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Impact of Physicochemical Characteristics of some Khors of Lake Nasser, Egypt

Mohamed E.F. Toufeek and Korium, M.A.

National Institute of Oceanography and Fisheries (NIOF), Aswan, Egypt

ABSTRACT

The physicochemical parameters of Lake Nasser Khors (Kalabsha, Wadi abyed, Kruosko and Toushka) were monitored during winter, spring, summer and autumn 2013. The minimum, maximum and mean ±SD in various physicochemical parameters for each Khor in different seasons were tabulated and discussed. Mean values ±SD of the parameters were: Temperature °C (19.29 ± 1.03, 27.45 ± 2.55, 29.19 ± 1.58 and 24.18 ± 1.11); Transparency cm (266.19 ± 31.13, 206.14 ± 13.23, 292.88 ± 55.46, 322.09 ± 41.99); electrical conductivity µmohs/cm (235.99 ± 11.21, 209.56 ± 9.03, 220.17 ± 6.08 and 197.38 ± 4.66); pH (8.66 ± 0.25, 8.36 ± 0.24, 8.18 ± 0.26 and 8.25 ± 0.34); dissolved oxygen mg/l (7.09 ± 1.48, 4.56 ± 1.57, 3.90 ± 1.11 and 6.18 ± 1.12); BOD mg/l (1.34 ± 0.59, 1.59 ± 1.30, 1.08 ± 0.59 and 2.65 ± 1.22) and COD mg/l (8.43 ± 2.49, 8.02 ± 4.82, 6.21 ± 3.57 and 4.16 ± 3.11) for winter, spring, summer and autumn respectively.The results of this monitoring reveal that the health status of the Lake Nasser water is very good of the natural cleaning process. Also, there does not found any pollution source on the Lake shore except small amount of agriculture wastes input in lake body which is negligible.

Key words: Lake Nasser, Physicochemical, Kores, Season

Introduction

High Dam Lake extends over an area of 500 km^2 long with northern two / third in Egypt known as Lake Nasser. It is extends within 20° 27' to 23° 58'N and 30° 07' to 33° 15' E.

Water quality refers the physical, chemical and biological characteristics of water in relation to human activity. In the other side, the water quality in Khors influence by fertilizer release from farm land around these Khors (Hooda *et al.,* 2000). Lake Nasser has a high number of Khor. 48 of them located on the eastern side and 37 of the western side (Entz, 1974). The important information of the studied Khors, Kalabsha, Wadi-Abyed, Krosko and Toushka are tabulated in Table (1).

Table 1: Some information of some Khors in Lake Nasser.

Khor	Volum (km^2)	Perimeter (km)	Length (km)	Surface area (km^2)	Average depth
Kalabsha	7.16	517	47.20	620	19.57
Wadi Abyed	1.11	184	18.30	48.7	21.85
Krosko	1.76	353	22.56	83.6	36.00
Toushka	1.44	117	15.02	66.9	16.83

The physical and chemical study could help to understanding the function of particular water body in relation to its habitants. The balance of physical and chemical properties of Lake Nasser water is essential for limnological study.

Physical and chemical properties as temperature, transparency, DO and pH value play important role in the plankton's distribution and stratification of lake. These factors with other used to determine the water quality (Trivedy *et al.,* 1985).

Water is known to contain large number of chemical elements. The interaction of both physical and chemical properties of water play a significant role in composition distribution and abundance of aquatic community (Hassan and Kathim, 2008).

The longitude and latitude in the station of Khors measured by Water quality refers the physical, chemical and biological characteristics of water human activity (Atobatele and Ugwumba, 2008 & El-Halage *et al.,* 2013). In the other side, the water quality in Khors of Nasser Lake influence by the fertilizer release from farmlands around of studied Khors. Several studied were carried in some Khors in Lake Nasser given by several authors (Toufeek, 1988, 1993 and Korium, 2001).

