MARSH BULLETIN

ISSN 1816-9848

Comparison of the Application of two Trophic Status Indices at East Al -Hammar marsh - southern Iraq

Zainab A. Ahmed Alshaaban Makia M. Khalaf Al-Hejuje

Department of Ecology- College of Science – University of Basrah -Basrah-Iraq

Abstract

Water samples were collected from four East Al Hammar Marsh stations from July 2019 to May 2020. The measured variables included water temperature, light penetration, dissolved oxygen, reactive nitrate, reactive nitrite, total phosphorous, ammonium ion, and chlorophyll-a. This study applied the Trophic State Index (TSI) and Trophic Index (TRIX). The results showed that the range of variables for the water of the East Hammar Marsh was: water temperature (15.4 to 28.3) ◦C, light penetration (24 to 60) cm, dissolved oxygen (3.60 to 9.33) mg/L, nitrate (3.6 to 7.1) mg/L., nitrite (0.2 to 1.2) µg nitrogen atom /L, ammonium (0.7 to 7.6) mg/l, total phosphorus (2.75 to 24.23) µg phosphorous atom/l, chlorophyll-a (10.24 to 59.19) mg/m^3. Seasonal changes in the values of the TSI index were 25.07 to 44.04, which classified the level of nutritional status ranged (low-medium). The general average (34.66) was classified within the first category of poor nutritional status (Oligotrophic), and based on the nutrition index (TRIX), results showed that the values ranged from (2.47 to 3.58) described as having a very low nutritional level. Results revealed that (TRIX) was more effective than (TSI) in determining the nutrient levels of the waters of the East Al-Hammar Marsh.

Key Words: East Al-Hammar Marsh, Oligotrophic, Trophic Status Index, TSI, TRIX

Introduction

Water quality assessment has become a central and significant issue in many countries, particularly in countries that have taken steps to address potential water shortages (Varol *et al*., 2011). The marsh is defined as a low water body dominated by weeds, sedges, and reeds. It is a natural plant with an accumulation of organic matter in its sediments and is constantly exposed to water immersion (Mitch and Gossilink, 2007).

The marshes of southern and central Iraq were described as important ecological areas with unique characteristics that were considered one of the main areas famous for growing crops and raising livestock for over ten thousand years (DouAbul *et al.* ., 2009). The United Nations programs have classified them as the most important centers of biodiversity in the world (UNEP/GEMS, 2006).

Water quality indices (WQI) are among the most effective methods in determining water quality and its adherence to uses due to the difficulty of

estimating many chemicals, physical and biological variables (Almeida, 2007).
Guan (2011) defined WQI as an expression used to describe water's physical, chemical, and biological properties and how it can be used. The process of estimating water quality is one of the critical processes (Salim *et al*., 2009) that requires the use of efficient means and evidence to monitor and communicate the necessary simple and accurate information to the decision-makers, as it is based on making appropriate decisions and drawing up policies to preserve water quality from deterioration (Ramakishnaiah *et al*., 2009 Karakaya and Evrendilek, 2010; Al-Asadi, 2019). The traditional studies conducted to assess water quality included physical, chemical, and biological variables (Stambuk, 1999). If the value of this variable deviates from permissible limits, it is the determining factor in water quality according to its use (Moyel, 2010; Dojlido *et al*., 1994). Common measures of nutritional status are Nutrients, Chlorophyll a, and Secchi disc depth (Nalamutt and Karmakar, 2014).

The Trophic status index (TSI) is one of the standard indicators used by marshes that are affected by freshwater sources, local runoff, industrial waste, and waste from agricultural and livestock activities that cause increased nitrogenous and phosphate compounds in the aquatic environment as well as of a trophic condition that supports the excessive growth of a variety of phytoplankton, benthic algae, and macro plants, which lead to unfavorable changes highly desirable in the aquatic ecosystem and the emergence of a eutrophic condition (Carlson, 1977; Al-Asadi,2019).

Vollenweider *et al*. (1998) present a complex nutritional indicator (TRIX); this is based on some physicochemical parameters (percentage of oxygen saturation, inorganic nitrogen, and total phosphate) and biological parameters (Chlorophyll a). This made the TRIX indicator more developed to assess the nutritional status. The index values range from 0-10. Water is classified as having a very high nutritional level if the index value is between 6-and 10. It is classified as a very low nutritional level if the index value is (less than 4).

