Determination and Evaluation Trophic State Index of Bamdezh Wetland in Iran

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Abstract

All water bodies fall into one of the three trophic states such as eutrophic, mesotrophic and oligotrophic. Because of the important of trophic states in surface water recourses in current study this factor was determined and analyzed. The values of Trophic State Index (TSI) have clearly indicated that the total phosphorus contents were increased in Bamdezh wetland, which resulted into its eutrophic condition. In this condition different types of algae grow luxuriantly and cause decrease in DO, as a result of this most of the aquatic organisms and plants culminate into death.

Key words: Bamdezh Wetland, Trophic State Index, Eutrophic Condition .

Introduction

Eutrophication is becoming one of the main problems in water deterioration (Manojlovic et al., 2007 and Choi et al., 2008). This process can be evaluated by determining the limiting nutrients and by calculating trophic state indices. The trophic state index (TSI) based on several biological, chemical and physical indicators, especially the Carlson-type TSI offers the most suitable and acceptable method for evaluating lakes eutrophication (Xu et al., 2001). Carlson (1977) introduced a set of lake trophic state indices (TSIs) based on measurement of phosphorus TSI (TSITP), chlorophyll a TSI (TSIChl a) and Secchi disc depth TSI (TSISD). Carlson's TSIs are based on the assumption that when phosphorus is the limiting nutrient in a lake, there will be a close relationship between TSITP and TSIChl a (Matthews et al., 2002).

Akbarzadeh et al. (2008) determined the trophic state of the Anzali wetland. This study was conducted for one year on 21 stations, in three zones, including receiving rivers, surface water and exiting rivers. Geographic information system was used for better understanding of the prevailing situation. Analysis was conducted according to international standards and classification of OECD for freshwaters. The indicators used were levels of total nitrogen (TN) and total phosphorous (TP) and the trophic state index (TSI). Data showed an increase of excess nutrients from domestic and agricultural sources, leading to eutrophication processes rather than natural eutrophication.

Fuller and Jodoin (2011) predicted the trophic state of lake by relating Secchi-disc transparency measurements through Landsat-Satellite Imagery for Michigan Inland Lakes during 2003–05 and 2007–08. The combination of improved satellite-data processing techniques and the Gethist method to identify open-water areas in inland lakes during 2003–05 and 2007–08 provided a stronger relation and statistical significance between predicted TSI (SDT) and measured TSI than did the AOI lake average method; differences in results for the two methods were significant at 99 (%) confidence level. In comparison of the regression equations, there was no statistically significant difference at 95 (%) confidence level, between the results of two equations. The previously used equation, in combination with the Gethist method gave coefficient of determination (R^2) values as 0.71 and 0.77 for the periods 2003–05 and 2007–08, respectively. The alternative equation, in combination with the Gethist method also gave R^2 values as 0.74 and 0.75 for the same period. Predicted TSI (SDT) and TSI (SDT) values for lakes used in the regression equations were very close to each other. The R^2 values 0.95 and 0.96 for predicted TSI (SDT) for the year 2003–05 and 2007–08 and calculated R^2 values for all inland lakes with available open-water areas same year were 0.91 and 0.93 also match very well.

Mirzajani et al. (2010) evaluated eutrophication trend of Anzali wetland based on 1992-2002 data. The data showed that according to all trophic state models Anzali wetland was eutroph except, the trophic state index TSI (PN), which indicated that Anzali wetland was in the final stage of mesotroph. Similar observation was noted by Kimbal (1974). The mesotroph condition of Anzali wetland was attributed to high growth of macrophytes. The content of chlorophylls, which is an index of phytoplankton biomass was high togather with the dominance of cyanobacteria species, is the sign of eutrophic condition.

