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Evaluation of water quality and heavy metals concentration in Lake Burullus, Egypt

Nour, A.M.[1], El-Ganainy, A.A. [2], [1]Zaki, M.A., Essa, M.A.[2] and El-Betar, T.A. [2]
1- Dept. Animal and Fish Production, Faculty of Agriculture, Alex. Univ., Egypt
2- National institute of Oceanographic and Fisheries, Egypt

ABSTRACT

Lake Burullus is located in the far north of the Nile Delta between the two branches of Damietta and Rosetta, directly on the coast of the Mediterranean Sea. The lake exposed to many environmental influences that have led to significant changes in the properties of water. The main objective of the current investigation was to provide a snapshot of water quality in the lake. Water sampling was carried out seasonally from six stations covering the three sectors of the lake. Physicochemical parameters were studied; water temperature, transparency, depth, salinity, total alkalinity, PH, DO, BOD and COD. The results of previous measurements have been found within the suitable range for freshwater fish species. According to the annual concentration values, the examined heavy metals were in the order; Zn> Cu>Pb> Cd> Ni, constituting about 12.33, 5.42, 4.97, 4.75 and 3.73µg/l, respectively.

Key words: Water quality, Heavy metals, Lake Burullus.

INTRODUCTION

Lake Burullus is located along the Mediterranean coast in the northern part of Nile Delta. It is bordered from the north by Mediterranean Sea and from south by the agricultural lands of north Nile Delta. It belongs administratively to Kafr EL-Sheikh Governorate. The lake is a Ramsar site and has been declared as a natural protectorate in 1998(NBU, 2005). It lies in a central position between the two branches of Nile: Damietta to the east and Rosetta to the west. The main basin of Burullus Lake is classified into three sectors: eastern, middle, and western, each one has some sort of homogeneity in the geomorphological, hydrological and biological characteristics (NBU, 2005). Eight drains discharge their water into the lake, mainly at its southern border. In the last few years, the lake has subjected to many environmental changes due to the huge amount of discharges originated from different sources as well as many human activities. These conditions lead to drastic changes in water quality and fish community. Results of the annual water balance indicated that the drainage water contributes about 97% (4 milliards m^3 yr^{-1}). Accordingly, this Lake seems to be distinct in terms of waste material receiving (Beltagy, 1985). Land run- off including solid materials from top soil erosion is carried out to the Lake through the drainage system.

Many authors (Beltagy, 1985; Abdel-Moati *et al*., 1988; Mahmoud and Beltagy, 1988; Abdel Moneim *et al*., 1990; Radwan, 2004; Radwan ; Shakweer, 2004) studied the pollution and water quality of Lake Burullus.The main objective of the current investigation is to monitor and reevaluate the water quality and pollution in the lake.

MATERIALS AND METHODS

Study area

Lake Burullus is a shallow, brackish lagoon, about 65km in length, varying in width from 6km to 16km, and containing about 50 islands and islets. Water depth ranges between 0.5m and 1.6m, the eastern part being the shallowest (average depth = 0.8m). The lagoon is separated from the Mediterranean along most of its length by a long sand dune bar, but is connected with the open sea by a narrow channel (about 50m wide) near the village of El Burge.

Sampling

Surface water was collected seasonally during Sep. 2014 - Oct. 2015.Water samples were collected from six stations (Fig.1) represent different basins of the lake. The latitudes and longitudes using Global Position System (Garmin GPS) for each station in the lake are shown in Tables (1). All water samples were transferred, using ice box to the laboratory, Baltim Research Station for Aquatic Resources, National Institute of Oceanography and Fisheries (NIOF), for analysis.

Water analysis

The physical and chemical parameters were analysed according to the standard methods for examination of water and wastewater (APHA, 2005). The pH was measured at 25˚C using pH meter InoLab WT level 1. Transparency (cm) was determined in the field by using Secchi disc. Dissolved oxygen (DO) concentration was determined titrimetrically according to the modified Winkler, full bottle technique (EPA, 1971).

For trace elements, Cu, Zn, Ni, Cd and Pb, the samples filtered by filtration system through membrane filter of pore size 0.45 µ and acidified with nitric acid to pH <2 before analyses.

