



## Investigating the trophy condition of Miankaleh wetland using TSI and TRIX index

M. Mirhashmi<sup>1</sup>, A. Shahnazari\*<sup>1</sup>, K. Nasir Ahmadi<sup>2</sup>

<sup>1</sup>Department of Water Engineering, Faculty of Agricultural Engineering, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran

<sup>2</sup>University of Science and Technology of Mazandaran, Behshar, Iran

**ABSTRACT:** The present study was conducted to investigate the water quality characteristics and nutritional status of the Miankaleh wetland using the Carlson Trophy Index (TSI) and TRIX. Measurement of parameters has been done during 6 seasons and 8 sampling periods in 6 stations of Dahane-ye-chopoghli, Bandar-e-Gaz, Gharehsu, Galogah, Ismaeilsay, and Miyan-ghaleh. Based on the results, Dahane-ye-chopoghli, and Gharehsu stations respectively have the highest amounts of phosphate (0.12 mg/l), nitrate (11.04 mg/l), the lowest DO (87 mg/l) and the highest BOD (mg/l 14/77) which indicates the unfavorable condition of the wetland in terms of quality. Calculation of TSI index based on TP shows that Miankaleh wetland is in hypertrophic condition (70-80) in four stations of, Dahane-ye-chopoghli, Gharehsu, Galogah, and Miyan-ghaleh and in eutrophic condition (60-70) in Bandar-e-Gaz and Ismaeilsay stations. On the other hand, based on TN, except for the Galogah station, which is in hypertrophic condition (70-80), the rest of the stations are in acute hypertrophic condition (80-100). Also, based on P/N, all the studied stations of the Miankaleh wetland are in mild mesotrophic conditions (30-40). In general, based on the total TSI index (29.62), the status of the wetland is in the eutrophic range (60-70). The results obtained for TRIX show that the two stations of Dahane-ye-chopoghli, and Galogah are in the mesozotrophic range (4-5) and the rest of the stations are in the oligotrophic range (2-4), which indicates the unfavorable condition of the wetland in terms of tropism. The main cause of these conditions is the discharge of sewage and drains from different units on the edge of the lagoon, which contain large amounts of nitrate and phosphate compounds.

### Review History:

Received: Mar. 16, 2023

Revised: Jun. 19, 2023

Accepted: Nov. 14, 2023

Available Online: Dec. 14, 2023

### Keywords:

Aquatic ecosystem

nutrients

nutritionism

pollution

water quality

### 1- Introduction

Eutrophication is a condition in an aquatic ecosystem where high concentrations of nutrients induce algal blooms. In fact, this phenomenon is characterized by the blooming of green or blue-green algae, often with an unpleasant smell and a severe decrease in dissolved oxygen. This phenomenon is one of the common issues in the quality management of water bodies. Rapid population growth, increased energy consumption, and diverse human activities accelerate the enrichment of aquatic ecosystems with nutrients. An increase in the concentration of nutrients can lead to the growth of aquatic plants and algal blooms and bring adverse environmental, economic, and social effects. Therefore, considering the negative effects of this phenomenon on the water body and the ecosystem of the region, it should be seriously considered by managers and planners. Determining the status and trophic trend of a wetland is the first step to describing the conditions of its non-living factors and living organisms. By determining the condition and food trend of a water body, its conditions in the future can be predicted and the need for any action can also be revealed. The most common and easiest way to determine the

trophy of an aquatic ecosystem is to calculate its trophic index based on the concentration of nutrients and plant products. One of the most reliable models for investigating the trophic status of wetlands was presented by Carlson (1976) and is known as TSI<sup>1</sup> trophic index. In this index, the degree of nutrition is classified based on the concentration of nutrients and chlorophyll a-, water clarity, and oxygen conditions near the bed. The TRIX<sup>2</sup> index is also one of the widely used indices for evaluating trophy conditions, especially in coastal ecosystems. The TRIX scale index was proposed by Wellen Wieder and his colleagues in 1998 to evaluate the trophic conditions of Adriatic coastal waters.