The current study aimed to know some environmental factors' seasonal changes and estimate the nutritional status in the waters east of the Al-Hammar Marsh.

Materials and Methods

The Study Area

The Al-Hammar Marsh is located in the southern region, specifically between Thi- Qar and Basrah provinces, one of the three main marshes in Iraq, representing 56% of its total area within Thi- Qar province and 44% of its total area within Basrah province. The Hammar Marsh is divided into eastern and western sections (Mutlaq *et al*., 2009). The East Al-Hammar Marsh represents the southeastern part of the marsh. Its length is estimated at 33 km, with a water depth ranging between 1.2-3 m depending on the tides' state (Hussain and Sabbar, 2020) , classified as a tidal marsh, as it is affected by the semi-daily tides and has brackish water, which receives its water from the Shatt Al-Arab (Hussain, 2014).

Four stations (Al-Siddah, Al-Mandhouri, Al-Mansouri, and Al-Nakara) were selected in East Al-Hammar Marsh. The locations of these stations were determined using the Geological Positioning System (GPS), as shown in Fig. (1)

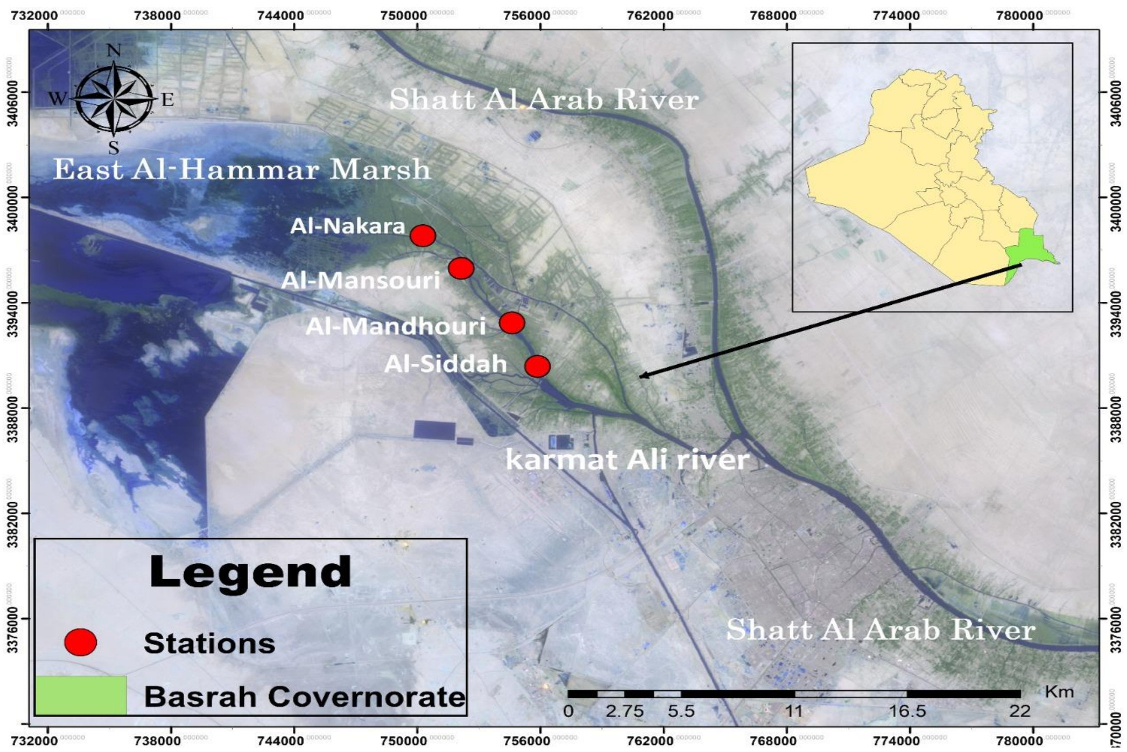

Figure 1: Map of study stations in East Al- Hammar Marsh

Water samples collection

Water samples were collected seasonally for the period from July 2019 to May 2020, which expressed as summer (July - August), autumn (October-November), winter (January-February)and Spring (May) from four stations (Al-Siddah, Al-Mandhouri, Al-Mansouri, and Al-Nakara) in the eastern marsh of Al-Hammar to conduct physical, chemical, and biological tests.

