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Assessment of Water Quality and Trophic Status of Duhok Lake Dam

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Abstract:

This study is conducted in order to, investigate the trophic state of Duhok Lake Dam located within Duhok city, Iraq. Water samples are collected seasonally from three monitored sites during 2011. The parameters used for assessing water quality and trophic status level include: water temperature, pH, EC, TDS, DO, BOD_5, nutrients, Secchi disk transparency, and chlorophyll *a*. The results reveal that DO is above 5 $mg.l^{-1}$ in all sites, BOD_5 value is within permissible level for domestic uses. Water quality considered as a hard type. High sulfate concentration is recorded during the study period. Trophic state shows that water type is classified as mesotrophic during autumn season, while it is regarded as eutrophic in other seasons. TDN/TDP ratio suggests that phosphorus is a limiting factor for algal growth. Based on IWQI, the water type is classified as excellent type for irrigation purpose.

Key words: TSI, TDN/TDP Ratio, Duhok Lake Dam, Water Quality.

Introduction:

Eutrophication is one of the greatest risks to aquatic ecosystems. It is a slow and long process [1]. Nutrients inputs from different point and non-point sources have a significant effect on eutrophication development, especially from untreated wastewater, fertilization of field crops and runoff erosion form land agriculture [2, 3, 4]. Introducing phosphorus and nitrogen to the major eutrophication nutrients causes impairment to the quality of water for various purposes [5, 6]. Accumulation of such nutrients over a long period of time can build up in the sediment creating the potential for an internal load that can be resuspended into the water column under different environmental conditions [5]. The trophic state index (TSI) introduced by Carlson (1977), is widely used and acceptable index to estimate the limiting nutrient causing eutrophication [7], which it has been adopted by [8] nutrient criteria recommendations for lakes and reservoirs. For trophic level evaluation some most indicative parameters such as, chlorophyll a, total phosphorus, transparency, in addition to, total nitrogen are taken into account [9, 10]. The most accurate parameter used for prediction productivity and algal biomass is chlorophyll, therefore, it is given the highest priority for classification compared with other variables (Transparency, TP and TN) [11]. Total phosphorus and total nitrogen represent the main nutrients for phytoplankton growth. They are commonly used as an index considered as the limiting factors for algal growth. For determining the availability of these nutrients, TN/TP ratio is used. According to [12], total nitrogen exceeds total phosphorus by more than 7 folds (>7:1) [13, 14, 15]. The aim of the study is to evaluate the water quality and determine the degree of eutrophication by using trophic state index for Duhok lake dam.

Materials and Methods:

Water samples are collected in a clean polyethylene bottle from Duhok lake dam in four seasons during 2013 at three sites. Standard techniques are used [16, 17] to analyze different physico-chemical parameters: pH, electrical conductivity in the field by using (pH meter Philips 4014 and EC meter Philips 4025 respectively), total dissolved solids (TDS, evaporation at 180 ºC), total hardness, calcium and magnesium (EDTA titrimetric method), Cl (argentometric method), SO_4^{-2} (titrimetric method), HCO_3 (titrimetric method), Na^+ and K^+ (flame photometric method), dissolved oxygen using azide modification of winkler method; reactive phosphate using phosphomolybdate- ascorbic acid reduction procedure; ammonia using indophenols' blue method, NO_2 using diazotized sulfanilamide methods.

Water transparency is measured by using Secchi disk. Total dissolved phosphate is measured by using persulphate digestion method, while chlorophyll- *a* is determined by using acetone extraction procedure. The absorbance is measured by spectrophotometer, total dissolved nitrogen using potassium persulphate ($K_2S_2O_8$) as described in in [16 and 17].

These equations (equation 1, 2, 3 and 4) are originally based on Carlson trophic static indices (1977). [1, 18, 19].

TSI (SD) = 60.0 − 14.41 ∗ ln(SD) (1)
TSI (TP) = 14.42 ∗ ln(TP) + 4.15 (2)
TSI (Chl) = 30.6 + 9.81 ∗ ln(Chl) (3)
in which the TSI based on TN data is calculated using [19] equation:
TSI (TN) = 54.45 + 14.43 ∗ ln(TN) (4)
Carlson's trophic state index (CTSI) = [TSI (TP) +TSI (CA) +TSI (SD)]/4

Where SD = Secchi Depth (m), TP = Total Phosphorous (µg/l), TN = Total Nitrogen, Chl = Chlorophyll (µg/l).