The physical and chemical characteristics of some lake in Africa were studied by Patil *et al.,* 2012. Some physic-chemical properties in some lakes in African recorded in Table, 2 (Ibrahim *et al.,* 2009). The water flood in High Dam Lake starts from summer to early autumn (Elewa and Latif, 1988). Recently the agriculture

Corresponding Author: Mohamed E.F. Toufeek, National Institute of Oceanography and Fisheries (NIOF), Aswan, Egypt
E-mail: m.toufeek@gmail.com

farmland founded in the shore of lake input a low amount of wastes in the lake water body at some Khors. These farmland mostly used organic fertilizer which has low contamination of water.
The present study aims to monitoring the physical and chemical parameters of the studied Khors and the effects on seasonal variation on the water quality of Khors.

Table 2: Average ± SD of Some physic-chemical properties in some lakes in African

Lake / parameter	Rujaram lake	Bhashabharm	Music depast mentle lake
Temp. C	20 ± 5.16	20.166 ± 4.98	19.0 ± 5.97
pH	7.848 ± 0.84	7.07 ± 0.490	7.708 ± 0.301
DO	3.941 ± 0.595	4.116 ± 0.445	3.93 ± 0.478

Materials and Methods

Study area:

The studied Khors lying in the northern part of Lake Nasser. The longitude and latitude in the different stations in the studied Khors are measured by using GPS and illustrated in the map (Fig. 1-4)

Sampling:

Surface and bottom water samples were collected seasonally from different stations for studied Khors, Khor Kalabsha (7 sites) Khor Wadi-Abyed (7 sites), Khor Krosko (6 sites) and Khor Toushka (6 sites).

Samples collected from each site by Van-Dorn polyethylene bottle and kept in clean plastic bottles for chemical analysis, in chemistry laboratory in Lake Nasser research station NIOF. Water temperature °C, electrical conductivity µmohs/cm and pH value were measured in the field using pH meter Model (CRISION MM40+), light penetration (transparency Cm) values obtained in the field using Un enameled seechidisk (50 cm diameter).

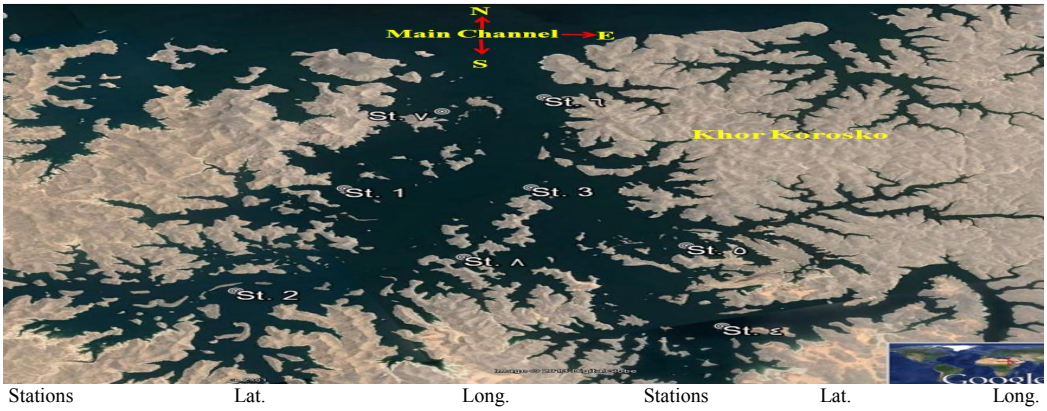
The concentration of dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand COD were measured using the titrimetric method described according American Public Health Association (APHA, 2001).

Stations Kalabsha	Lat.	Long.
St.1	23°35'8.47"	32°49'38.13"
St.2	23°31'53.85"	32°49'28.97"
St.3	23°35'36.42"	32°45'38.88"
St.4	23°33'21.71	32°45'2.83"
St.5	23°31'16.92"	32°45'3.21"
St.6	23°36'46.59"	32°41'57.74"
St.7	23°30'18.85"	32°39'19.30"

Fig.1: A map illustrate sampling station in Kore Kalabsha

Stations	Lat.	Long.	Stations	Lat.	Long.
St.1	23°21'39.62"	32°59'44.99"	St.4	23°23'15.10"	32°58'57.78"
St.2	23°20'55.56"	33° 0'1.03"	St.5	23°24'31.76"	32°58'25.59"
St.3	23°21'59.25"	32°58'53.74"	St.6	23°21'43.55"	33° 1'46.14"