The air and water temperature was measured using a graduated mercury thermometer (0-100) °C. The light penetration was measured to express water transparency using a 25 cm diameter Secchi disc. Azid Modification for Winkler's method (Lind, 1979) was used to determine dissolved oxygen levels in the water, while Chlorophyll a was measured according to the method described in APHA (2017). Total phosphorous was measured according to the APHA method (2005) using a device spectrophotometer with a wavelength of 885 nm.

As for nitrate measurement, its estimation was based on the ultraviolet method (APHA, 2005). Nitrite was measured according to the method described in APHA (2005). The ammonium ion was estimated according to what was mentioned in APHA (2005).

Trophic Indices

Trophic State Index (TSI):

This index is intended to classify the trophic status of rivers and lakes into primary productivity by phytoplankton and aquatic plants (Dodds and Cole, 2007). According to the method described by Carlson (1977), the Trophic Status Index (TSI) was calculated as in the following equations:

$$TSI\ (SD) = 60 - 14.41\ \ln(\text{Secchi disc depth (m)})$$

$$TSI\ (Chl) = 9.81\ \ln(\text{Chlorophyll a } (\mu g/l)) + 30.6$$

TSI (TP)=14.42 Ln (Total phosphorus(µg/l)) +4.15

Average TSI=[TSI(TP)+TSI(Chl) +TSI(SD)]/3

Where:
SD= Secchi disk
Chl.a= Chlorophyll a
TP= Total Phosphorus.

Table (1): Water Trophic Index Scale (Carlson, 1977)

Categories Index (TSI)	**Description**
<30	Oligotrophic (low productivity)
40-50	Mesotrophic (medium productivity)
50-70	Eutrophic (high productivity)
70-100	hypertrophic (Very high productivity)

Trophic State Index (TRIX)

Trophic state index was calculated according to Vollenweider *et al*.(1998) as the equation below:

TRIX = [$\log_{10}$ (Chl. a *DO% * min N *TP)+1.5] /1.2

Whereas:

Chl.a = Chlorophyll A concentration (µg/l)

DO% = is the percentage of dissolved oxygen calculated as the absolute value of the deviation in the oxygen concentration from the percentage of water saturation with oxygen at water temperature. The percentage of complete deviation Equals 100%

Inorganic nitrogen N = is metallic nitrogen (inorganic) (nitrate + nitrite + ammonia in µg/L).

Table (2): TRIX nutritional status index values (Vollenweider *et al*.1998)

Index Value) (TRIX	Description nutritional level
<4	Low
4≤TRIX<5	Medium
5≤TRIX<6	High
6≤TRIX<10	Very high

Statistical Analysis

One-way analysis of variance (ANOVA test-one way) correlation coefficient was applied.

Primary Component Treatment Analysis (PCA) through software (XLSTAT 2015) to determine a variety of physical, chemical, and biological waters most important to water values, user guide, main evidence, and that angle indicates the extent of the relationship between variables and evidence. The obtuse angle is an inverse relationship.

Results and Discussion

The values of the environmental variables were recorded seasonally for the East Al-Hammar Marsh, as shown in Table (3). The highest average values of water temperatures(28.3°C)were recorded at the first station in summer, while the lowest (15.4°C) at the first station in winter table(3). The One Way (ANOVA) statistical analysis showed significant differences in seasons' water temperatures (P = 0.00).

Table (3): Ranges of water variables at East Al-Hammar Marsh stations during the studied period.

Parameters	Unit	Station 1	Station 2	Station 3	Station4
Water Temperature	°C	15.4 - 28.3	16.1 - 28.2	16.6 - 25.5	15.5 -25.4
Transparency	cm	26 - 60	24 - 59	24 - 41	26 - 39
DO	mg/L	4.90 - 8.93	5.17 - 9.33	3.68- 8.90	3.60 -8.83
NO^-_3	mg/L	4.6 - 6.8	4.1 - 6.8	3.9 - 6.9	3.6 -7.1
NO^-_2	µg N/L	0.4 -1.1	0.2 -1.2	0.2 -1.1	0.3 -1.0
NH^+_4	mg/L	1.1 - 2.9	1.3 - 7.6	1.0- 2.2	0.7 - 2.5
Total Phosphorus	µg P/ L	2.75 -24.23	3.93 - 13.01	4.50 - 23.94	5.65 -10.13
Chlorophyll a	µg/L	19.80 - 41.39	10.24 -50.29	15.13 - 59.19	14.24 -50.29