Table (1): Latitudes and longitudes of sampling locations in Lake Burullus

Station No.	Location	Latitude (N)	Longitude (E)
1	Boughaz	31◦ 33` 29.9„	31◦ 04` 25.3 „
2	El-Zanka	31◦ 28` 52 „	30◦ 48` 37 „
3	Mastroh	31◦ 29` 9 „	30◦ 45` 24.4 „
4	Tawila	31◦ 27` 13 „	30◦ 45` 18 „
5	Abu-Amer	31◦ 25` 41 „	30◦ 40` 40.2 „
6	Front of Brinbal	31 ◦ 24` 6.3 „	30◦ 35` 0.4 „

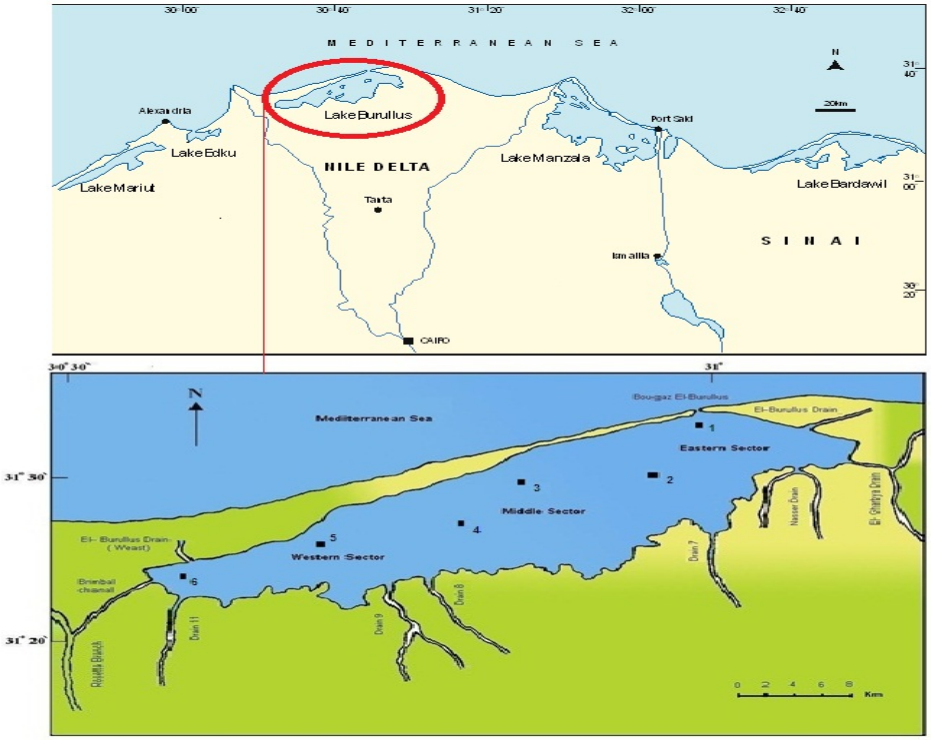

Fig. (1): Map showing Lake Burullus and sampling stations.

Statistical analysis

Arithmetic mean, Standard deviation and correlation coefficient were used in the analysis of the data obtained in this study. Raw and corrected data were compared using ANOVA. Differences between the means of the calculated parameters were tested for the different samples by one-way ANOVA and the least significant differences (LSD test) between means. The software used for the statistical analysis was Spss ver. 15 and Microsoft Excel (Office 2010) for Windows 7.

RESULTS

Physicochemical conditions of Lake Burullus water

The Physicochemical parameters of Lake Burullus water were studied seasonally and the data obtained in were shown in Table (2).

Water temperature:

From the illustrated data it was clear that water temperature varied from season to season with a maximum average value in summer (29.7°C), while the minimum average one was recorded in winter (19.9°C). According to the individual values of different stations, the maximum water temperature was recorded in station 2 (30.6°C) during summer, while the minimum one (16.3°C) was recorded during winter in station (4).

Transparency

The average secchi depths indicated that, the maximum mean value was recorded during summer, constituting about 28 cm, while the minimum one was 21.7 cm recorded during winter. Individually, the maximum transparency was recorded in station 6 (50cm) during spring, station (4) had the minimum record of water transparency (15cm).