Fig.2: A map illustrate sampling stations in Kore Wadi-Abyed



Stations	Lat.	Long.	Stations	Lat.	Long.
St.1	22°34'25.58"	32°17'1.72"	St.5	22°32'38.92"	32°19'8.13"
St.2	22°32'59.98"	32°15'35.51"	St.6	22°35'27.89"	32°19'4.72"
St.3	22°33'59.19"	32°18'23.37"	St.7	22°35'28.73	32°18'14.27"
St.4	22°31'15.02"	32°18'52.10"			

Fig.3: A map illustrate sampling station in Kore Korosko

Stations	Lat.	Long.	Stations	Lat.	Long.
St.1	22°37'50.12"	31°41'35.19"	St.4	22°34'25.82"	31°44'44.18"
St.2	2°36'0.97"	31°40'42.09"	St.5	22°33'14.10"	31°43'17.78"
St.3	22°35'49.49"	31°46'21.53"	St.6	22°32'1.51"	31°47'3.32"

Fig. 4: A map illustrate sampling stations in Khor Toushka

Results and Discussion

Frequencies and mean ±SD of seasonal variation in different stations for studied Khors; temperature, transparency, electrical conductivity, pH value, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD) are tabulated in Tables (4-10).

Table 4: Minimum, maximum and mean± SD of temperature C in studied Khors of Lake Nasser

Season	Winter			Spring			Summer			Autumn		
Khore	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	17.0	19.7	18.35 ± 0.865	21.9	29.7	26.61 ± 2.47	25.4	30.4	28.52 ± 1.34	22.8	27.2	24.87 ± 1.43
Wad.	18.4	22.2	19.85 ± 1.01	22.6	29.6	26.21 ± 2.22	24.3	30.8	28.73 ± 2.41	21.3	24.9	23.57 ± 1.34
Kros.	18.1	22.3	20.28 ± 1.37	21.9	31.4	27.9 ± 3.32	26.2	31.7	29.95 ± 1.50	23.4	26.4	24.85 ± 1.04
Toush.	17.5	20.6	18.68 ± 0.87	25.3	31.6	29.07 ± 2.19	28.2	31.3	29.57 ± 1.06	22.7	29.9	23.43 ± 0.64

Kala. = Kalabsha; Wad. = Wadi-Abyed; Kros. = Krosko and Toush. = Toushka.

Table 5: Minimum, maximum and mean± SD of transparency Cm in studied Khors of Lake Nasser.

Season	Winter			Spring			Summer			Autumn		
Khore	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	250	370	291.93±42.59	180	220	196.67±20.82	300	430	360.71±52.31	250	420	366.7±61.30
Wad.	24	350	286.67±49.26	225	250	234.17±9.17	320	470	358.33±58.28	260	400	352.5±63.97
Kros.	180	280	230±32.66	180	220	208.75±12.46	140	375	252.5±82.29	300	380	357.5±25.5
Toush.	220	320	256.67±37.24	170	200	185.0±10.99	170	240	200±28.98	190	240	211.67±17.22

Table 6: Minimum, maximum and mean± SD of electrical conductivity µmohs/Cm in studied Khors of Lake Nasser.

Season	Winter			Spring			Summer			Autumn		
Khors	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	213	260	236.85±12.67	201.0	232	215.93±8.96	197.7	222	209.41±6.83	195.5	211	203.24±5.68
Wad.	210	255	236.07±11.95	195.6	243	209.97±14.09	203.0	224	213.75±5.92	196.3	206	199.7±3.41
Kros.	215	260	237.14±13.11	194.3	219	203.67±7.24	212.0	238	226.12±7.69	187.7	202	195.4±5.71
Toush.	220	245	233.92±7.12	198.0	219	208.67±5.83	224.0	237	231.42±3.91	187.6	201	191.19±3.87

Table 7: Minimum, maximum and mean± SD of pH value in studied Khors of Lake Nasser.