Temperature is one of the important environmental indicators of its direct impact on the aquatic environment's physical, chemical, and biological properties, as it affects the activity of living organisms (Larinier *et al*., 2010). The seasonal changes in water temperatures are due to Iraq's hot, dry climate and long daylight hours during summer and spring, whereas cold rainy winter, with long night hours (Al-Atbee, 2018). The results did not show significant differences in water temperatures among stations; this is due to the closeness of the stations to each other or perhaps a return to climate changes (Al-Hejuje, 1997).

The highest average light transition Secchi disc was 60 cm in the first station, and the lowest was 24 cm in the second and third stations, and there were significant ($P<0.05$) differences among the stations. The highest average light transition values were recorded in winter and the lowest in spring ($P<0.05$). The statistical analysis using analysis of variance showed significant differences in light transition (P = 0.00) among seasons.

Light transition is an important characteristic of water that expresses the transparency of the water surface due to organic and inorganic substances suspended in the water column, such as mud, silt, plant, animal, plankton, and other suspended matter, or due to external influences such as dust and the effect of weather conditions (Al-Abbawy,2012), or high temperatures that cause an increase in the decomposition of organic matter (Rasheed, 2019), or the flourishing and presence of prominent and submersible plants (Mutlaq, 2012). The high percentage of permeability in the winter season, especially in Al- Nakara station, may be attributed to the increase in water levels in the winter season, the lack of vital activities, and the delay in the decomposition of organic matter due to low temperatures, and this is consistent with Rasheed (2019).

The highest value of dissolved oxygen was recorded in the second station (Al-Mandori) 9.33 mg/L during the winter season, while the lowest (3.60) mg/L was in the fourth station (Al-Nagara) during summer. There were no significant differences (P = 0.674) among stations because they are too close, while significant differences (P = 0.00) among seasons.

The high percentage of dissolved oxygen during the winter and the lowest during the summer was agreed with most previous studies (Abdul, 2010; Al-Asadi, 2014; Al-Zaidi, 2017; Al-Asadi, 2019). The increase in rainfall, low temperature reduce the rate of evaporation and the decrease in the activity of living organisms, leading to A decrease in the rate of decomposition processes of organic matter (Lind, 1979), and the solubility of oxygen in water is inversely proportional to the temperature (Al-Hejuje, 2014).

The highest value of nitrate (7.1 mg/L) was recorded in the fourth station (Al-Nagara) during the winter season, while the lowest value (3.6 mg/l) was recorded in the fourth station during the autumn season. There were no significant differences among stations (P=0.997) but significant differences among seasons (P=0.005).

Nitrate values increased during the winter season in the fourth station, this may be due to the presence of dead fish floating on the surface coinciding with the times of sample collection due to incorrect fishing operations (personal observation), which results in decomposition processes of organic compounds rich in nitrates or due to rainwater and torrential rain that washes away soils, rocks, and sewage water containing nitrates of human and animal waste, which increase the values of nitrates, and the high level of oxygen in the water in winter oxidizes nitrites into nitrates. An increase in nitrates increases decomposing bacteria and converts them into nitrates (Al-Hejuje *et al*., 2014). Its decline in the autumn season in the fourth station may be due to its consumption by aquatic plants and phytoplankton or its reduction and transformation into nitrite due to high temperatures (Akbar *et al*., 2005).

The highest value of nitrite (1.2 µg atom N as NO_2/ L) was recorded in the second station (Al-Mandhouri) during the autumn season, while the lowest value (0.2 µg atom N as NO_2/ L) was recorded in the second and third stations during the spring season table(3). There were no significant differences (P = 0.950) among the stations. While significant differences in the nitrite values(P=0.005) among seasons.

The highest values of nitrite may be due to an increase in the levels of organic pollution waste in nearby residential areas or due to buffalo breeding, where the high level of nitrite indicates pollution with sewage, or The reduction of nitrates to nitrites occurs at high temperatures, and the nitrification processes of free ammonia increase or drainage from agricultural lands (Varol *et al*., 2011) and the decrease of nitrite may be due to aquatic plants growth (Al-Shammary, 2008).