Water depth

The field observation revealed that the seasonal mean of water column ranged between 106.7cm and 95.8cm, recorded during summer and winter, respectively. Station (5) recorded the maximum water depth during summer, constituting about 130cm, while the minimum water depth found in station (2) was 75cm during winter season. The field studying during the present investigation indicated that, Lake Burullus is a shallow basin with mean depth varied according to station and season.

Salinity (S‰)

From the illustrated data it was clear that, seasonal mean of water salinity ranged between 3.3‰ and 2.4‰ during spring and winter, respectively. Station 1() attained the maximum value of water salinity (9.6‰) during spring season, while station (6) attained the minimum one (1‰) during winter.

Hydrogen ion concentration (pH)

The seasonal mean of pH lied within a specific range, contributing about 8.36 and 8.68 during winter and summer, respectively. Concerning pH values in different stations, it was found to be ranged from 9 in station (5) and (8) in station 6 during summer and winter, respectively.

Total Alkalinity

The seasonal mean values of total alkalinity ranged between 225.8 mg/l and 314.2 mg/l during winter and summer, respectively. The highest value of total alkalinity was 335 mg/l

which recorded in station (2) during summer, while the lowest one was 198mg/l, recorded in station (6) during autumn.

Dissolved Oxygen

Through the results of seasonal monitoring it was clear that, the annual mean of DO recorded during winter, constituting about 13.3 mg/l, while the minimum one recorded during summer (7.2 mg/l). Individually, station (6) attained the maximum value of DO during winter with 14.8 mg/l, while the minimum one recorded in station (2) during summer with 6.8 mg/l.

Table (2): Physicochemical parameters of Lake Burullus water during Sep. 2014 - Oct. 2015.

Parameter / Station	Season	Air Temp.(°C)	Water Temp.(°C)	Transp. (cm)	Water depth(cm)	Salinity S‰	pH	Alkalinity (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)
1	Winter	18	16.5	25	75	7.2	8.45	215	13.6	6.2	52.0
	Spring	24.5	23.8	20	80	9.6	8.5	298	8.1	7.2	36
	Summer	29.5	28.1	35	85	7.2	8.6	255	7	4.1	68.6
	Autumn	25	24.3	30	90	8	8.4	295	11.4	12.2	61
	Mean	24.3	23.2	27.5	82.5	8.0	8.5	265.8	10.0	7.4	54.4
2	Winter	18.2	16.6	20	70	1.5	8.41	270	13.3	7.8	41.2
	Spring	24.8	23.2	18	85	2.8	8.47	250	9	7.8	43
	Summer	28	30.6	30	85	4.5	8.3	355	6.8	12.1	80.8
	Autumn	25.5	25.2	25	80	1.6	8.27	280	8.4	6.8	115
	Mean	24.1	23.9	23.3	80.0	2.6	8.4	288.8	9.4	8.6	70.0
3	Winter	17.5	17.1	15	110	1.6	8.37	260	12.8	7.1	36.7
	Spring	24.2	23.1	18	110	2	8.66	240	7.3	4.9	40.6
	Summer	29.6	29.2	25	125	2	8.77	335	7.6	13.4	92.2
	Autumn	25.8	25.8	25	115	1.3	8.7	230	9.1	7.1	73
	Mean	24.3	23.8	20.8	115.0	1.7	8.6	266.3	9.2	8.1	60.6
4	Winter	18	16.3	20	100	1.5	8.32	280	12.9	10.4	68.8
	Spring	24.7	24	25	120	1.8	8.69	289	8.8	6.2	70.2
	Summer	31.3	31	25	105	2	8.62	300	7	5.8	84.3
	Autumn	25	23	20	115	1.4	8.6	300	10.1	11.2	28
	Mean	24.8	23.6	22.5	110.0	1.7	8.6	292.3	9.7	8.4	62.8
5	Winter	18	16.6	20	115	1.5	8.60	180	13.6	5.3	32.6
	Spring	24.8	22.8	25	115	2.5	8.79	230	8.3	7.5	44.4
	Summer	30.7	29.3	25	130	2.1	9	310	7.3	9.2	86.3
	Autumn	25.5	23.5	25	110	1.4	8.68	225	9.8	8.1	103
	Mean	24.8	23.1	23.8	117.5	1.9	8.8	236.3	9.8	7.5	66.6
6	Winter	18.5	17	30	105	1.0	8.0	150	14.8	4	39.4
	Spring	25	24.7	50	115	1.1	8.3	240	9.8	11.1	79
	Summer	28.5	29.5	28	120	1.2	8.81	330	7.2	5.3	55.7
	Autumn	25.5	23	40	120	2	8.4	198	10.5	2.4	59.4
	Mean	24.4	23.6	37.0	115.0	1.3	8.4	229.5	10.6	5.7	58.4