Season	Winter			Spring			Summer			Autumn		
Khors	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	8.62	9.37	8.85 ± 0.18	7.89	8.59	8.26 ± 0.23	7.21	8.33	8.01 ± 0.28	7.98	8.53	8.27 ± 0.18
Wad.	8.15	8.86	8.62 ± 0.22	8.13	8.81	8.51 ± 0.198	7.54	8.32	8.02 ± 0.25	7.73	8.45	8.19 ± 0.23
Kros.	8.0	9.33	8.61 ± 0.43	7.72	8.72	8.41 ± 0.31	7.78	8.86	8.28 ± 0.37	7.31	8.37	7.91 ± 0.30
Toush.	8.32	8.90	8.59 ± 0.19	7.64	8.61	8.29 ± 0.24	8.21	8.65	8.42 ± 0.14	8.49	8.77	8.63 ± 0.65

Table 8: Minimum, maximum and mean± SD of dissolved oxygen mg/l in studied Khors of Lake Nasser.

Season / Khore	winter			Spring			Summer			Autumn		
	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	5.7	8.5	7.60 ± 2.28	2.0	8.4	4.70 ± 1.97	1.9	5.0	4.15 ± 0.84	6.0	7.8	6.50 ± 0.50
Wad.	5.8	8.2	6.92 ± 1.03	2.3	6.2	4.87 ± 1.54	0.9	5.5	3.72 ± 1.36	1.4	7.3	5.42 ± 1.77
Kros.	5.2	8.1	6.82 ± 1.06	1.9	6.3	4.32 ± 1.55	1.6	5.7	3.49 ± 1.57	2.5	7.2	5.10 ± 1.62
Toush.	6.4	8.2	7.53 ±1.55	1.7	6.0	4.36 ± 1.29	3.0	5.0	4.27 ± 0.67	6.8	8.4	7.73 ± 0.57

Table 9: Minimum, maximum and mean± SD of BOD mg/l in studied Khors of Lake Nasser.

Season / Khore	winter			Spring			Summer			Autumn		
	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	0.6	1.9	1.26 ± 0.45	0.0	4.5	1.47 ± 1.49	0.0	1.9	1.08 ± 0.48	0.0	2.2	1.40 ± 0.83
Wad.	0.2	1.9	1.20 ± 0.70	0.0	3.5	2.28 ± 1.27	0.3	2.2	1.08 ± 0.59	2.0	2.7	2.35 ± 0.49
Kros.	0.4	1.8	1.07 ± 0.45	0.1	3.5	1.60 ± 1.27	0.0	2.5	0.81 ± 0.74	1.3	5.5	2.98 ± 1.75
Toush.	0.8	2.8	1.84 ± 0.76	0.0	4.2	1.03 ± 1.19	0.4	2.1	1.34 ± 0.55	1.4	6.4	3.87 ± 1.82

Table 10: Minimum, maximum and mean± SD of C OD mg/l in studied Khors of Lake Nasser.

Season / Khore	winter			Spring			Summer			Autumn		
	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Kala.	6.4	14.4	9.3 ± 2.0	4.0	20.0	9.51 ± 4.68	0.8	10.4	5.13 ± 3.53	1.6	18.1	5.70 ± 4.98
Wad.	4.0	16.8	7.6 ± 2.34	2.4	22.0	10.0 ± 7.67	1.6	18.4	7.63 ± 4.67	0.0	8.0	3.30 ± 2.85
Kros.	3.2	11.2	7.6 ± 2.39	2.4	15.2	6.65 ± 3.76	0.0	7.20	4.02 ± 2.30	0.0	5.60	2.20 ± 1.95
Toush.	4.0	10.4	7.7 ± 2.25	1.6	12.0	8.93 ± 3.17	3.2	16.0	8.09 ± 3.79	0.0	9.60	5.47 ± 2.68

Temperature:

The lowest value 17 °C was recorded in bottom water layer of Khor Kalabsha during winter while the highest value 31.7 °C found in the surface layer of Khor Krosko during summer. There no wide variation (homothermal condition) during winter while the high differences of more than 10 °C between surface and bottom water layer during summer, leads to formation stratification in water column especially in northern part of Lake Nasser. The fundamental observation that the stratification starts to break down during autumn in southern part of Lake Nasser (Khor Toushka), which the mean value of oxygen was high (7.73 ± 0.57) and the temperature difference at Khor Toushka is small (2.2 °C). water temperature was strongly negatively significant

with dissolved oxygen (r = -0.92) where oxygen depleted during summer in bottom layer especially in northern part of lake.

