The Scientific Temper
Vol. 12, No 1-2, January-July, 2021:pp 162-165
ISSN 0976 8653, E-ISSN 2231 6396
A Web of Science Journal
Doc ID: https://connectjournals.com/03960.2021.12.162

Carlson's Trophic State Index of Shatiya Wetland in Gopalganj District of Bihar

Manisha Pallvi
Jai Prakash University, Chapra (Bihar)
Corresponding author: manisha789pallavi@gmail.com

ABSTRACT

Wetlands are vulnerable ecosystems and under-valued despite their high utility to environment and economy which tells about emphasis on their management and conservation. The efficient wetland management requires monitoring of trophic status especially in summer season. Shatiya wetland located in North Bihar is currently under excess anthropogenic pressure. This study was assessed to monitor trophic status in terms of Carlson Index. The study confirmed mesotrophic status in through chlorophyll a presence in initial investigation possibly caused by low input of chemical fertilizers around wetland. However, the trophic status showed a move towards eutrophy in the last stage of study indicated anthropogenic pressure on the wetland was initiating its shrinkage and ultimately conservation must be prioritized.

Keywords: Shatiya wetland, Trophic status, Carlson's TSI, Phosphorus, Chlorophyl a, Secchi disc depth, Mesotrophic, Eutrophic, Macrophytes

INTRODUCTION

Shatiya is a wetland chaur seasonally connected to Gandak river in the Gopalganj district of Bihar. This is an important centre of several anthropogenic activities including fishing, aquatic plant harvesting and a reservoir for agricultural and domestic run-off. It is also an important migratory bird site. However, owing to the incessant population pressure it is gradually shrinking as more of its area is being reclaimed for agriculture.

The threat faced by Shatiya wetland is similar to other freshwater ecosystems. The freshwater ecosystems through increased anthropogenic disturbances are most threatened ecosystems in the earth due to their gross under-estimation (Brouwer et *al*, 1999). The population pressure is immense on such ecosystem and a vast trophic level depends on them for survival.

The management of aquatic systems is the need of present because wetlands are shrinking and becoming shallow at an alarmingly fast rate. The problem is an urgent one in vast populated country like India where agricultural works also manifesting to encroach wetland area. This is true particularly for Shatiya wetland as an field study as 56% of the surveyed population wanted wetland drainage for agricultural purposes through study on Shatiya wetland. The evaluation of trophic status of a wetland is most important condition for lake classification, management and the primary steps in the direction of freshwater ecosystem conservation (Liu et *al*, 2001a).

The trophic status is important to estimate the total biological production of the lake and has been evaluated using several parameters including shape of oxygen curve, concentration of nutrients, faunal and phytoplankton diversity, morphometry of lake and climate of the region. This classic trophic state classification system divides lakes into three broad classes-Eutrophic, Mesotrophic and Oligotrophic based on nutrient concentration in the water. While eutrophic lakes have high nutrient concentration, oligotrophic lakes have low nutrient levels and mesotrophic lakes lie in between the two extremes. Apart from that there are several narrower ranges like ultra-oligotrophic, meso-eutrophic etc. There is however, an inherent problem with this system as it provides more qualitative than quantitative description of wetland and as such gives similar and not discrete classes. In such condition, Trophic state Index provided by Carlson (2005) proposed a clear classification and are more suitable than the other parameters to assess the trophic status of the wetlands (Carlson, 2005). There oligotrophic ranges as 0-20, low mesotrophic as 20-30, mesotrophic as 30-40, high mesotrophic as 40-50, eutrophic as 50-70, hyper-eutrophic as 70-80 and 80-100 as extreme eutrophic on a scale of 1-100 (Xing et *al*, 2005). Although this index was specific to lakes but it can also be used to estimate the trophic status of the wetlands (Duan et *al*, 2007).

This study was also aimed to estimate flora characteristics as species abundance, density, frequency with class distribution and importance value index (IVI) in the Shatiya wetland.