Biological oxygen demand (BOD)

The rate of oxygen consumption by the plankton and bacteria in water was measured to determine the biological oxygen demand. The data show that, the seasonal mean of BOD in Lake Burullus Water ranged between 6.80 mg/l to 8.32mg/l, recorded during winter and summer, respectively, as well as the annual mean of BOD was 7.6 mg/l. Concerning BOD values in the examined stations, the maximum value of BOD (13.4 mg/l) was recorded in station (3) during summer, as well as the minimum one (2.4 mg/l)was recorded in station (6) during autumn.

Chemical Oxygen Demand (COD)

COD considered as an index of the organic enrichment of water, as well as its values expressing the milligrams per liter of oxygen would be necessary to oxidize completely the organic matter. The range of COD in Lake Burullus was 45.12 to 77.98 mg/l, during winter and summer, respectively. The annual mean of COD constituted about 62.13 mg/l. During spring, station (1) recorded the minimum COD value (36 mg/l), while station (2) recorded the maximum one (115 mg/l) during autumn.

Heavy metals concentrations in Lake Burullus water

Cu concentrations

The seasonal mean concentrations of Cu in Lake Burullus water obtained is shown in Table (3) and Figure (2). The maximum seasonal mean value was recorded during autumn (9.11µg/l), while the minimum one was recorded during winter (2.32µg/l). The annual mean of Cu concentrations was 5.42µg/l. The concentrations of Cu in the surface water of Lake Burullus found to be within the permissible limits (50µg/l) according to EPA (1989).

Zinc concentration

From the data obtained in Table (3) and Figue (2) it was obvious that the concentrations of Zn in Lake Burullus water ranged between 3.9 - 19.2 µg/l, with 12.33 µg/l for the annual mean. The maximum seasonal mean of Zn was recorded during autumn (14.49 µg/l), while the minimum one (9.16 µg/l) was recorded during summer.

Nickel concentration

Nickel content in Lake Burullus water ranged between 8.17µg/l and 2.1µg/l, recorded in station 4 during autumn and summer respectively (Table 3and Fig. 2). The maximum seasonal mean was recorded in autumn (5.41 µg/l) while the minimum one was found in winter (2.59 µg/l). The annual mean of Ni concentrations in Lake Burullus water was 3.73µg/l.

Cadmium concentration

Table (3) and Fig.(2) reveals the concentrations of cadmium in Lake Burullus water. Cd was presence in Lake Burullus water with a range of 1.18µg/l (station 2) and 8.71 µg/l (station 3) during winter and spring respectively. The maximum seasonal mean was 6.25 µg/l, recorded during spring, while the minimum one (2.42 µg/l) was recorded during winter.

Lead concentration

From the data obtained we can concluded that, the concentrations of lead in Lake Burullus water ranged from 2.18 µg/l in station 2 and 8.21 µg/l in station 5 during winter and autumn respectively. The seasonal mean attained the maximum value (6.58 µg/l) during autumn, while the minimum one (2.77 µg/l) was recorded during winter. The annual mean of

lead concentrations was 4.97µg/l. The highest value of Pb might be attributed to heavy agricultural run- off which contains agrochemicals.

Table (3): Seasonal concentrations of Heavy metals in Lake Burullus water during Sep. 2014 - Oct. 2015.