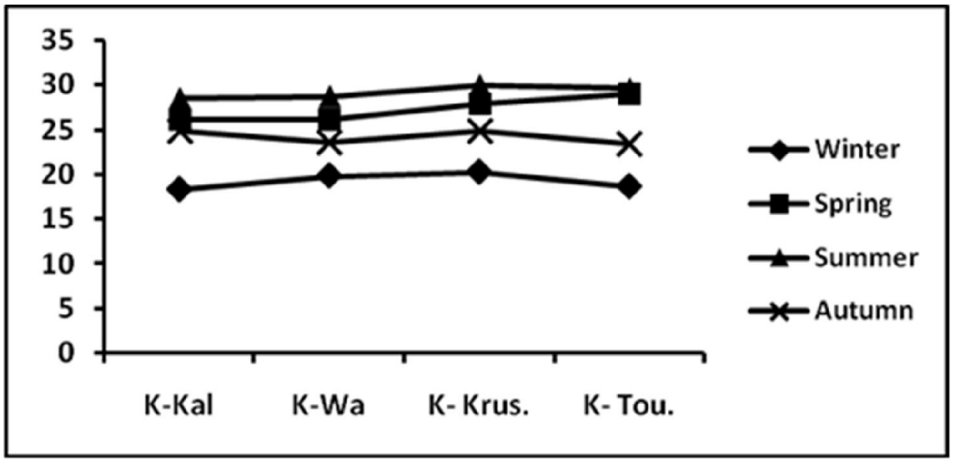


Fig. 5: Seasonal water temperature in Khors in Lake Nasser

Electrical conductivity (E.C):

The maximum value was (260 µmohs/cm) recorded in Khor Kalabsha during winter as compared with the minimum value (187.6 µmohs/cm) found in southern part of lake (Khor Toushka) during autumn.

The available data shown that EC values was lower in southern Khors (Toushka and Krosko) than its values present in northern Khors (Kalabsha and Wadi-Abyed) during autumn. The relative high EC values were recorded during summer with average (220.17 ± 6.08 µs/cm) before the flood period and low during autumn at the end of flood with mean value of (197.38 ± 4.6 µs/cm). The decrease in EC value during autumn, related to the flood water has a low dissolved salt and high suspended particles. Where the Blue Nile water which contributes 80% of total Nile flood has low E.C. value (Elewa, 1980 and Aboul Atta, 1998).

The high values were recorded in winter may be due to the drop of water level during this season. On the other side, the low E.C. value found during spring (209.5 ± 9.03 µs/cm) may be due to uptake of dissolved salts by plankton, algae and other organisms (Ovie and Adeniji, 1993 & Kolo and Oladimeji, 2004) where its flourished during this season in Nasser Lake. The higher EC value in Lake Nasser during winter could be attributed to reduce of water level and decrease of water volume (Kolo and Oladimeji, 2004).

According to Meade (1989), the desirable EC value for pond fish culture is ranged between 700-2500 µmohs/cm. In the present study in Lake Nasser is acceptable where it ranged between 187.6 and 260 µmohs/cm during the period of study (Table).

In general, EC value is functional of income dissolved salts in water. Also, chemical and biological processes.