The highest value of ammonium (7.6 mg/L) was recorded in the second station (Al-Mandhouri) during the autumn season, while the lowest value (0.7 mg/L) was recorded in the fourth station during the spring season. There were no significant differences between stations (P=0.102) and no significant differences in the values of the ammonium ion (P=0.536) among seasons.

The highest value may be untreated wastewater or organic materials and fertilizers from neighboring agricultural lands. At the same time, the lowest value may be due to low water levels and coincided with the increase in nitrate levels, as the ammonium ion oxidizes to nitrite (Al-Asadi, 2019). Al -Saadi *et al.* (1980) found that high ammonium values attributed to the fact that water-containing plants contain higher concentrations than open water due to the decomposition of plant parts and ammonium to the water.

The highest value of total phosphate (24.23 mg/L) was recorded at the first station (Al-Seddah) during the spring season, while the lowest (2.75 mg/L) was recorded at the first station during the winter season. There were no significant differences (P = 0.885) among the stations. While there were significant differences in the total phosphorous values (P = 0.001) among seasons.

The increase in phosphate is due to animal and plant wastes and plants containing chemical pesticides. Its decrease sometimes is due to its consumption by phytoplankton and aquatic plants, which is consistent with the study of Al-Hejuje *et al.*(2014). The decrease in phosphorous levels may be due to the increase in water levels, the dilution, and the growth of plants and phytoplankton that consume phosphorous compounds (Faragallah *et al.*, 2009).

The highest value of Chlorophyll a (59.19 µg/L) was recorded in the third station during the spring season, while the lowest value (10.24 µg/L) was recorded in the second station (Al-Mandhouri) during the winter. There were no significant differences (P=0.434) among stations. There were significant differences in Chlorophyll a (P=0.000) values among seasons.

Chlorophyll is a measure of living mass due to its presence in all phytoplankton and aquatic plants (Al-Rakabi, 1990). Chlorophyll values increase during the spring season due to higher nutrient values such as Nitrate, Phosphate, and Silica, which contribute to the growth of aquatic plants and phytoplankton (Harnstrom *et al*., 2009). This study agreed with Radi's (2014) and Al-Rasheed (2019) studies. While a decrease in Chlorophyll during the winter season may be due to the high water level and the death of plants in this season due to the cold weather and low temperatures.

Trophic state index (TSI)

The nutritional index is calculated from three variables (light transition, Total phosphorous, and Chlorophyll-a). The stations were classified into the first and second categories (low to medium nutritional status) (Table 4). The index values in the spring season44.04(Mesotrophic) at the fourth station is attributed to the low levels of domestic waste disposal or due to the high levels of Chlorophyll in that station as a result of agricultural lands discharge or due to low levels of transparency due to the flourishing of plants, phytoplankton and materials. The relationship that caused an increase in the level of turbidity as a result of the decrease in the index values in the winter Season 25.07 (Oligotrophic) is due to the increase in water levels and the dilution of pollutants, and the death of plants and phytoplankton that affects Chlorophyll and total phosphorous.

Trophic index combined images of inorganic nitrogen, Chlorophyll a, and oxygen saturation ratio, in addition to the effective phosphorous concentration, as it is one of the best evidence compared to Carlson's index (TSI) because it used images of inorganic nitrogen and oxygen saturation and not use a Secchi disc because of its inaccuracy. The highest values of the index were 3.58(Oligotrophic) in the fourth station (Al-Nakara) during the spring season, while the value was 2.47(Oligotrophic) in the fourth station in the autumn season (Table 4). The lowest value may be attributed to the high water levels and the possibility of rain that reduce the amount of total phosphorous, total nitrogen, and chlorophyll-a, which proved their influence on the index value. Whereas the rise in the index value resulted from the high percentage of phosphorous due to animal waste from neighboring residential areas (Al-Asadi, 2019), and thus the index values were classified within the first category (low nutritional status level).