Parameter	Station	Season				Annual mean
		Winter	Spring	summer	Autumn	
Cu	1	2.32	5.88	4.11	7.17	4.87
	2	2.89	5.13	3.1	6.33	4.36
	3	3.18	5.55	2.18	8.16	4.77
	4	4.13	7.11	6.55	8.15	6.49
	5	7.15	6.13	5.13	9.11	6.88
	6	3.15	7.15	3.16	7.21	5.17
	mean	3.80	6.16	4.04	7.69	**5.42**
Zn	1	16.20	15.60	9.30	19.20	15.08
	2	15.10	14.13	12.67	18.30	15.05
	3	10.22	15.10	12.92	17.11	13.84
	4	11.60	13.68	10.05	10.12	11.36
	5	10.88	12.12	6.10	15.08	11.05
	6	9.16	10.30	3.90	7.10	7.62
	mean	12.19	13.49	9.16	14.49	**12.33**
Ni	1	2.30	4.15	2.38	3.88	3.18
	2	2.70	3.27	2.91	5.17	3.51
	3	2.15	6.22	4.15	3.55	4.02
	4	3.11	4.16	2.10	8.17	4.39
	5	3.17	4.18	2.18	4.55	3.52
	6	2.12	2.72	3.13	7.11	3.77
	mean	2.59	4.12	2.81	5.41	**3.73**
Cd	1	2.23	9.15	7.13	3.16	5.42
	2	1.18	5.11	5.66	3.22	3.79
	3	1.98	8.71	6.17	4.54	5.35
	4	2.61	4.13	3.15	4.50	3.60
	5	3.70	4.30	6.76	4.19	4.74
	6	2.80	6.10	5.15	8.33	5.60
	mean	2.42	6.25	5.67	4.66	**4.75**
Pb	1	2.77	5.18	4.07	6.70	4.68
	2	2.18	6.21	5.13	4.20	4.43
	3	3.15	5.52	8.11	4.75	5.38
	4	2.66	4.13	7.16	8.13	5.52
	5	2.70	5.05	4.10	8.21	5.02
	6	3.15	3.10	5.32	7.50	4.77
	mean	2.77	4.87	5.65	6.58	**4.97**

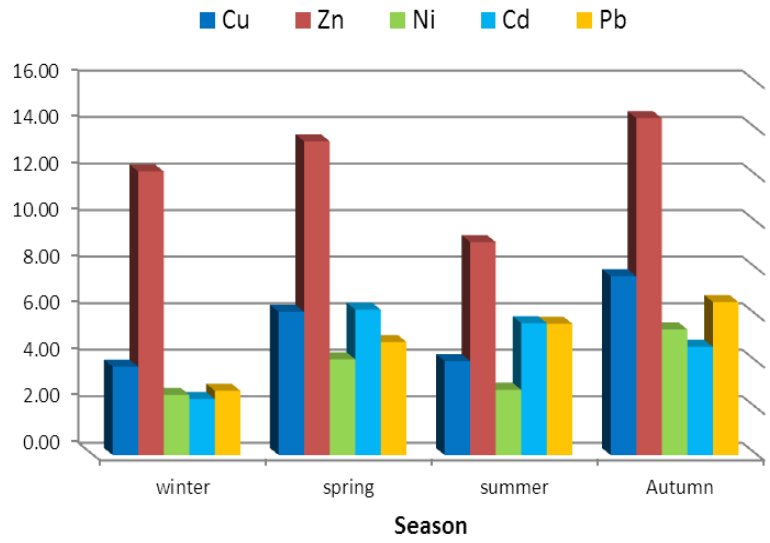

Fig. (2): Seasonal concentrations of Heavy metals (µg/l) in Lake Burullus water during Sep. 2014 - Oct. 2015.

DISCUSSION

In the present study, surface water temperature was fully compatible with air temperature ($r = 0.996$ & $P < 0.01$). Welch (1952) found that shallow water bodies attain the changes in atmospheric temperature more quickly. Fishes are very sensitive to temperature variations. The most dramatic effect of temperature is to act as a lethal agent (Fry, 1947), whereas most fish species perish in nature are caused by exposure to low temperature (Beitinger*et al*., 1999). On the other hand, few examples of fish species perish directly attributed to heat death (Huntsman, 1942 and Mundahl, 1990). Generally, surface water temperature in Lake Burullus was found to be within the safe limits for different fish species. Al-Sayes *et al.* (2007) reported that the minimum water temperature recorded in Lake Burullus was 16.2°C during winter, while the maximum one (28.5°C) was recorded during summer. Close results were recorded by Radwan (2004). The previous results were in accordance with those obtained by many authors (Radwan 2005; Darwish, 2008 and Basiony, 2014).