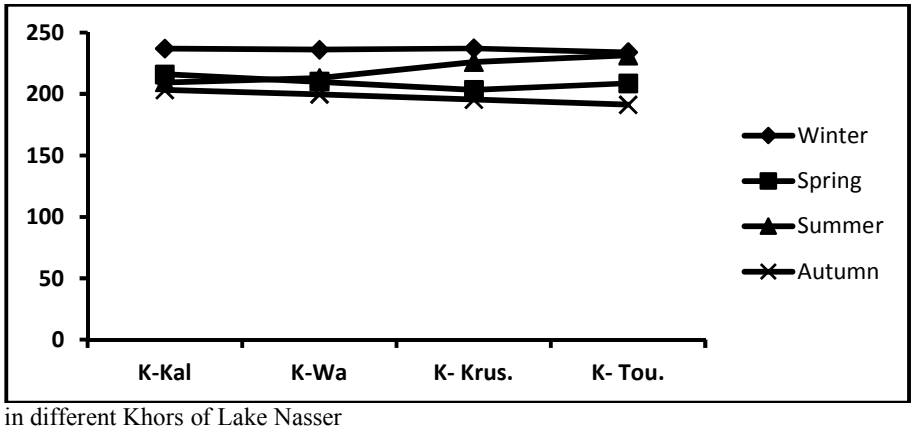


Fig. 6: EC in different Khors of Lake Nasser

Transparency:

Transparency value is a function of turbidity. Transparency level in the studied Khors were ranged between 180 -370, 170 – 250, 140 – 470 and 190 -420 cm within the total average 266.19 ± 31.13, 206.14 ± 13.23, 292.88 ± 55.46 and 322.09 ± 41.99 during winter, spring, summer and autumn respectively. The highest

values were recorded in northern Khors (Kalabsha and Wadi-Abyed) during autumn as compared with the lowest values found in southern Khors (Krosko and Toushka) during spring and summer.

Light penetration is mostly higher in the main channel water than values found in the Khors. This is mainly ascribe to the abundance of the green algae present in the Khors.

The minimum average value was 185 ± 10.49 µs/cm recorded in Khor Toushka in southern part of lake in spring, while the maximum average value 366.7 ± 61.30 recorded during autumn in Khor kalabsha in southern part of lake. The decrease in transparency value measured during spring attributed to autochthonous organic turbidity caused by phytoplankton Uooms of the blue green algae, reduce the light penetration to reach a minimum average value in Khor Toushka. In contrast, the increase value of transparency was detected in autumn mainly related to diminish of the phytoplankton consequently the light penetration increases. The obtained data reveal that the transparency in southern Khors were lower than the values found in northern Khors especially in summer and autumn. Due to income of turbid flood water is confined only to the southern part of lake, this is leads to decrease in transparency value.

Hydrogen ion concentration (pH value):

Hydrogen ion concentration (pH) is one of the most important used as test of water chemistry. The values depend on combination factors as water temperature, photosynthetic activity and dissolved oxygen content.
Seasonal values of pH of studied Khors were: Winter 8.66 ± 0.25 (range 8.0 to 9.37); spring 8.36 ± 0.24 (range 7.60 to 8.81); summer 8.18 ± 0.26 (range 7.21 ± 8.86); autumn 8.25 ± 0.34 (range 7.31 to 8.77). The maximum pH values were recorded during winter and spring while the minimum values found in summer and autumn. Also, the highest values present in upper water layer as compared with the lowest values in bottom layer especially during summer especially in northern Khors (Kalabsha and Wadi-Abyed). No wide variation in pH values for different studied Khore while it detected high values during spring especially in Khor Wadi-Abyed and Krosko. The high pH value related to the increase photosynthetic activity. The high pH value recorded in Khor Toushka during autumn and summer. This is may be related to the high nutrient salt during flood period consequently high primary production (Sayaah *et al.,* 1988).

Santhosh and Singh, 2007 and Anita *et al.,* 2013 stated that the acceptable pH range for fish culture 7.0 to 9.5 while the ideal pH value lies between 6.5 and 9.0 and stress pH range (0 < 4 and > 12).

The obtained data from our study is accepted. WHO (2004) for drinking water reported that the ideal pH ranges between 7 to 8.0 while the permissible range from 6.5 to 9.2 for different aquatic life. pH is a strong positively significant with BOD (r = 0.712). This mean that an increase in pH value lead to an increase in organic contaminate in water (Gao *et al.,* 1988). pH value has negatively significant with temperature (r = -0.884), COD (r = -0.51). This is may be due to the degradation of organic materials increases with increasing water temperature.