The appearance of some aquatic plant species and vanishing of others were observed during 1988 to 2002 in Anzali wetland. Their density was also increased in Siahkeshim, Shijan and in the partial of central basin due to high nutrient river load. The presence of exotic species Azolla filiculoides since 1991 was due to the internal nutrient load, which had a negative impact on Anzali wetland ecosystem. According to Sabetraftar (1999) about 2950 (ha) of Anzali wetland surface area was covered by Azolla and in 45 (%) of the area the growth was very dense. The first effective measure for controlling eutrophication of the wetland was to prevent nutrient input load in it. Kimbal (1974) suggested some recommendations for the restoration of Anzali wetland. They conducted a study on the trophic state of these lakes during February 2003 to January 2004 and found that total nitrogen (TN), total phosphorus (TP), Secchi disc depth (SD) and chlorophyll a (Chl a) were the major factors to change its trophic state. According to calculated nutrient ratios, phosphorus was found to be the primary limiting nutrient in Lake Uluabat. Carlson's trophic state index values, based on TP, SD and Chl a, indicated that lake Uluabat was in the eutrophic system. The overall evaluation of this study clearly gave the signals of eutrophication of Uluabat lake during the study period. Due to its importance as being a Ramsar site, management solutions must be urgently applied in order to avoid degradation and deterioration of the lake. Therefore, comprehensive efforts must be undertaken to control excessive phosphorus inputs as well as to evaluate phosphorus release from sediment and waste water.They reported that excess growth of blue green algae was producing many toxins which were harmful to fishes and other organism in the lake. The excessive growth of phytoplankton and their subsequent death was consuming DO and making anaerobic conditions in the lake. All such activities causing eutrophic condition in most of the lakes should be controlled very well to protect the wetland ecosystems.

Because of important of trophic state of condition of water resources by using Bamdezh wetland parameters the amount of TSI was calculated and evaluated.

Materials and methods

Bamdezh wetland is located in Khuzestan province of Iran at the distance of about 40 (Km) on northwest site of Ahwaz-Dezful road. Kharkheh river is located on west and Dez river in east of Bamdezh wetland which is located between $48^0\ 27'$ to $48^0\ 42'$ eastern longitude and $31^0\ 38'$ to $31^0\ 55'$ northern latitude. The area of this wetland is 44 (Km^2) (11 Km X 4 Km). Bamdezh wetland ecosystem is surrounded by villages like Mazrae 2, Seyed Saleh to the north side, while on the west side there are four important villages like Kaab Abod, Seyed Zahrab, Sadat Tavaher and Ghaleh Sahar and to the south of Bamdezh wetland is Elhaee village. The famous Shavoor Dam is situated towards north side. Bamdezh wetland is a natural wetland, permanent fresh water marsh and recharged with Shavoor river as surface water source. Additionally, it is also recharged through saline ground water (Jamee, 2002). Figure 1 shows the location of Bamdezh wetland in Iran.

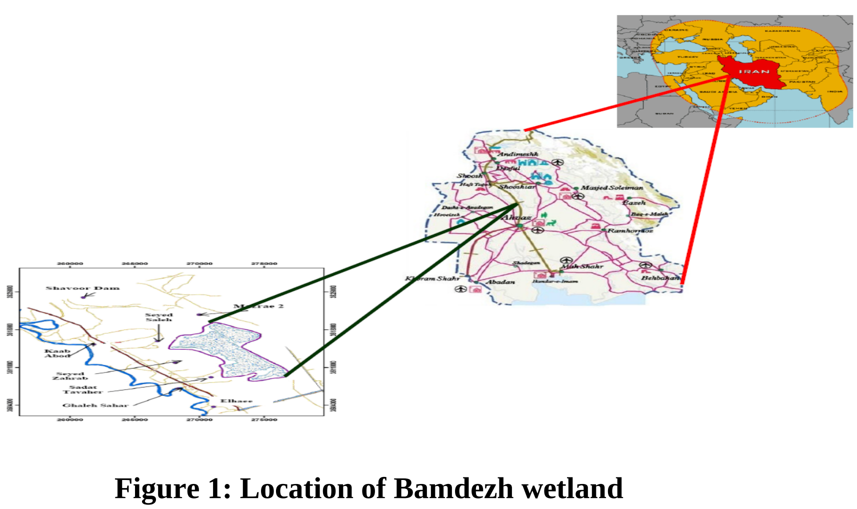

Figure 1: Location of Bamdezh wetland

Data on various aspects were collected in the month of April 2008 to June 2010. For this four sampling stations were selected. Shavoor Bridge was as input of wetland and Tavana canal (Kharoor canal) was the output of wetland. In addition two more stations were selected in the body of wetland. By using the amount of total phosphorus, TSI is calculated by using the following formula:

$$TSI = 14.42 Ln(TP) + 4.15 \qquad \text{(eq. 1)}$$

Where, TP is total phosphorus.

Results and Discussion

As mention before by using equation 1 the amount of TSI was calculated and the results were compared with standard. Results were represented on tables 1 and 4. Also, standard amounts show on tables 2 and 3.