Concerning transparency, the lowest seasonal mean value which recorded in winter may be due to continuous disturbance of the muddy bottom by the wind blowing, in spite of the decrease in the total count of phytoplankton during the same season (Radwan, 2004). The highest mean value which recorded in summer may be due to the moderation in wind speed. Station (6) attained the maximum value which may attributed to sheltering by reed and other aquatic plants, while station (3) situated in the open water, attained the minimum value. Basiony (2014) reported that the monthly mean values of the water transparency varied between 16.5 cm in February and 47 cm in October. Radwan (2005), Al-Sayes*et al*. (2007) and Basiony (2009) reported the range of 15- 65.5cm for water transparency of Lake Burullus.

The highest value of water salinity in station (1) can be attributed to the effect of sea water through El-Boughaz opening (Lake- sea connection).On the other hand, the minimum salinity value recorded in station (6) may be due to the effect of fresh water from Brinbal canal (a canal connected the Rosetta branch of the River Nile with the western sector of Lake Burullus. The previous results were in agree to greet extend with those of El-Shinnawy

(2002) who illustrated that the annual mean of water salinity decrease from the east to the west. El- Betar (2010) studied the environmental factors which affecting on species diversity in Lake Burullus. He mentioned that among all environmental factors, water salinity appears to be the most important one affecting the distribution of fish species. Lbosvarsky *et al*. (1971) found that the largest number of fish species was caught at the Lake side of El-Boughaz opening (about 21 species). On the other hand, pure marine species were absent from the southern locations and replaced by fishes of Nile origin. This phenomenon combined with the different range of requirements towards water salinity for different fish species.

Concerning pH values, The highest seasonal value recorded during summer may be due to the increase of the total count of phytoplankton and photosynthetic activates which consuming CO_2 affecting on pH values (Fathi *et al*., 2001).The decrease in pH values during winter coincided with the discharge of brackish water and organic matter, in addition to the decomposition of plankton (Sayed, 2003). Generally, changes in pH values was in the alkaline side and within the permissible limits reported by ICMAR (1963). The best water for fish living is the neutral or slightly alkaline with a range of 7.0 to 8.0 for pH value (Huet, 1972). The maximum dangerous limit of pH various according to the differentiation in fish species and located in the range of 9.0 and 10.0 (Abdel Hakeem *et al*., 2002). The seasonal average of total alkalinity found to be correlated with the amounts of drainage water which loaded with huge amounts of sewage, organic matter and alkaline wastes. Based on the forgoing, the seasonal difference between the mean values of total alkalinity was mainly due to the differences in the amounts of drainage water which increase during summer and significantly decrease during winter and to the extend the different stations were close or far from the various drains in Lake Burullus. The total alkalinity of the Lake water was studied by many authors (Radwan, 2004; Al-Sayes *et al*., 2007; Younes, 2011 and Basiony, 2014). They reported a range of 70-500mg/l. Younes (2011) reported that the decrease of the seasonal average of total alkalinity during winter may be due to the little amounts of drainage water discharged into the Lake. Ravichardran (1985) mentioned that the sewage and its decomposition seem to be a possible cause for the higher values of alkalinity in the water. The total alkalinity has a great importance in the aquatic environments. It tells you to what extend the water pH can vary as well as the availability of carbon dioxide (CO_2). Waters of low alkalinity (< 20 mg/l) are poorly buffered, and the removal of carbon dioxide (CO_2) during photosynthesis results in rapidly rising in pH, in addition, alkalinity was not greatly affected by biological activities or aquaculture operations and the initial concentrations are determined by their level in the water supply or drains (Coche *et al*., 1996).The suitable alkalinity for fish growth ranged between 50-200 mg/l, therefore, the total alkalinity in Lake Burullus water exceed the normal range to a great extent.

The surface oxygen content differed in the Lake according to the conditions of each station. The lowest DO values during summer occurs as a result of the increase in the discharged water loaded with organic matter, which consumed the dissolved oxygen during its decomposition. The low DO concentration is associated with the increase in water temperature.Close results obtained by many authors. Radwan (2007) recorded that the annual mean of dissolved oxygen in Lake Burullus was 10.1 mg/l, as well as 9.5 mg/l during the study of Younes (2011). Basiony (2014) reported that DO of Lake Burullus was generally high in particularly at the western side than in the eastern sector, which receives the greatest wastewater effluents from four drains. Abdalla *et al*. (1991) observed a pronounced decrease of DO in Lake Mariute in summer. Abdelhakeem *et al*. (2002) mentioned that 5 mg/l of DO was suitable for a wide range of fish species.