Low pH value during autumn summer especially in bottom water layer in northern Khor probably related to the decrease of phytoplankton density consequently limiting factor in productivity than high pH. And due to the decomposition of organic matter leads to decrease in pH value. During winter and spring pH values increase from south (Khor Toushka) to north (Khor Kalabsha and Wadi-Abyed). In contrast, in summer and autumn where pH value decrease from south to north direction. From available data conclude that no variation in pH values of lake water from 1987 to 2013, although the different factors and recently agriculture wastes input in lake body at same sites of Lake Nasser .

Ranges of pH values in Lake Nasser from 1987 to 2013.

Year	1987	1990	1993	2006	Present study
pH range	7.05-9.20	7.17-8.94	6.98-9.27	7.80-9.50	7.21-9.37

Toufeek, 1988; abd El-Rahman, 1990.

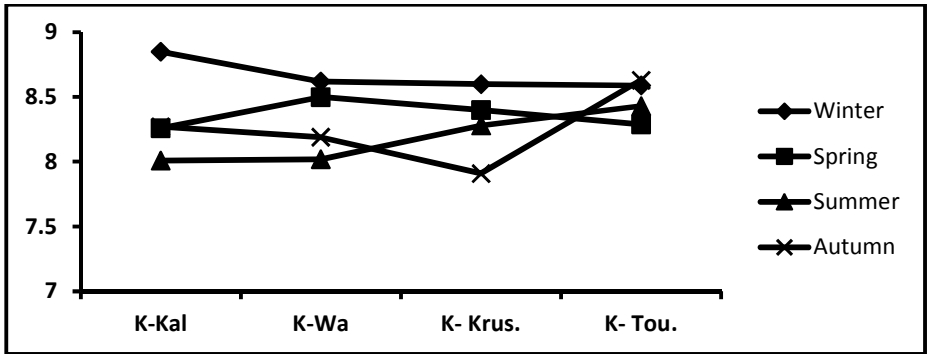


Fig. 7: pH value in different Khors of Lake Nasser

Dissolved oxygen (DO):-

The mean values of dissolved oxygen were 7.09 ± 1.48, 4.56 ± 1.57, 3.90 ± 1.11 and 6.18 ± 1.12 mgl^{-1} during winter, spring, summer and autumn respectively. The highest value was 8.5 mgl^{-1} recorded in surface water Kalabsha during winter as compared with the lowest value 0.9 mgl^{-1} recorded in bottom layer in Khor Wadi-Abyed during summer. The low DO especially in bottom layer in different Khors due to depletion of oxygen demand for the decomposition of organic matter during summer.

In turn, the decrease in DO during the hot period considered a normal results, as the amount of free oxygen decreases with the increase of the temperature (Opream *et al.,* 2007).

This is a good agree with the strongly negatively correlated between DO and temperature (r = -0.92) during the period of study. DO values were high during winter and spring in different Khors, mainly related to the high rate of photosynthesis during these period.

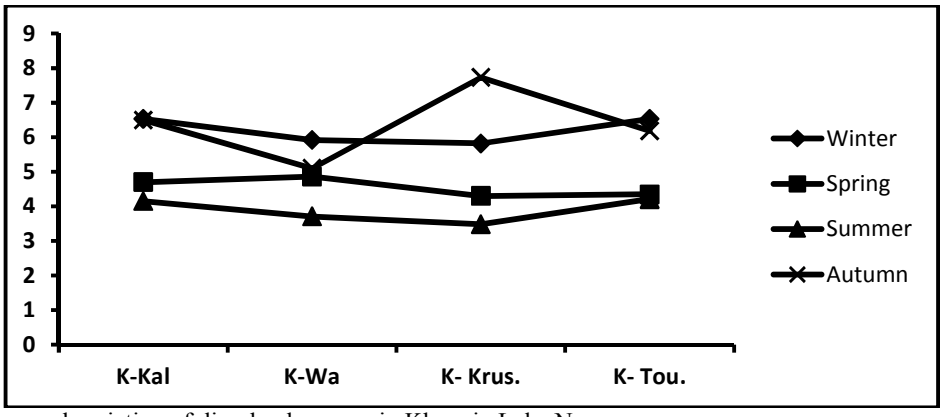


Fig. 8: Seasonal variation of dissolved oxygen in Khors in Lake Nasser

Biological oxygen demand (BOD):