Table.4.The values of nutritional status indicators during the seasons and study stations

Study stations	sessions	TSI	Category classification	TRIX	Category classification
Station 1	Summer	34.77	oligotrophic	2.85	Low Trophic level
	Autumn	33.92	oligotrophic	2.98	Low Trophic level
	Winter	25.92	oligotrophic	2.62	Low Trophic level
	Spring	43.63	mesotrophic	3.54	Low Trophic level
Station 2	Summer	33.86	oligotrophic	2.79	Low Trophic level
	Autumn	32.79	oligotrophic	2.94	Low Trophic level
	Winter	25.07	oligotrophic	2.62	Low Trophic level
	Spring	40.67	mesotrophic	3.30	Low Trophic level
Station 3	Summer	36.24	oligotrophic	2.83	Low Trophic level
	Autumn	36.71	oligotrophic	3.04	Low Trophic level
	Winter	29.19	oligotrophic	2.65	Low Trophic level
	Spring	39.16	oligotrophic	3.30	Low Trophic level
Station 4	Summer	35.69	oligotrophic	2.71	Low Trophic level
	Autumn	32.45	oligotrophic	2.47	Low Trophic level
	Winter	30.50	oligotrophic	2.77	Low Trophic level
	Spring	44.04	Mesotrophic	3.58	Low Trophic level
Average		34.66	oligotrophic	2.90	Low Trophic level

Conclusions

The current study found a significant increase in some variables values and deterioration in the water quality of the East Al-Hammar Marsh over the previous years, while some variables recorded a marked decrease than previously, including the fluctuation of water levels, chlorophyll-a (Chl.a) and dissolved oxygen levels. Case evidence relied on the nutritional status showed that (TRIX) was more effective than (TSI) in determining the nutrient levels of the waters of the eastern Hammar marsh Because it uses oxygen and N2 compounds, and its divisions are very precise, which is classified under the category of poor nutritional status (Oligotrophic).

Acknowledgment

I would like to thank the Ecology department for supporting during this project.

References

Al-Hejuje, M.M. (1997). Distribution of Heavy Elements in Water and Sediments from Al-Ashar and Al-Khandak Canals Connected with Shatt – Al-Arab River and their Effects on Algae". M.Sc. Thesis. The University of Basrah, college of science, biology department, 104 pp. (In Arabic)

AI-Hejuje, M.M. (2014). Application of water quality and pollution indices to evaluate the water and sediments status in the middle part of Shatt AI-Arab River. Ph.D. Thesis, college of science, University of Basrah., 240 pp.

AI-Hejuje, M.M.; Al-saad H.T and Hussain, N.A.(2014). Application of (TRIX) Index to Evaluate the Trophic Status of the Middle Part of Shatt Al-Arab River, South of Iraq. Indian J. Applied Research, 4(5):131-136.

Akbar, Manal Muhammad, Awad Abdul-Hussein Habash and Muhammad Imad Hadi (2005). An ecological study of zooplankton in the marshes of southern Iraq. Mesopotamia Journal, 20(1): 5-39.

AL-Abbawy, D. A.H. (2012). Assessment of trophic status for Shatt Al-Arab River using trophic state index (TSI). Journal of Basrah Researches., 38 (3): 36-44.

Al-Asadi, Azhar Abbas (2019). Assessment of the impact of sanitation on the level of pollution and environmental pollution in the central marshes / southern Iraq. Master's Thesis, College of Science, University of Basra. 160.

Al-Asadi, Wedad Taher Meziane (2014). Studying the effect of some environmental variables on the abundance and distribution of submerged aquatic plants in the Hammar Marsh and Shatt Al-Arab. Basra Journal of Science.32 (1):20-.42

Al-Atbee, Rehab Salim Khazaal. (2018). Assessment of Some Heavy Elements and Hydrocarbons in the Water, Sediments and Dominant Aquatic Plants at Al-Chibayish marshes. M.Sc. Thesis, College of Science, University of Basrah., 208.

Al-Hussein, Mayada Hazem Muhammad Ali (1998). Deduction of water quality parameters for the Tigris River in the city of Mosul. Master's thesis, College of Engineering, University of Mosul. 82 pages.

Almeida, C.A. (2007) Influence of Urbanization and Tourist Activities on the Water Quality of the Potrero De Los Funes River (San Luis – Argentina). Environmental Monitoring and Assessment, 133(1-3):459- 465.

Al-Rikabi, Khaled Majid Dakhil (1990) A study on diatoms in the Khor Al-Zubayr area in the northwest of the Gulf Arabi. Master's thesis, Marine Sciences Center, University of Basra: 250 pages

Al-Saadi, H. A.; Antoine, S. E. and Islam, A. N. (1980). Limnological investigations in Al-Hammar marsh area in southern Iraq. In 4th and 5th Bangladesh Science Conference, Rajshahi (Bangladesh), 2-5 Mar 1980. BAAS

Al-Shammary, Ahmed Chaseb (2008). Environmental assessment of fish populations southeast of the Hammar Marsh north of Basra, Iraq, using the Life Integration Guide, College of Agriculture, University of Basra 121 pages.