### 2- Materials and Method

In order to evaluate the nutrition status of Miankaleh Lagoon using the TSI and TRIX index, it is necessary to measure the parameters of phosphate, total nitrogen,

1 Trophic State Index

2 Trophic Index

\*Corresponding author's email: aliponh@yahoo.com



**Table 1. Standard classification of TSI nutritional index**

Water quality class	TSI Range
Oligotrophic	0-30
Mild mesotrophic	30-40
Mesotrophic	40-50
Acute mesotrophic	50-60
Eutrophic	60-70
Hypertrophic	70-80
Acute Hypertrophic	80-100

**Table 2. Classification of trophic status based on TRIX index**

Trophy status	System type	TRIX Range
Good	Aligotrophic	2-4
medium	Mesotrophic	4-5
Poor	(meso-eutrophic) medium	5-6
Bad	Eutrophic	6-8

chlorophyll-a, and dissolved oxygen. The information required to calculate these indicators includes the data measured by the General Directorate of Environmental Protection of Mazandaran province. The measurement of the mentioned parameters has been done during 6 seasons and 8 sampling periods in 6 stations of Dahane-ye-chopoghli, Bandar-e-Gaz, Gharehsu, Galogah, Ismaeilsay and Miyanghaleh. Among the parameters required to evaluate the TSI and TRIX indices, the measurement of the chlorophyll parameter has been limited.

**2- 1- TSI index calculation**

To calculate this index, equation (1) to (5) is used. In “Table 1” the range of changes of this index is presented.

$$TSI (TP) = 14.42 \ln(TP) + 4.15 \tag{1}$$

$$TSI (TN) = 14.43 \ln(TN) + 54.45 \tag{2}$$

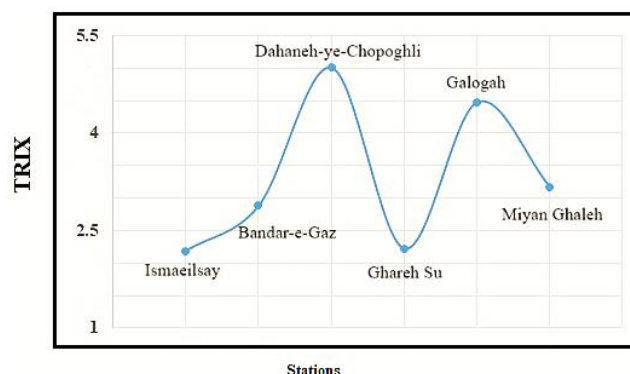
$$TSI (PN) = 9.81 \ln(10^{PN}) + 30 \tag{3}$$

$$\log(pn) = 1.25 LOG_{XPN} \tag{4}$$

$$XPN = \left[ P^{-2} \left[ \frac{N - 150}{12} \right]^{-2} \right] - 0.05 \tag{5}$$

**2- 2- TRIX index calculation**

This index is based on equation (6) and parameters, the percentage of oxygen deficiency from saturated oxygen, and general nutritional parameters including nitrate and total phosphate, which is calculated based on equation (6). In “Table 2” the range of changes of this index is presented.



**Fig. 1. Average values of the TRIX index in the sampled stations**

$$TRIX = \frac{K}{n} \times \sum \left( \frac{\log M_i - \log L_i}{\log U_i - \log L_i} \right) \tag{6}$$

**3- Results and discussion**

**3- 1- The results of applying the TRIX index**

According to the results presented in “Figure 1” of the lagoon, the highest value (5) of the TRIX index is related to Dehnechapagli station and the lowest value (2.3) belongs to Ismaeilsay station. According to the presented results, in terms of trophic conditions, Galogah and Dehnechapagli stations are in the mesotrophic range (4-5) and Qarasu, Ismaeilsay, Mian-Qalae, and Bandar Gaz stations are in the oligotrophic range (2-4).

**3- 2- The results of applying the TSI index**

The results of calculating this index are presented in “Figure 2”. The calculation of index (TSI) based on (TP) shows that Miankaleh wetland is in hypertrophic condition (70-80) in four stations of Dehnechapagli, Qarasu, Galogah, and Mianqala and in eutrophic condition (60-70)