Mean values BOD were; winter 1.34 ± 0.59 (range 0.2 to 2.8 mgl^{-1}), spring 1.59 ± 1.30 (range 0.0 to 4.5 mgl^{-1}), summer 1.08 ± 0.59 (range 0.0 to 2.5 mgl^{-1}) and autumn 2.65 ± 1.22 (range 0.0 to 6.4 mgl^{-1}).

The BOD value has a reversible relation with temperature (r = -0.61), due to the depletion of free oxygen resulted the increasing of water temperature where the lowest value was recorded during summer in different Khors under study. In contrast, the high BOD values measured during autumn and spring may be due to the low activity microorganisms. While the low value obtained in summer may ascribed to the presence of dead microorganisms in water not be able to perform aerobic biochemical oxidation of organic material during summer stagnation and low oxygen content.

According to Ekubo and Abowei (2011), the aquatic system with BOD levels between 0.1 – 2.0 mgl^{-1} considered clean; 3.0 mgl^{-1} fairly clean; 5.0 mgl^{-1} doubtful and 10 mgl^{-1} definitely bad and polluted. While Meade 1989 reported that the BOD values in fish pond must be not more than 5.0 mgl^{-1}.

From available data concluded that the Lake Nasser Khors water is very good and accepted for drinking and fish culture.

BOD value had strongly positively correlated with pH, EC, DO and COP (r = 0.712, 0.756, 0.871 and 0.662) respectively, while it had negatively correlated with temperature (r = -0.611). Generally the BOD value depends on temperature organic matter and density of phytoplankton.

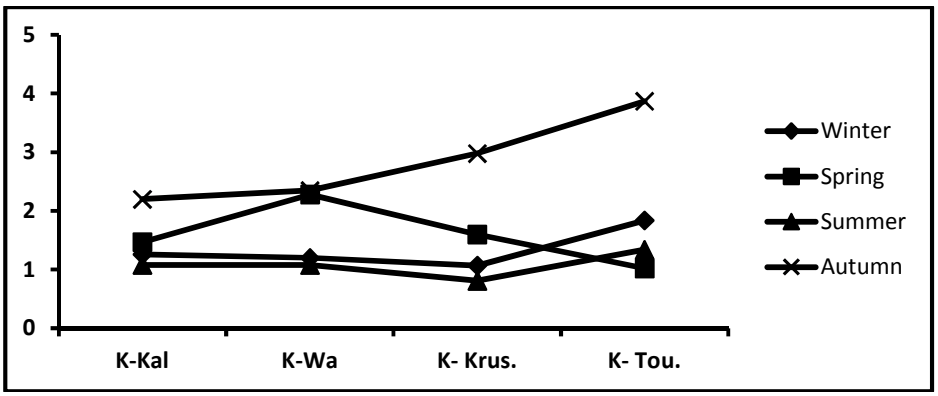


Fig. 9: BOD values in different Khors of Lake Nasser

Chemical oxygen demand (COD):

The total organic matter is functional of chemical oxygen demand (COD).The mean values of COD in the studied Khors were 8.43 ± 2.49 (range 3.2 to 16.8 mgl^{-1}); spring 8.02 ± 4.82 (range 1.6 to 22.0 mgl^{-1}); summer 6.21 ± 3.57 (range 0.0 to 18.4 mgl^{-1}) and autumn 4.16 ± 3.11 (range 0.0 to 18.1 mgl^{-1}).

The highest values were measured in oxygenated seasons (winter and spring) as compared with the lowest values found when oxygen depleted at summer stagnation during summer and autumn. This good explained the reversible relationship between COD with temperature (r = -0.521) and positively correlated with DO and BOD (r = 0.718, 0.662). This means that COD is functional with both DO and BOD (Jordao *et al.,* 2002 and Al Afify, 2006).

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