Table 1: TSI of Bamdezh wetland

Season and year	Sampling stations				Average of wetland
	Shavoor Bridge (Input)	Mazraeh	Sadat Tavaher	Kharoor canal (Output)	
Spring 2008	62.89	68.49	55.69	53.59	65.57
Summer	62.50	63.57	61.45	53.98	66.03
Fall	62.42	63.78	67.23	66.68	69.14
Winter 2009	58.96	57.24	70.45	64.86	65.07
Spring	55.01	53.48	50.02	51.23	59.38
Summer	61.22	57.42	63.18	51.17	68.44
Fall	63.71	71.55	61.58	69.61	65.45
Winter 2010	54.12	51.11	58.10	56.79	59.16

Table 2: Standards of TSI for lake and wetland

Trophic state	Secchi disk transparency		Chlorophyll a (mg/l)	TSI
	(in)	(m)		
Oligo trophic	>157	>4.0	<2.6	<40
Meso trophic	79-157	2.0-4.0	2.6-7.2	40-50
Eutrophic	20-79	0.5-2.0	7.2-55.5	50-70
Hyper eutrophic	<20	<0.5	>55.5	>70

Table 3: Standards of EPA for trophic state

Parameters	Minimal	Slight	Moderate	High	Indication
TSS (mg/l)	<5	5-15	15-25	>25	Lake use important
Turbidity (NTU)	<3	3-7	7-15	>15	Suspended sediment
COD (mg/l)	<10	10-20	20-30	>30	Organic enrichment

Table 2 and 3, Source:-Hand book of Environmental Engineering Calculation, C.C.Lee, S.D. Line 2000, Mac Graw Hill.

Table 4: Trophic state of Bamdezh wetland

Season	Sampling stations				Average of wetland
	Shavoor Bridge (Input)	Mazraeh	Sadat Tavaher	Kharoor canal (Output)	
Spring 2008	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Summer	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Fall	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Winter 2009	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Spring	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Summer	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Fall	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Winter 2010	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic

All water bodies fall into one of the three trophic states such as eutrophic, mesotrophic and oligotrophic. Eutrophic water bodies such as lakes have a TSI value greater than 55 and are considered highly fertile or productive. They often have an abundance of algae and high phosphorus contents. This high algal growth decreases the transparency of the water and gives the water a greenish or brown color. Mesotrophic water bodies have TSI value from 40 to 55. Due to lower nutrient availability, mesotrophic water bodies are less productive. Being less productive, there is less algal growth and the water is very clearer. Oligotrophic water bodies have TSI value of less than 40. These are the least productive and have the clearest water.

The water bodies having TSI value below 30 are lacking in nutrients and are minimally productive, but would be good areas for water sports and good sources for drinking water. These lakes exhibit clear water with good visibility; however, they may not provide the necessary nutrients and algae to maintain a healthy environment for fishes and other wildlife.

The water bodies having TSI values ranging between 30 and 45 are considered to be of mid-range in nutrients and they are reasonably productive. They have an adequate amount of nutrients and generally support a fair amount of algae, aquatic plants, birds, fishes, insects and other wildlife.

Water bodies having TSI values ranging between 46 and 70 are considered to be good and have sufficient nutrients and have fairly high productivity; they have a greater amount of nutrients and are able to support abundant algae, aquatic plants, birds, fishes, insects and other wildlife.

Water bodies with TSI values ranging between 71 and 100 are considered to be with over abundance of nutrients and are the most productive trophic class. Because they have the highest nutrients concentrations, these water bodies have the potential to support the highest level of biological productivity (e.g. an abundance of algae, aquatic plants, birds, fishes, insects and other wildlife). These water bodies have the greatest potential for widely ranging dissolved oxygen conditions, which can have a detrimental effect on native plants and animals.

Conclusion

The water quality of Bamdezh wetland is changing very fast, which is affecting the flora and fauna in it. The value of TSI as one of the factors that affected the health of wetland have also indicated that during study period Bamdezh wetland was in eutrophic conditions, clearly indicating that the wetland is degrading fast and it requires restoration as well as improvement. This is because of the average water quality of Bamdezh wetland during the study period when compared with standard values having clearly indicated that its water was not suitable for the growth of flora and fauna. As a result of this both were declining at a faster rate. This has adverse impact on the biodiversity of Bamdezh wetland. This situation has clearly confirmed the degrading nature of Bamdezh wetland.

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