Study Area:

The Dohuk lake dam is an earth-fill embankment dam (latitude: 36º 52′ 33″ N; longitude: 43º 00′ 13″ E). It is built on the Dohuk River just to the north of Dohuk city, Iraq. The dam is completed in 1988 with the primary purpose of providing water for irrigation. It is 60 m tall and can withhold 52,000,000 m^3 of water. The dam has a bell-mouth spillway with a maximum discharge of 81 m^3/s. maximum length of reservoir is 4km and maximum width is about 1.7km, with maximum depth of 60m [20] (Figure 1).

Applied Irrigated Water Quality Indices:

For the IWQI nine important parameters were chosen are pH, EC, HCO_3^-, Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, and SO_4^{2-}. It is calculated from the following formula:

$$IWQI = \frac{1}{N} \sum_{i=1}^{N} WQIi$$

Where, ***WQIi*** is Water Quality Index for the characteristic and ***IWQI*** is Irrigation

Water Quality Index. The results, are classified according to [21] Table (1).

Table (1): Depending on [21] the Irrigation Water Classified into Four Categories.

Classes	(IWQI)value
Excellent	WQIi or IWQI≤ 1.96
Good	1.96 < WQIi or IWQI ≤ 5.88
Average	5.88 < WQIi or IWQI ≤ 9.80
(Poor)	WQIi or IWQI > 9.80

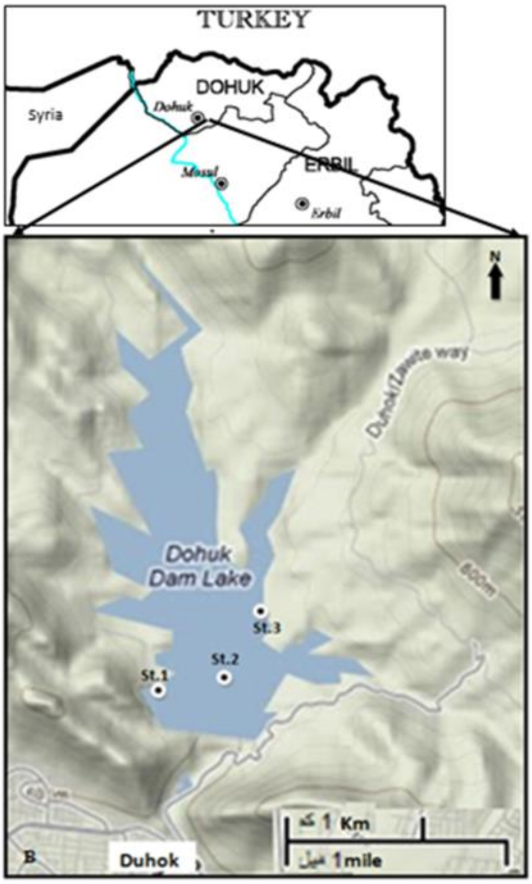

Fig.(1):Shows Map of : A- Northern Part of Iraq, B- Sampling Sites of Duhok Lake Dam.

Results and Discussion:

The trophic progression of water bodies from oligotrophic to eutrophic state a gradual process in nature. The change from one trophic stage to another is based on the conversion in the degree of nutrient inflow and the productivity in the lake [22].

Water quality properties of Duhok lake dam water samples are measured as shown in (Table 2 and 3). As noted the pH value of studied sites tends to alkaline side of neutrality. The minimum value is recorded at site 2 (7.98). Dissolved oxygen concentration is above 5 $mg.l^{-1}$ in all sites. The maximum DO concentration is noted 7.17 $mg.l^{-1}$ during summer season. There is an inverse fluctuation pattern between DO and water temperature, which reduces oxygen solubility. [5] state that increasing water temperature reduces water capacity for DO holding due to rapid saturation. Electrical conductivity (EC) and TDS values fluctuate in the same manner at all sites, the highest value is recorded in site1 which is 970 $\mu s.cm^{-1}$, 629 $mg.l^{-1}$ respectively. On the other hand, the minimum values for both parameters, are noted in winter season (749 $\mu s.cm^{-1}$, 488 $mg.l^{-1}$) respectively, and the highest value is noted during summer season (1240 $\mu s.cm^{-1}$, 806 $mg.l^{-1}$) respectively. Statistically significant differences ($P \leq 0.05$) are observed between seasons, except between summer and autumn. These differences between dry and wet seasons, may be attributed to rainfall, erosion of minerals and dilution effects [23].