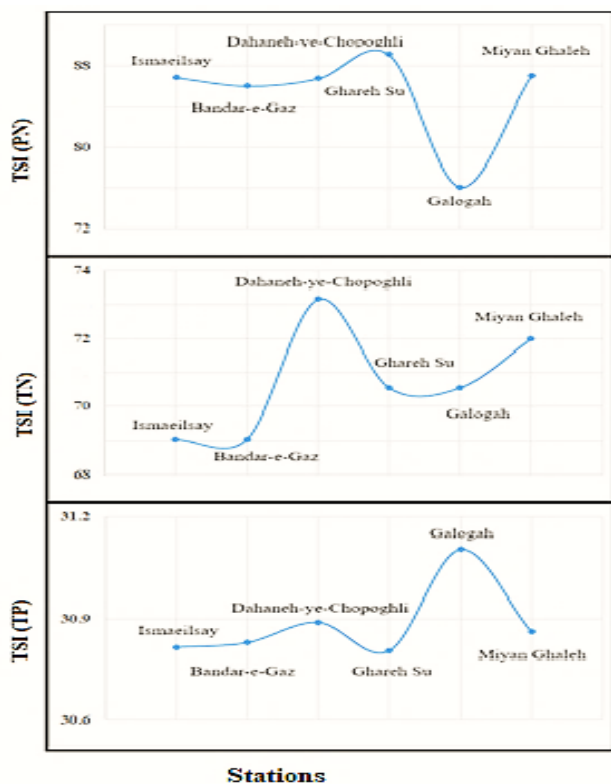


Fig. 1. Average values of the TRIX index in the sampled stations

in Bandargaz and Ismaeilsay stations. On the other hand, based on (TN), except for the Gulogah station, which is in hypertrophic condition (70-80), the rest of the stations are in acute hypertrophic condition (80-100). Also, based on the P/N ratio, all the studied stations of the Miankaleh wetland are in mild mesotrophic conditions (30-40).

#### 4- Conclusion

The results of the evaluation of both indicators indicate the unfavorable condition of the wetland and being in the dangerous range of nutritionalism. This situation has occurred due to the expansion of agricultural and industrial activities on the edge of the wetland and the discharge of their wastewater and production drains in the wetland environment.

Therefore, controlling and managing the discharge of these wastes is the most effective solution to improve the condition of the wetland and prevent the aggravation of its nutritional conditions. On the other hand, considering that the use of fertilizers containing nitrates and phosphates in agricultural lands and aquaculture centers has led to the aggravation of the trophic conditions of the wetland, therefore, replacing organic fertilizers can improve the trophic state of the wetland in addition to reducing the load of organic substances. In addition to the mentioned cases, it is possible to purify the water of the rivers feeding the wetland such as Qarasu and Gaz before entering the wetland by creating relaxation ponds or dams. This reduces the amount of nutrients entering the wetland through the washing of agricultural lands by these rivers and slows down the phenomenon of Nutritionism.

#### References

- [1] Olsson, L.; Ye, S.; Yu, X.; Wei, M.; Krauss, K.W. and Brix, H. Factors influencing CO<sub>2</sub> and CH<sub>4</sub> emissions from coastal wetlands in the Liaohe Delta, Northeast China. *Bio geosciences*. Vol. 12 (2015) 4965-4977.
- [2] Ling, D., Wu, J. Q., Pang, Y., Li, L., Gao, G., and Hu, D. W. Simulation study on algal dynamics based on ecological flume experiment in Taihu Lake, China. *Ecological Engineering*, 31 (2007) 200-206.
- [3] Samadi, J. Spatial-temporal modeling of qualitative characteristics and trophic status of Chaghakhor wetland using pollution indicators and deterministic techniques and GIS geostatistics. *Iran's water resources research*. 12(1) (2016) 122-132. [In Persian]
- [4] Elmaci, A., Ozengin, N., Teksoy, A., Topac, F.O. and Baskaya, H.S. Evaluation of trophic state of lake Uluabat, Turkey. *Journal of environmental biology*, 30(5) (2009) 757-757.
- [5] Kratzer, C. R. A Carlson-type trophic state index for nitrogen in florida lakes. *Water Resources Bulletin*. 17 (1980) 713-715.
- [6] Carlson, R. E. A Trophic State Index for lakes. *Limnology and Oceanography*. 22 (1976) 363-369.
- [7] Zoriatein, N., Jalili, S., and Poor, F. Evaluation of Ecological Quality Status with the Trophic Index (TRIX) Values in Coastal Area of Arvand, Northeastern of Persian Gulf, Iran. *World J Fish Mar Sci* 5 (2013) 257-62.

#### HOW TO CITE THIS ARTICLE

M. Mirhashmi, A. Shahnazari, K. Nasir Ahmadi, Investigating the trophy condition of Miankaleh wetland using TSI and TRIX index, *Amirkabir J. Civil Eng.*, 55(12) (2024) 527-530.

DOI: 10.22060/ceej.2023.22279.7944