The obtained results of BOD at different seasons, as well as in different stations revealed that, the highest value of BOD was recorded during summer (increase in water

temperature) in the eastern sector, which is characterized by the massive load of organic matters which leads to heavy demands on dissolved oxygen by the bacterial activities with high water temperature in summer. The lowest BOD value was recorded in the western sector (station 6) which affected directly by the fresh water from Brinbal canal, that reduce the water content of organic matter and bacterial load. Youns (2011) found that the highest BOD value (29 mg/l) was determined at station (2) in the eastern sector during spring, under the effect of sewage and fish farms discharges. Basiony (2014) reported the range of 6.42 mg/l to 17.52 mg/l for the mean values of BOD in Lake Burullus. Forsberg *et al*. (1996) mentioned that BOD < 20 mg/l is suitable for different fish species. Whereas, Chattopadhyay *et al*., (1988) indicated that the optimum range of BOD for fish culture was 10- 20 mg/l. Boyd (1998) reported that the higher the BOD, the greater the degree of water enrichment with organic matter.

Station (2) which recorded the maximum COD value, located in the eastern sector of Lake Burullus, which is characterized by a massive effect of 5 drains. On the other hand, station (1) (El- Boughaz) is characterized by a continuous water current from El- Boughaz opening, in addition to keeping a way from pollution sources. Basiony (2014) reported that the monthly mean value of COD in Lake Burullus water varied between 37.96 mg/l (July) and 257.89 mg/l (October). Moreover, the variation in COD values was due to the chemical decomposition of organic and inorganic contaminants, dissolved or suspended in water. The present results coincided with the range of COD (19.2- 230mg/l) reported by EEAA (2010). Boyd (1998) mentioned that the usual range of COD is 40 to 80 mg/l.

The concentrations of Cu in the surface water of Lake Burullus was found to be within the permissible limits (50µg/l) according to EPA (1989). The significant increase of Cu concentrations during autumn may be synchronized with the beginning of the agricultural cycle of winter crops which accompanied with the extensive use of the agriculture fertilizers containing copper, as well as the extensive use of copper compounds in several daily fields. Beltagy (1985) found that the concentration of copper in Lake Burullus water ranged from 0.00 to 4.0µg/l, while Younes (2011) reported a range of 0.75 to 47.5 µg/l for Cu concentration in Lake Burullus water. Another wide range was found by Basiony (2014) who reported a range of 4.42 to 77.7µg/l. From the above it was clear that, there were wide variations in the concentrations of copper in Lake Burullus water from year to another.

Zinc is an essential trace element for all living organisms. It has a significant impact on the various biological processes such as reproduction and metabolism. Zinc is bioacumulated by all organisms even in areas of low Zn (Furness and Rainbow, 1990 and Eisler, 1990). Moreover, Zn is the most harmful to aquatic life during early life stages (Eisler, 1993).The occurrence of Zn with high concentrations in Lake Burullus water was due to the discharged water containing Zn, which is widely used in many industrial purposes. In spite of this, Zn concentrations was found to be within the permissible limits (500 µg/l) according to EPA (1989). A range of 6.76- 190 µg/l of Zn in Lake Burullus water was obtained by many authors (Radwan and Shackweer, 2004; Younes *et al*., 2012; Nafea and Zyada, 2015).

Nickel is discharged into fresh water habitats through atmospheric deposition by nickel mining, smelting, industries, oil and coal burning power plants and trash incinerators (Younes, 2011). The increase of Ni concentration during autumn may be due to the intensive agricultural activities during this season, which associated with the heavily uses of chemical fertilizers and pesticides containing Ni compounds and contaminants. A range of 3.73µg/l to 4.13µg/l was reported by Radwan and Shakweer (2004). Nickel concentrations in surface water of Lake Burullus were in a safe range and within the permissible limits (10µg/l) according to EPA (1989).

The highest value of Cd during spring may attribute to the agricultural runoff, containing fertilizers, pesticides contaminants. Radwan (2000); Radwan and Shackweer

(2004); Radwan (2007); Basiony (2009); Darwish (2011) and Nafea and Zyada (2015) reported a similar range (0.005 – 7.03 µg/l) for cadmium concentrations in Lake Burullus exceed the permissible limits (2.37 µg/l) reported by EPA (1989).