Spatially and temporarily, the sulfate concentration is high and it ranging from 474- 525 $mg.l^{-1}$ for studied seasons, the main source of sulfate in Water Lake it may be return to water discharge from sulfur spring into water dam, in addition to the catchment area could be participated to add more sulfate into the water dam [24]. Duhok water dam characterized by a hard water according to [25] classification, and the highest value of hardness reported at site 1(402 mg $CaCO_3.l^{-1}$). BOD_5 values, on the other hand, are within the acceptable range for human water consumption depending on [26] classification for drinking water.

Table (2): Physico-Chemical Properties of Studied Site, Data Represented as mean ± SE.

Water Properties	Site 1	Site 2	Site 3
Water temperature (ºC)	21.0±0.047^{a}	21.0±0.047^{a}	20.9±0.047^{a}
pH	8.04±0.018^{a}	7.98±0.018^{a}	8.02±0.018^{a}
EC (µs.cm^{-1})	970.75±2.7^{a}	960.33±2.7^{b}	963.92±2.7^{ab}
TDS (mg.l^{-1})	629.01±2.15^{a}	624.52±2.15^{a}	624.48±2.15^{a}
Hardness (mg $CaCO_3$.l^{-1})	384.92±2.50^{b}	402.75±2.50^{a}	390.33±2.50^{b}
Ca^{+2} (mg $CaCO_3$.l^{-1})	76.10±1.06^{b}	77.47±1.06^{ab}	79.97±1.06^{a}
Mg^{+2} (mg $CaCO_3$.l^{-1})	47.18±1.07^{ab}	49.76±1.07^{a}	46.27±1.07^{b}
HCO_3^- (mg $CaCO_3$.l^{-1})	159.83±1.78^{a}	162.96±1.78^{a}	164.08±1.78^{a}
Na^+ (mg.l^{-1})	72.74±1.55^{b}	80.17±1.55^{a}	79.29±1.55^{a}
K^+ (mg.l^{-1})	9.86±0.12^{a}	9.81±0.12^{a}	10.05±0.12^{a}
Cl^- (mg.l^{-1})	32.83±0.89^{b}	30.63±0.89^{b}	35.67±0.89^{a}
SO_4^{+2} (mg.l^{-1})	474.05±5.98^{b}	520.6±5.98^{a}	525.3±5.98^{a}
DO(mg.l^{-1})	5.31±0.06^{b}	5.53±0.06^{a}	5.45±0.06a^{b}
BOD_5 (mg.l^{-1})	1.55±0.047^{a}	1.36±0.047^{b}	1.267±0.047^{b}
NO_2 (µg.l^{-1})	0.628±0.08^{b}	0.623±0.08^{b}	0.913±0.08^{a}
NH_4 (µg.l^{-1})	18.06±0.44^{b}	19.42±0.44^{ab}	19.90±0.44^{a}
TDN (µg.l^{-1})	38.57±6.5^{a}	41.94±6.5^{a}	34.5±6.5^{a}
PO_4 (µg.l^{-1})	1.65±0.16^{a}	1.28±0.16^{a}	1.54±0.16^{a}
TDP (µg.l^{-1})	3.33±0.499^{b}	6.98±0.499^{a}	3.47±0.499^{b}
Chlorophyll *a* (µg.l^{-1})	21.64±5.86^{a}	21.95±5.86^{a}	14.63±5.86^{a}

Table (3): Seasonal Variation of Some Physico-Chemical Properties of Studied Sites, Data Represented as Mean ± SE.

