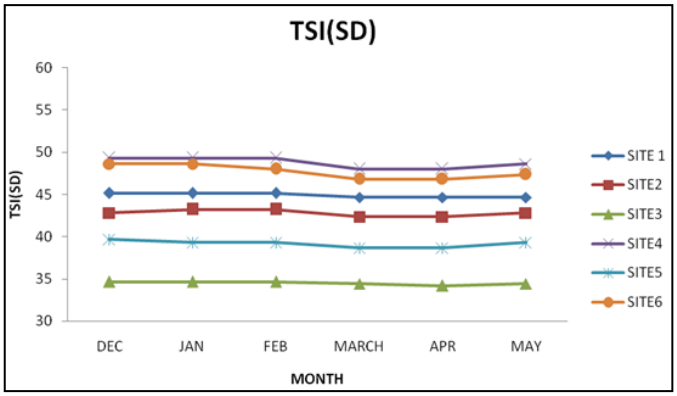


Fig 1: Monthly variation in TSI (SD) at different sites of Nigeen Lake

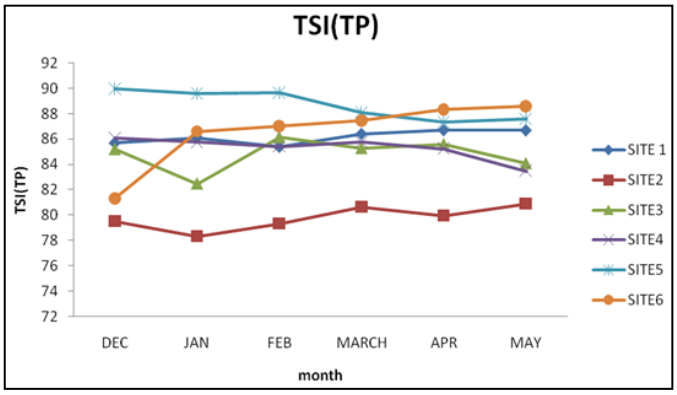


Fig 2: Monthly variation in TSI (TP) at different sites of Nigeen Lake

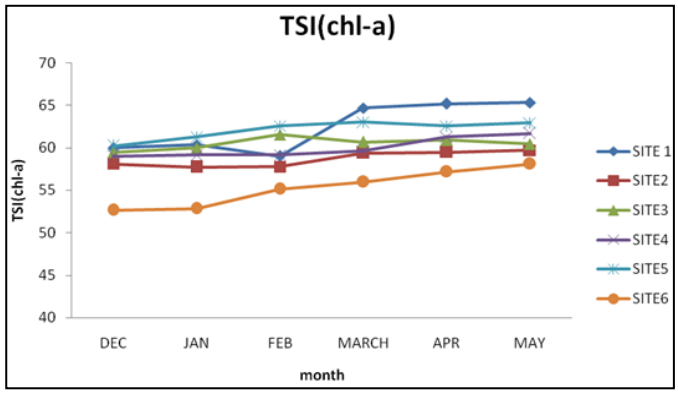


Fig 3: Monthly variation in TSI (Chl-a) at different sites of Nigeen Lake

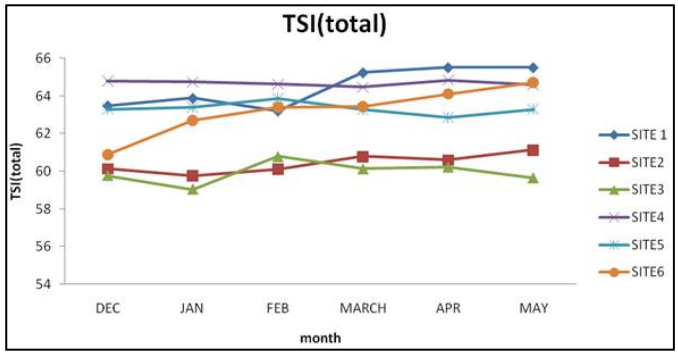


Fig 4: Monthly variation in TSI (total) at different sites of Nigeen Lake

Conclusion

The overall TSI of Nigeen Lake during the present study was recorded as 66.33, therefore, the lake is classified under hyper-eutrophic category based on Carlson's TSI. Nigeen Lake witnessed tremendous changes with respect to increased nitrate and phosphate levels with concomitant decrease in dissolved oxygen levels. The major classes of stress, which still continue to degrade the Nigeen Lake water quality are excessive input of nutrients and organic matter from point and non-point sources, leading to eutrophication, hydrological and physical changes, rapid cultural development of its catchment areas with indiscriminate and unauthorized use for residential purposes including dumping of garbage, sewage and sewerage from the houseboats and adjacent habitations. At some places the self-purifying capacity of Nigeen Lake is unsatisfactory due to low dissolved oxygen level. Therefore, management of Nigeen Lake needs a holistic approach for its conservation, preservation and overall management, which considers lake as a component of landscape and its restoration at a watershed scale. There is a need of immediate systematic monitoring and management to keep lake alive in regard to their aesthetic value, tourist attraction and their importance for aquatic game recreations and economically important animal and plant resources.