METHOD AND MATERIALS

Shatiya wetland was divided into two sites and random sampling of water and sediment was carried out. The surface water was collected with 1 litre water sampler while sediments were sampled using metal ladles. The samples of water, soil and algae were collected from these 2 sites in pre-monsoon, monsoon and post-monsoon periods during 2018-2020.

The Persulphate oxidation method described by Ebina et al (Nouri et *al*, 2010) as water samples filtered and then digested with 5 ml water and 5 ml oxidizing solution (20 gm Potassium Persulfate and 3 gm Sodium Hydroxide in 1 litre water) autoclaved at 120^{0}C for 30 minutes. Total phosphorus was measured as orthophosphate by the stannous chloride-ammonium molybdate method (Ebina et *al*, 1983). It required adding of 0.4 ml Ammonium Molybdate reagent and 0.05 Stannous chloride reagent adding in 10 ml digested sample and the sample mixed thoroughly. Thereafter, strict 10 minute incubation, absorbance reading was taken at 690 nm. A double-beam UV-Visible spectrophotometer with quartz cuvette was used to all absorbance readings. Total chlorophyl was measured using 9:1 acetone and ethanol (v/v) extraction method as per Duan et *al* (2007). The transparency of the water was estimated using a traditional Secchi disk.

Total chlorophyll was measured using 9:1 acetone and ethanol (v/v) extraction method as per Duan et *al* (2007). Clarity of the water was measured using a traditional Secchi disk. There three Carlson indices (Liu et al, 2001) applied namely Secchi disk depth, Total Phosphorus and Algal chlorophyl (Chlorophyl a) for estimation of trophic status of Shtiya wetland.

TSI value about total phosphorus was calculated using the Carlson equation-TSI (TP)=$10\left(6-\dfrac{\ln\dfrac{48}{TP}}{\ln 2}\right)$; TSI for total chlorophyll according to Carlson as-TSI (Chla)= $10\left(6-\dfrac{2.04-0.68\ln Chl}{\ln 2}\right)10\left(6-\dfrac{2.04-0.68\ln chl}{\ln 2}\right)$ and TSI value about Secchi disc depth through using equation as- TSI (SD)=$10\left(6-\dfrac{\ln SD}{\ln 2}\right)10\left(6-\dfrac{\ln SD}{\ln 2}\right)$. The TSI values so obtained were compared with the table provided by Carlson and the Trophic State Index of Shatiya wetland was calculated.

The study of plant community was performed by calculation of percentage frequency, frequency class, species density and abundance with quadrate of 3mx3m size constructed of collapsible wooden frames as per Bendre and Kumar (2002).

RESULTS AND DISCUSSION

The Trophic state index provide varying estimates as calculated from three parameters-Secchi disc depth, Total Phosphorus and Total Chlorophyl about trophic position of Shatiya wetland (Table 1). The trophic status is determinant of species diversity, abundance and distribution of consumers in this wetland and may be utilized to analysis and perspective strategy to improve fish culture and management at local market demand and value.

Table 1: Details of Shatiya wetland

Characteristic	Description
Latitude	26.4177 N
Longitude	84.5046 E
District	Gopalganj
Mean Annual Precipitation	1.034.8 mm
Altitude	74 meter to sea-level
Ecological Importance	Fish diversity and Irrigation
Geographical Importance	Connected to Gandak river in Monsoon

The trophic status fluctuated between mesotrophic and eutrophic with secchi disc depth reading, while chlorophyll a quantity showed mesotrophic nature of the wetland (Figure 1). Phosphorus level also indicated the wetland as mesotrophic during the study period, however an increasing trend was observed in the trophic status between the two years (Table 2).