APHA: American Public Health Association. (2005). "Standard methods for the examination of water and wastewater”, 21st Edition .Washington, DC. USA

APHA: American Public Health Association. (2017). "Standard methods for the examination of water and wastewater”, 22th Edition .Washington, DC. The USA. Aquaculture a list Stirling Univ. Scotland. 199. Aquatic animals. Comp. Biochemical Physiology. 135A: 9-24.

Carlson, R.E. (1977). Atrophic state index for lakes. Limnol. And Oceanogr. 22: 361-369.

Dojlido, J.; Raniszewski, J. and Woyciechowska, J. (1994). Water Boland. Environ. Monit. Assess. 33: 33-42.

DouAbul, A. A. Z.; Al-Hello, M. A. R.; Al-Taein, S. M., and Al-Saad, H. T. (2009). Hydrocarbons and trace elements in the waters and sediments of the marshland of southern Iraq. Mesopotamian J. of Marine Science., 24(2): 126-139.

Dodds, W. K., and Cole, J. J. (2007). Expanding the concept of trophic state in aquatic ecosystems, it's not just the autotrophs. Aquatic Sciences.,69(4): 427-439.

Faragallah, H.M. ; Askar, A.I. ; Okbah, M.A. and Moustafa, H.M. (2009). Physico-chemical characteristics of the open Mediterranean Sea water far about 60 Km from Damietta harbor, Egypt. J. of Ecology and the Natural Environment, 1(5): 106-119

Guan, W.Y.(2011). Sustainability Water Quality in UTM river. Bachelor Thesis in Faculty of Civil Engineering, University of Technology, Malaysia.114.

Harnstrom, K.; Karnuasagar, I. and Godhe, A. (2009). Phytoplankton species assemblage and their relationship to hydrographic factors-a study at the old port in Mangalore-coastal Arabian. Indian Journal of Marine Sciences, 38(2): 224-234.

Hussain, N.A and Sabbar, A.A (2020). Trophic levels of tidal and non-tidal Marshes of Southern Mesopotamia .basrah journal of agriculture, 33(2):172-181.

Hussein, Najah Abboud. (2014) Environments of the Iraqi Marshes. Dar Al-Fikr for Publishing and Distribution, Basra, Iraq. 432.

Karakaya, N. and Evrendilek, F. (2010).Water quality time series for big melen stream (Turkey): its decomposition analysis and comparison to up stream. Environ Monit .Assess. 165:125-136.

Larnier, K.; Roux, H.; Dartus, D. and Groze, O. (2010). Water temperature modeling in the Garonne River (France). Knowl. Managet. Aquatic Ecosystem. 398: 4- 17.

Lind, O.T. (1979)."Handbook of common method in limnology”, 2 nd edition. C.V. mosby Co. ST. Louis. 199.

Mitch, W.J.andGosselink, J.G. (2007).Wetlands.4th edition.Columbus, Ohio.

Moyel, M.S.(2010).Assessment of water quality of the northern part of Shatt Al-Arab river , using water quality index (Canadian version).Msc. Thesis. University of Basrah, college of science, biology department: 100pp.

Mutlaq, Falah Maarouf (2012). Assessment of the stocks of some fish species from the eastern Hammar marsh in southern Iraq, PhD thesis, College of Agriculture, University of Basra. 195 pages.

Mutlaq, Falih Maarouf and Ali, Thamer Salem and Muhammad, Abdul Razzaq Mahmoud (2009). Species of marine fish migrating to the inland waters of southern Iraq for the period from 1973-2008 The Third Scientific Conference for the Rehabilitation of the Marshes of Southern Iraq, 3/14-13-2009 .

Nalamutt, T.D.; and Karmakar, S. (2014). Modeling impreciseness of trophic state levels for eutrophication assessment. J.Clean Energy Technologies, 2(2):140-144.

Nasirian, M. (2007) .A New Water Quality Index for Environmental Contamination Contributed by Mineral Processing: A Case Study of Amang (Tin Tailing) Processing Activity. J.of Applied Sci., 7(20): 277-298.