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References

1. Naik AB. Tourism potential in ecological zones and future prospects of tourism in Kashmir valley. Ph.D thesis, A.M.U. Aligarh, 2008, 276.
2. Sarah S, Jeelani GH, Ahmad S. Assessing variability of water quality in a groundwater-fed perennial lake of Kashmir Himalayas using linear geostatistics. J Earth Syst. Sci. 2011; 120(3):399-411.
3. Nissa M, Bhat SU. An Assessment of Phytoplankton in Nigeen Lake of Kashmir Himalaya. Asian J Biol. Sci. 2016; 9:27-40.
4. Shah IK, Shah H. Physico-chemical dynamics in littoral zone of Nigeen basin of Dal lake, Kashmir, India. Int. Res. J Env. Sci. 2013; 2(3):11-14.
5. Matthews R, Hilles M, Pelletier G. Determining trophic state in Lake Whatcom, Washington (USA), a soft water lake exhibiting seasonal nitrogen limitation, Hydrobiologia. 2002; 468:107-121.
6. Wetzel RG. Limnology. Lake and River Ecosystems, Academic Press, San Diego, California, 2001; pp. 1006.
7. Carlson RE. A trophic state index for lakes. Limnology and Oceanography. 1977; 22(2):361-369.
8. Baban SMJ. Trophic classification and ecosystem checking of lakes using remotely sensed information, Hydrological Sciences Journal. 1996; 41(6):939-957.
9. Rather MI, Yousuf AR, Shahi N, Mehraj M, Khandey SA. Understanding the cause of fish kill in Nigeen Lake. J Res. Dev. 2013; 13:20-32.
10. Abubakr A, Kundangar MRD. Bacterial dynamics of Dal Lake, a Himalayan temperate Fresh-water lake in Kashmir. Nat. Env. and Poll. Tech. 2005; 4(2):291-298.
11. Bhat PA, Bhat AJ, Khan BU. Hydrochemistry and pollution assessment of freshwater lakes. Int. J. Engg. Sci & Res. Tech. 2016; 5(11).
12. Malik M, Balkhi MH, Abubakr A, Farooz Bhat F. Assessment of Trophic State of Nagin Lake Based on Limnological and Bacteriological Studies, Nature Environment and Pollution Technology. 2017; 16(2):485-491.
13. Alexander MA. A trophic status analysis of lakes in Yellowstone National Park. M.Sc. Thesis submitted, Faculty of Brigham Young University, 2013.
14. Kaul V, Handoo JK. Water characteristics of some fresh water bodies of Kashmir, 1980.
15. Goetzman JS. Initial limnological evaluation and trophic state classification of Jessie Lake, Minnesota. Report submitted to Grand Rapids Senior High School, 1986.
16. Vollenweider RA. Scientific fundamental of the Eutrophication of lakes and flowing waters with particular reference to nitrogen and phosphorous as factors in Eutrophication. OECD. Tech. Rep. DAS/CSI/68. 1968, 27-61.
17. Pandit, Yousuf AR. Trophic status of Kashmir Himalayan lakes as depicted by water chemistry. J Res. Dev. 2002; 2:1-12.
18. Lee CC, Lin SD. Handbook of environmental engineering calculations, 2007.
19. Pathak NB, Mankodi PC. Hydrological status of Danteshwar pond, Vadodara, Gujarat, India. Int. Res. J Environment Sci. 2013; 2(1):43-38.
20. Sharma S, Kumar V, Yadav KK, Gupta N, Verma C. Long-term assessment of fly ash disposal on physico-chemical properties of soil. Int. J Curr. Res. Biosci. Plant Biol. 2015a; 2(8):105-110.
21. Zutshi DP, Wanganeo A. Nutrient dynamics and trophic status of Kashmir lakes. In. Prospectives in plant sciences in India. (S.S. Bir and M.I.S. Saggo, Eds.) Indian National Science Congress Association, 1989, 205-212.
22. Sharma JN, Kanakiya RS, Singh SK. Limnological study of water quality parameters of Dal Lake, India. IJIRSET. 2015b; 4(2):380-386.
23. Dillon PJ. The phosphorous budget of Cameron Lake, Ontario: The importance of flushing rate to the degree of eutrophy of lake. Limnol. Oceanogr. 1975; 20:28-29.
24. Kasprzak P, Padisak J, Koschel R, Krienitz R, Gervais F. Chlorophyll a concentration across a trophic gradient of lakes: An estimator of phytoplankton biomass. Limnologica. 2008; 38:327-338.
25. Wetzel RG. Limnology. 2nd Edn. Saunders College Publishing, Philadelphia, PA, 1983, 858.
26. Banita DM, Tapati D, Susmita G. Limnologica studies of temple ponds in Cachar District, Assam, North East India. International Research Journal of Environment Sciences. 2013; 2(10):49-57.
27. Sakamoto M. Primary production by phytoplankton community in some Japanese lakes and its dependence on lake depth. Arch. Hydrobiol. 1966; 62:1-28.
28. Dillon PJ, Ringer FH. The phosphorous-chlorophyll relationship in lakes. Limnology and Oceanography. 1974; 19:767-773.
29. Jones JR, Bachmann RW. Prediction of phosphorous and chlorophyll levels in lakes. J Water Poll. Cont. Fed. 1976; 48:2176-2182.
30. Edmondson WT. Phosphorous, nitrogen and algae in lake Washington after diversion of sewage. Science. 1970; 169:690-691.
31. Vollenweider RA. Advances in defining critical loading levels for phosphorous in Lake Eutrophication. Mem. Ist. Ital. Idrobiol. 1976; 33:53-83.
32. Bachmann RW, Jones JR. Phosphorous inputs and algal bloom in lakes. Iowa State J Res. 1974; 49:155-160.