Water properties	Winter	Spring	Summer	Autumn
Water temperature (ºC)	8.33±0.067^{c}	27.2±0.067^{a}	26.6±0.067^{b}	21.7±0.067^{c}
pH	7.70±0.021^{c}	8.40±0.021^{a}	7.98±0.021^{b}	7.96±0.021^{b}
EC (µs.cm^{-1})	749.78^{d}	823.44^{c}	1240.89^{a}	1045.89^{b}
TDS (mg.l^{-1})	488.46±2.48^{d}	535.24±2.48^{c}	806.61±2.48^{a}	673.82±2.48^{b}
Hardness (mg $CaCO_3$.l^{-1})	382.4±2.91^{b}	440.0±2.91^{a}	383.3±2.91^{b}	364.9±2.91^{c}
Ca^{+2} (mg $CaCO_3$.l^{-1})	89.46± 1.22^{a}	57.0± 1.22^{c}	92.18± 1.22^{a}	72.76± 1.22^{b}
Mg^{+2} (mg $CaCO_3$.l^{-1})	38.12±1.24^{c}	70.76±1.24^{a}	37.51±1.24^{c}	44.56±1.24^{b}
HCO_3^- (mg $CaCO_3$.l^{-1})	189.2± 2.05^{a}	155.3± 2.05^{c}	165.1± 2.05^{b}	139.6± 2.05^{d}
Na^+ (mg.l^{-1})	73.85±1.79^{b}	72.65±1.79^{b}	71.36±1.79^{b}	91.74±1.79^{a}
K^+ (mg.l^{-1})	11.57±0.14^{a}	7.00±0.14^{d}	11.11±0.14^{b}	9.94±0.14^{c}
Cl^- (mg.l^{-1})	26.83± 1.02^{c}	36.0± 1.02^{a}	39.11± 1.02^{a}	30.22± 1.02^{b}
SO_4^{+2} (mg.l^{-1})	543.89±6.90^{a}	501.0±6.90^{b}	436.12±6.90^{c}	545.54±6.90^{a}
DO(mg.l^{-1})	7.17± 0.07^{a}	4.33± 0.07^{c}	4.29± 0.07^{c}	5.93± 0.07^{b}
BOD_5 (mg.l^{-1})	1.23± 0.05^{b}	1.17± 0.05^{bc}	2.14± 0.05^{a}	1.02± 0.05^{c}
NO_2 (µg.l^{-1})	0.493± 0.096^{b}	0.749± 0.096^{ab}	0.920± 0.096^{a}	0.724± 0.096^{ab}
NH_4 (µg.l^{-1})	2.39±0.51^{d}	33.17±0.51^{b}	36.56±0.51^{a}	4.42±0.51^{c}
TDN (µg.l^{-1})	26.0±7.50^{b}	63.56±7.50^{a}	53.84±7.50^{a}	9.93±7.50^{b}
PO_4 (µg.l^{-1})	1.206±0.18^{b}	2.056±0.18^{a}	2.539±0.18^{a}	0.16±0.18^{c}
TDP (µg.l^{-1})	2.56±0.58^{b}	7.72±0.58^{a}	7.38±0.58^{a}	0.72±0.58^{c}
Chlorophyll *a* (µg.l^{-1})	6.18± 6.77^{b}	16.33± 6.77^{ab}	37.49± 6.77^{a}	17.62± 6.77^{ab}

The highest TDN and TDP compounds are noted during warm seasons, and this may be due to inputs of chemical fertilizers and other plant residues from around agricultural lands [27]. It is found that chlorophyll a during summer and spring seasons is coincided by higher nutrients content. [28] observe the same phenomenon and comment that plant growth and photosynthesis depend on nourishments. On the other hand, they state that water temperature 20-35ºC is the most favorable temperature for plant growth. [27] record the highest chlorophyll a content in Marzanaland shallow wetland in Iran during warm periods.

Depending on irrigated water quality index (IWQI) values for Duhok lake dam in different seasons, water quality is regarded as excellent types for irrigation purpose based on [21] classification (Table 4). Site 3 is characterized by higher values with maximum value 1.72 observed during winter. It is lower than the maximum permissible value of IWQI as excellent water quality type for irrigation purpose. This may be attributed to high dissolved salts and ionic composition at site3 compared with other sites. [29, 30] conclude that ionic composition of water estimate the quality of water for irrigation purpose.

Table (4): Shows Water Properties as Irrigated Water Quality Index.