Noman, Muhammad Muthanna. (2008) Devising the water quality parameters of the Tigris River between Al-Sharqat and Albu Ajil. Master's thesis, College of Engineering, Tikrit University. 127 pages.

Ramakrishnaiah, C.R.; Sadashivalah, C. and Ranganna, G (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State Indian J. Chem., 6 (2):523-530

Radi, Fadia Khaled. (2014) Assessment of the East Hammar Marsh as a nature reserve using environmental evidence. Master Thesis, College of Agriculture, University of Basra 135. P.

Rashid, Sarah Sadiq (2019). Qualitative and quantitative composition of floating and attached diatoms on aquatic plants in the eastern Hammar marsh. Master's thesis, College of Science, University of Basra. 138 pages.

Salim, B.J.; Gholamreza, N.B.; Amir, S.; Masoud, T. and Mojtaba, A. (2009). Water Quality Assessment of Gheshlagh River Using Water Quality Indices .Environmental Science. 6(4):19-28.

Stambuk, N.G. (1999). Water quality Evaluation by index Dalmatia. Water research, 33(16):3423-3440.

UNEP GEMS - United Nations Environment Programme Global Environment Monitoring System Water Programme (2006). Water Quality Ecosystem and Human Health. UNEP GEMS / Water, Burlingtons, Ontario University of Waterloo. 382 pp. urban municipal wastewater effluent and its impact on the receiving

Varol, M. ; Gökot , B. ;Bekleyen , A. ; and Șen ,B. (2011) ." Water quality assessment and apportionment of pollution sources of Tigris River (Turkey) using multivariate statistical techniques – A case study ". River Res. Appl., published online in Wiley Online Library. (Wileyonlinelibrary.com) DOI: 10.1002/rra. 1533.

Vollenweider ,R. A. ; Giovanardi , F.; Montanari , G. and Rinaldi , (1998) Characterization of the trophic conditions of marine coastal waters with special referenceto the NW Adriatic Sea . Proposal for a trophic scale, turbidity and generalized water quality index, Environmetrics. 9: 329-357.

مقارنة بين تطبيق مؤشرين للحالة الغذائية في هور الحمار الشرقي - جنوب العراق

زينب علي أحمد الشعبان   مكية مهلهل خلف الحجاج

قسم البيئة - كلية العلوم - جامعة البصرة - البصرة - العراق

المستخلص

تم جمع عينات المياه من أربع محطات من هور الحمار الشرقي من تموز 2019 إلى أيار 2020. شملت المتغيرات المقاسة درجة حرارة الماء، ونفاذية الضوء، والأكسجين المذاب، والنترات الفعالة، والنتريت الفعال، والفوسفور الكلي، وأيون الأمونيوم، والكلوروفيل-أ. طبقت هذه الدراسة مؤشر الحالة الغذائية (TSI) والمؤشر الغذائي (TRIX). أظهرت النتائج أن نطاق المتغيرات لمياه أهور الحمار الشرقي كان: درجة حرارة الماء (15.4 إلى 28.3) C° ، نفاذية الضوء (24 إلى 60) سم ، الأكسجين المذاب (3.60 إلى 9.33) ملغم / لتر ، نترات (3.6 إلى 7.1) ملغم / لتر ، نتريت (0.2 إلى 1.2) ميكروغرام ذرة نيتروجين / لتر ، أمونيوم (0.7 إلى 7.6) ملغم / لتر ، مجموع الفوسفور (2.75 إلى 24.23) ميكروغرام ذرة الفوسفور / لتر ، الكلوروفيل-أ (10.24 إلى 59.19) ملغم/م3. تراوحت التغيرات الموسمية في قيم مؤشر TSI بين 25.07 و 44.04، مما أدى إلى تصنيف مستوى الحالة التغذوية من (منخفض - متوسط). تم تصنيف المتوسط العام (34.66) ضمن الفئة الأولى من الحالة التغذوية الفقيرة (Oligotrophic) ، وبناء على دليل التغذية (TRIX) ، أظهر Teat أن القيم تراوحت بين (2.47 إلى 3.58) الموصوفة بأنها ذات مستوى غذائي منخفض جدا. وكشفت النتائج أن (TRIX) كان أكثر فعالية من (TSI) في تحديد المستويات الغذائية لمياه هور الحمار الشرقي.