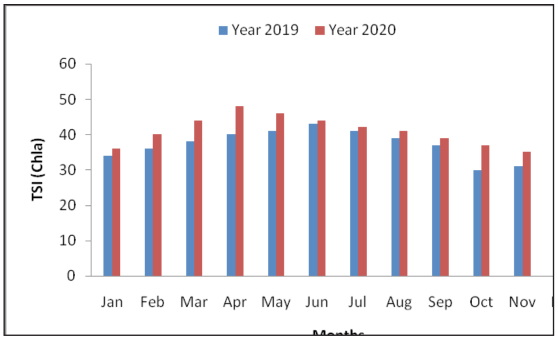

Figure 1: Carlson' s Index (TSI) of Shatiya wetland using Chlorophyll as parameter.

Table 2: Abiotic parameters during study period

Sampling period	Mean Chlorophyll a		Mean depth (cm)		Mean Phosphorus (mg/l)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
May	2.18±0.24	2.65±0.82	3.12±0.07	2.82±0.10	0.49±0.05	0.26±0.07
September	1.58±0.30	1.83±0.23	5.64±0.56	3.41±0.58	0.56±0.02	0.64±0.07
January	1.46±0.15	1.78±0.30	3.32±0.22	2.28±0.18	0.59±0.04	1.62±0.10
March	1.92±0.30	3.24±0.41	2.78±0.18	2.26±0.76	0.45±0.07	1.02±0.18

A total of 10 species were recorded in the first session of which the most abundant were *Phragmitis karka*, *Eichhornia crassipes* and *Lemna major*, while some species as *Vallisnaria natans*, *Ceratophylum demersum*, *Nymphaea nouchalli* and *Ipomoea aquatica* were more common in monsoon period. The mean total number of individuals of the species present during the first sampling session has been listed in Table 2. The second year results are shown in Table 3, where loss of species richness was observed and only *P. karka*, E. *crassipes*, *H. verticillata* and *L. major* were visible. These remaining species did not show high seasonal variation and encountered all the year round.

Among the three studied parameters, chlorophyll a is most important because its association with plant biomass (Xing et *al*, 2005; Bendre and Kumar, 2002). The Secchi disc depth variation provides the optical clarity of water as a function of the suspended solids, excessive floating vegetation or algal bloom and the turbulence caused by rain water. Algal blooms are common in the summer months while the degree of disturbance caused by rainwater cause optical clarity to reduce in the monsoon period. These observations lead to the conclusion that the Secchi disk depth variations in Shatiya wetland in the first sampling session were only due to the fact that the depth of the wetland was subject to seasonalvariation. Naturally, the depth of the wetland increases in the rainy season as compared to the other seasons. However, increasing trend was observed in last year. The water of Shatiya wetland showed exceptional clarity in the first year of study.

The phosphorus quantity increased in the post-monsoon season (Figure 1). However, a large part of drained phosphorus appears as Dissolved Inorganic Phosphorus (DIP) and Dissolved Organic Phosphorus (DOP) instead of Particulate Inorganic Phosphorus (PIP) and Particulate Organic Phosphorus (POP), as it did not affect the optical clarity of the water. The increased phosphorus also appear as no positive effect on the persisted algae as no increase in the total chlorophyll a content was observed. There was instantly increase in the number of macrophyte species in the first year (Table 2) and in the number of density of the existent species in the last year of investigation (Table 3).

Table 3: Relative frequency, Density, Abundance and IVI of Macrophyte species in 2019

Species	Relative Frequency %	Relative Density	Relative Abundance	IVI
Phragmites karka	8.10	14.49	9.32	31.91
Hydrilla verticillata	8.10	16.80	13.41	38.31
Chara corallina	18.91	5.84	5.24	29.99
Nymphaea nauchali	18.91	3.85	6.41	29.41
Ipomoea aquatica	13.50	0.74	4.66	18.90
Ceratophyllum demersum	10.81	2.15	2.62	15.58
Lemna major	5.40	12.23	2.04	19.67
Vallisnaria natas	16.21	34.00	56.26	106.47

Table 4: Relative frequency, Density, Abundance and IVI of Macrophyte species in 2020