IWQI	Winter	Spring	Summer	Autumn	Class
S1	0	1.13	1.02	1.18	Excellent
S2	1.02	0	0	0	Excellent
S3	1.72	1.3	1.32	1.42	Excellent

Trophic State Index:

Chlorophyll a is used to estimate the amount of phytoplankton or algae in an aquatic system. It is a useful parameter for determining the biological productivity of a water body [31]. The highest TSI (chloro a) is observed during summer (TSI chloro a 66.15). This may be attributed to various factors, such as, increasing water temperature, high intensity of incident radiation, in addition to , nutrients input from surrounding agricultural lands [3, 32], while, the lowest TSI (chloro *a*) value is recorded in winter season (48.44). This can be explained by lower water temperature and increasing turbidity.

Table (5): Trophic Status Index Values and TDN/TDP Ratio for Duhok Lake Dam during Study period.

	Winter	Spring	Summer	Autumn
TSI SD	45.16	48.251	44.90	42.79
TSI TN	101.47	114.36	111.9	87.55
TSI TP	17.761	33.616	32.96	0.856
TSI Chlorophyll *a*	48.44	57.996	66.15	58.73
TSI average	53.21	63.56	63.99	47.91
DIN/TDP ratio	10.2	8.25	7.30	13.0

TSI for (SD) transparency is ranged from 42.79 that recorded during autumn to 48.25 noted during spring season. The transparency is correlated with increasing in phytoplankton density (higher content of chlorophyll a) and decrease in light penetration [1]. The Secchi disk depth variation is essentially the measure of the optical clarity of water. It is a function of the presence of suspended solids, excessive floating vegetation or algal bloom and the turbulence caused by rain water [33].

Nitrogen is more abundant compared with phosphorus, it exists in atmosphere and may be removed from aquatic ecosystem through denitrification [34]. The highest nitrogen value recorded during spring 63.6 µg.l-1 (TSI TDN 114.36) and the lowest value observed during autumn season (TSI TDN 87.55). It seems from this study the nitrogen is not considered as a limiting factor for phytoplankton growth. N:P ratio exceeds 7 folds during the study period in Duhok lake dam, indicating that the phosphorus is the primary limiting factor for phytoplankton growth. [35] indicate that a reduced N input into lakes increasingly favors the N_2- fixing activity of cyanobacteria as a response by the phytoplankton community to seasonal N limitation. N_2 fixation is sufficient to allow continuation of biomass production in proportion to the phosphorus present in the water. [12] reported that phosphorus tends to be the limiting factor if N:P ratio is greater than 7:1, less than 7 fold the nitrogen being the limiting factor.

High phosphate content in eutrophic lakes supports an increased level of primary production till nitrogen limiting [31]. Minimum TDP concentration recorded during autumn season, according to N:P ratio phosphate considered as limiting factor for plant growth in this study. TSI (SD and chloro a) were close together, and both were above the TSI (TDP). This suggest that phosphate is limiting factor affect algal biomass [13, 14].

Generally, TSI average of four calculated parameters, indicated that Duhok lake dam showed the mesotrophic status during autumn season (47.91), while it regarded as eutrophic status in the rest seasons, because it values exceed 50 (Fig. 2).

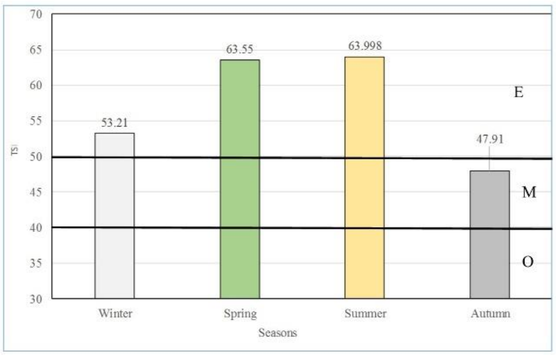

Fig. (2): Shows the Trophic Status Index for Duhok Lake Dam at Different Seasons.

References:

[1] Zbierska, J.; Lawniczak, A. E. and Zbierska, A. 2015. Changes in the trophic status of lakes Niepruszewskie (Poland). Journal of Ecological Engineering. 16(4): 65-73.

[2] Bio, A.; Couto, A.; Costa, A.; Prestes, A.; Vieira, N.; Valente, A. and Azevedo, J. 2008. Life and Marine Science. 25:77- 87.