Lead is one of the most prevalent types of pollutants which discharged into fresh water habitats through the industrial wastes. It belongs to the group of non-essential and toxic metals (Wagner and Boman, 2003). The highest value of Pb might be attributed to heavy agricultural run-off which contains agrochemicals. The concentrations of lead in Lake Burullus water was found to be within the permissible limits (50 µg/l) reported by EPA (1989). The previous results coincided with those of Nafea and Zyada (2015), where they reported a range of 4.3- 10.1µg/l for lead concentration in Lake Burullus water.

From the overall results we can conclude that, the concentrations of heavy metals in surface water of Lake Burullus were strongly affected by their levels in the drainage water discharged, containing high levels of different heavy metals, which varied between stations according to seasons as well as closeness or farness from lake's drains. On the other hand, except cadmium, the examined heavy metals concentrations in Lake Burullus water were found to be within the permissible limits (EPA, 1989). According to the annual concentration values, heavy metals had the order; Zn> Cu>Pb> Cd> Ni, constituting about 12.33, 5.42, 4.97, 4.75 and 3.73µg/l, respectively.

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تقييم جودة المياه وتركيزات العناصر الثقيلة ببحيرة البرلس، مصر

عبد العزيزموسي نور[1] ، عزة عبد الحميد الجناينى[2] ، محمد عبد الله ذكي[1] ، محمد عبد الرازق عيسي[2] ، تامرعطية البيطار[2]

1 - قسم الإنتاج الحيواني والسمكي- كلية الزراعة بالشاطبي- جامعة الإسكندرية

2 - المعهد القومي لعلوم البحار والمصايد

المستخلص

تعتبر بحيرة البرلس واحدة من أهم بحيرات مصر الشمالية. تقع البحيرة في شمال دلتا النيل علي ساحل البحر الأبيض المتوسط بمساحة تبلغ 460كم^2. ونظرا لأهمية البحيرة والتنوع البيولوجي الفريد بها تم إعلانها كمحمية طبيعية وكذلك إدراجها ضمن إتفاقية رامسار الخاصة بصون الأراضي الرطبة. خلال السنوات القليلة الماضية تعرضت البحيرة للعديد من المتغيرات البيئية التي أدت إلي تغيرات كبيرة في خصائص المياه والتوزيعات السمكية بالبحيرة. أجريت الدراسة في الفترة من أبريل 2014 إلي مارس 2015. بهدف التعرف علي الخصائص الطبيعية والكيميائية وكذلك تركيزات العناصر الثقيلة لمياه بحيرة البرلس. تم تجميع عينات المياه موسميا من عدد 6 محطات تمثل الفطاعات الثلاث للبحيرة. ويمكن تلخيص النتائج في الآتي:

الخصائص الطبيعية والكيميائية للمياه

تم دراسة العديد من العناصر التي يمكن من خلالها تقييم جودة مياه بحيرة البرلس بالمحطات المحددة وكانت نتائجها كالتالي ; درجة الحرارة (19,9°C – 29,7), العمق (75- 130سم), الشفافية (15- 50 سم), درجة الملوحة (1- 9,6 جزء في الألف), الأس الهيدروجيني (8- 9), القلوية الكلية(198- 335 مليجرام/ لتر), الأكسجين الذائب (6,8- 14,8 مليجرام/لتر) ، الأكسجين المستهلك بيولوجيا (2,4- 13,4 مليجرام/ لتر ، الأكسجين المستهلك كيميائيا (36- 115 مليجرام/لتر). و تبين أنها في الحدود الدولية المسموح بها لحياتية أغلب الأنواع السمكية.

تركيزات العناصر الثقيلة في المياه

تم دراسة العناصر التالية; النحاس ، الزنك ، النيكل ، الكادميوم والرصاص. وكانت المتوسطات السنوية لتركيزاتهم; 5,42, 12,33, 3,73, 4,75و 4,97 علي التوالي. وتقع جميعها في نطاق الحدود الدولية المسموح بها فيما عدا عنصر الكادميوم. ويمكن ترتيبها حسب التركيز كالتالي: زنك> نحاس> رصاص> كادميوم> نيكل.