Species	Relative Frequency %	Relative Density	Relative Abundance	IVI
Phragmites karka	37.97	60.40	31.25	129.62
Hydrilla verticillata	12.65	13.83	15.38	41.86
Chara corallina	30.37	4.57	6.25	41.19
Nymphaea nauchali	0	-	-	-
Ipomoea aquatica	0	-	-	-
Ceratophyllum demersum	0	-	-	-
Lemna major	0	-	-	-
Vallisnaria natas	18.98	91.19	47.11	87.28

The first year also exhibited water lower than usual temperature and a reduced diversity among the aquatic plants which supported the absence of eutrophy in the study. In the second year, reduced secchi disc depth, and

TP and total chlorophyll content showed an increasing trend.

In the second sampling session, the Secchi disk depth reduced, and TP and Total chlorophyll a contents showed an increasing trend. Although not apparent in terms of TSI values, the wetland showed clear indications of advancing eutrophy with increasing trend in water temperature and suspended solids. The decreased water clarity was perceived to be due to increase in the population of *Eichhornia crassipes*.

CONCLUSION

The change in the trophic nature of Shatiya wetland is alarming to pollution, as it indicates the possibilities of shrinkage in cover area. The conservation of Shatiya wetland must be prioritized to prevent its increasing pollution.

REFERENCES:

S Irfan and Shardendu (2009): Dynamics of nitrogen in sub-tropical wetland and its uptake and storage by *Pistia stratiotes*. Journal of Environ Biol 30(6): 977-981.

Ambastha K, Hussain SA and Badola R (2007a): Socio and Economic Considerations in conserving wetlands of Indo-Gangetic Plains-A case study of wetland, India. Environmentalist 27: 261-273.

Brouwer R, Langford IH, Bateman IJ and Turner RK (1999): A meta-analysis of wetland contingent valuation studies. Regional Environmental Change 1 (1): 47-57.

Ambastha K, Hussain S A and Badola R (2007): Resource dependence and attitudes of local people toward conservation of Kabartal wetland: A case study from the Indo Gangetic Plains. Wetlands Ecol Management 15:287-302.

Liu SX, Athar M, Lippai I, Waldren C, Hei TK (2001): Induction of oxy-radicals by Arsenic: Implication for mechanism of Genotoxicity. Proc Natl Acad Sci 98 (4): 1643-1648.

Carlson RE (2005): A trophic state index of lakes. Limnol Oceanogr 22(2): 361-369.

Xing KX, Guo HC, Sun YF and Huang YT (2005): Assessment of the spatial-temporal eutrophic character in the Lake Dianchi. J Geo Sci 15 (1): 37-43.

Duan H, Zhang Y, Zhang B, Song K and Wang Z (2007): Assessment of chlorophyll-a concentration and trophic status for Lake Chagan using Landsat TM and Field Spectral Data. Environ Monit Assess 129: 295-308.

Nouri J, Mirbagheri SA, Farrokhian F, Jaafarzadeh N and Alesheikh AA (2010): Water quality and eutrophic state in wet and dry years in wetlands of the semi-arid and arid regions. Environment, Earth and Science 59 (7): 1397-1407.

Ebina J, Tsutsui T and Shirai T (1983): Simultaneous determination of Total Nitrogen and Total Phosphorus in water using Peroxodisulphate digestion. Water Res 17 (12): 1721-1726.

Walinga I, Vander lee JJ, Honba VJG, Van Vosk W and Novozamsky I (1995): Plant Analysis Manual. Kulwer Academic Publisher, Dordrecht.

Bendre and Kumar (2002): A Practical Botany (7th Edition). Rastogi Publications, Meerut.

Zhang Y, Koponen S, Pulliainen I and Hallikainen M (2003): Application of empirical neural networks to chlorophyll-a estimation in coastal waters using remote optic sensors. IEEE Sensar Journal 3 (4): 376-382.