[3] Duan, H.; Zhang, Y.; Zhang, B.; Song, K. and Wang, Z. 2007. Assessment of chlorophyll a concentration and trophic state for lake Chagan using Landsat TM and field spectral data. Environmental Monitoring Assessment. 129:295-308.

[4] Sayed, M.F. and Abdel- Satar, A.M. 2009. Chemical assessment of Wadi El- Rayan lakes, Egypt. American-Eurasia J. of Agriculture and Enivironmental Science. 5(1):53- 62.

[5] Hou, D.; He, J.; Lu, C.; Sun, Y.; Zhang, F. and Otgonbayar, K. 2013. Effect of environmental factors on nutrients release at sediment- water interface and assessment of trophic status for a typical shallow lake water, Northwest China. The Science World Journal.

[6] Carlson E. Robert. 1977. A tropical state index for lakes. Limnology and oceanography, 22:363- 369.

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

[8] Environmental Protection Agency (EPA). 2000. Ambient water quality criteria recommendations lakes and reservoirs in nutrient Ecoregion. XI Office of Water, EPA.

[9] Popovicova, J. and Celi, D. E. F. 2009. The trophic status of Prairie creek reservoir: Implications for resource management. Proceedings of Indiana Academy of Science. 118(1): 1- 12.

[10] Rahul, U.; Arvind, P. K. and Upadhyay, S. K. 2013. Assessment of lake water quality by using Palmer and trophic state index- a case study of upper lake, Bhopal, India. International Research Journal of Environmental Sciences. 2(5): 1-8.

[11] Murphy, G. P.; Shivalingaiah; Leelaja, B. C. and Hosmani, S. P. 2008. Trophic state index in conservation of lake ecosystems. The 12th World Lake Conference:840-843.

[12] Redfield, A. C. 1958. The biological control of chemical factors in the environment. American Scientist. 46:205-221.

[13] Marashoglu, F. and Gonulol, A. 2014. Phytoplankton community, functional classification and trophic state indices of Yedikir dam lake (Amasya). J. of Biology and environmaetal Science. 8(24):133-

[14] Carlson, R. E. 1983. Discussion on using differences among Carlson's trophic state index values in regional water quality assessment. Water Resources Bulletin. 19:307- 309.

[15] Elmaci, A.; Ozengin, N.; Teksoy, A.; Topac F. O. and Baskaya, H. S. 2009. Evaluation of trophic state of lake Uluabat, Turkey. J. of Environmental Biology. 30(5):757-760.

[16] American Public Health Association (A.P.H.A.). 1998. Standard methods for the examination of water and wastewater. 20th. Ed. A.P.H.A., 1015 Fifteenth Street, NW, Washington, DC. 20005-2605.

[17] Bartram, J. and Balance, R. 1996. Water quality monitoring (a practical guide to the design and implementation of freshwater quality studies and monitoring programmes). United Nation Environmental Programme- and WHO. Chapman and Hall. UK. 383p.

[18] Rahul, U.; Arvind, P. K. and Upadhyay, S. K. 2013. Assessment of lake water quality by using Palmer and trophic state index- a case study of upper lake, Bhopal, India.

International Research Journal of Environmental Sciences. 2(5): 1-8.
[19] Kratzer, C. R. and Brezonik, P. L. 1981. A Carlson- type trophic state index for nitrogen in Florida lakes. Water Resources Bulletin. 17: 713-715.
[20] Shekha Y. A.; Ismael H. M. and Ahmed A. A. 2013. Bacteriological and mycological assessment for water quality of Duhok Reservoir. Jordan J. of Biological Sciences (JJBS), 6(4):1-10.
[21] Maia, C. E. and Rodrigues, K. K. R. P. 2012. Proposal for an index to classify irrigation water quality: a case study in Northeastern Brazil. R. Bras. Ci. Solo. 36: 823-830.
[22] Chaurasia, S. and Karan, R. 2014. Assessment of water quality index and trophic state index of river Mandakini, India. International J. of Plant, Animal, and Environmental Sciences. 4(1):343- 347.
[23] Wetzel, R. G. 1975. Limnology. W.B. Saunders Company. 741p.
[24] Al- Nakshbandi, I. Z. R. 2000. A phycologicalstudy on Duhok impoundment its main watershed. PhD Dissertation- Duhok University-Iraq. 143p.
[25] Spellman, F. R. 2008. The science of water: Concepts and applications. CRC Press Taylor & Francis Group. USA. 422p.
[26] Iraqi water quality standards. 1986. Environmental legislation (Iraqi standards), Iraqi Directorate for Environment Protection and Improvement. Ministry of Health, Baghdad-Iraq.
[27] Rahmati, R.; Pourgholam, R.; Najafpour, S. H. and Doustdar, M. 2011. Trophic status of a shallow lake (North of Iran) based on the water quality and the phytoplankton community. World Applied Sciences J. 14 (Special Issue of Food and Environment):112- 120.
[28] Kara, Y.; Kara, I. and Basaran, D. 2004. Investigation of some physical and chemical parameters of water in the lake Isykli in Denizli, Turkey. International J. of Agriculture and Biology. 6(2): 275- 277.
[29] Hana, N. S. 2015. Using aquatic insects as bioindicators in water quality assessment of Bekhal (Maran), Zar Gali, and Khalan streams. MSc Thesis Salahaddin University, Erbil, Iraq.
[30] Rajab, K. S. 2015. Classification of some groundwater for irrigation purpose depending on IWQI in Erbil plain, Iraq. MSc Thesis Salahaddin University, Erbil, Iraq.
[31] Mahesh, S.; Srikantha, H.; Mohan, K. S. and Vathsala, S. 2014. Eutrophication assessment for the Dantaramakki lake of Chikmagalur city using GIS technique. International J. of Chem Tech Research. 6(1):440- 449.
[32] Santos, J. C. N.; Andrade, E. M.; Neto, J. R. A. ; Meireles, A. C. M. and Palacio, H. A. Q. 2014. Land use and trophic state dynamics in a tropical semi- arid reservoir. Revista Ciencia Agrondmica. 45(1):35- 44.
[33] Sharma, D. and Shardendu. 2012. Determination of Carlson's trophic state index of Kabar wetland of Bihar. Proc. Indian National Science Academy. 78(2): 189- 196.
[34] Chapra, S. C. 1997. Surface Water-Quality Modeling. McGraw-Hill Companies.
[35] Schidler, D. W.; Hecky, R. E.; Findlay, D. L.; Stainton, B. R.; Parker, M. J.; Paterson, K. G.; Lyng, B. M. and Kasian, S. E. M. 2008. Eutrophication of lakes cannot be controlled by reducing nitrogen inputs: results of a 37- year whole-ecosystem experiment. National Academy of Science. 105(32): 11254- 11258.

تقيم نوعية المياه و دليل الحالة التغذوية لبحيرة دهوك

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الخلاصة:
أجريت هذه الدراسة للتحقق من الحالة الغذائية لبحيره دهوك التي تقع داخل مدينة دهوك، العراق. تم جمع عينات المياه موسميا من ثلاثة مواقع تم رصدها خلال عام 2011. المعايير المستخدمة لتقييم جودة المياه ومستوى الوضع الغذائي تشمل: درجة حرارة الماء، ودرجة الحموضة، التوصيل الكهربائي، المواد الكلية الذائبة، الاوكسجين المذاب، المتطلب البايوكيماوي، المغذيات، قرص ساكي للشفافية، والكلوروفيل أ. اظهرت النتائج أن الاوكسجين المذاب كان فوق 5 ملغم /لتر في جميع المواقع، وكانت قيمة المتطلب البايوكيماوي ضمن المستوى المسموح به للاستخدامات المنزلية. نوعية المياه تعتبر من نوع العسر. تراكيز عالية للكبريتات سجلت خلال فترة الدراسة. وأظهرت الحالة الغذائية ان نوعية المياه هي متوسطة المغذيات خلال موسم الخريف، في حين أنها تعتبر غنية بالمغذيات في مواسم أخرى. وأشارت الدراسة أن نسبة النتروجين الكلي الذائب الى الفسفور الكلي الذائب و أن الفوسفور هو العامل المحدد لنمو الطحالب. بناء على دليل نوعية المياه للزراعة و تصنف المياه على أنها نوع ممتاز لأغراض الري.

الكلمات المفتاحية: دليل الحالة الغذائية، نسبة النتروجين الذائب الكلي/ نسبة النتروجين و الفسفور الكلي، بحيرة دهوك، نوعية المياه.